

STATUS OF CENTER ACER' S RESEARCH PROJECTS AND RELATED ACTIVITIES 2007

PROJECT 330 STUDY ON THE IMPACT OF THE USE OF AIR INJECTORS ON MAPLE SYRUP PROPERTIES (PHASE 2)

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 various packaging and storage conditions.

A preliminary study (Project 329-Phase 1) evaluated syrup from 17 producers using air injectors and 17 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 syrup from 4 producers using early, mid and late season sap, in extremely well controlled lab conditions to ensure that all effects measured were directly attributable to the air injector process.

The study was designed to answer which hypothesis prevailed for the changes observed:

Mechanical action?

Lower temperature causing a reduction or delay in caramelisation and Maillard reactions?

Oxidation?

Experimental design included:

- control (no injection),
- 0% oxygen - 100% nitrogen injection,
- 10% oxygen - 90% nitrogen injection,
- 21% oxygen - 78% nitrogen injection (air)

There were 3 parts to this study:

Fundamental aspects: Does air injection contravene Quebec's provincial regulation forbidding the use of decoloring, bleaching and refining processes in maple syrup?

Impact on product characteristics: What effect do air injectors have on physical and sensory attributes such as color, taste, PH, Brix, dissolved oxygen, oxidative-potential reduction, organic acids, sugar and phenolic compound profiles, etc.?

Impact on conservation: What is the stability of air injected syrup in different packaging materials and with regards to long term storage?

Findings: Physical changes observed cannot be attributed to mechanical action or delayed caramelisation and Maillard rx.

Injection of air in maple syrup produces a number of complex chemical reactions.

It appears that proportional to the oxygen introduced, hydroperoxides are formed in-situ and oxidize the following:

- color producing compounds such as furfural and HMF associated with the caramelisation process
- melanoidins, Maillard reaction by-products
- Colored polymers

Thus a decoloring and bleaching effect is observed for early and mid season syrup. For late season syrup, this bleaching effect is considerably reduced due to the much higher rate of production of Maillard reaction by-products (highly colored) compared to the lower rate of production of hydrogen peroxide.

A number of different sensory evaluations conducted all point to higher prevalence of off-flavors in air injected samples and a diminution of the characteristic flavors.

No effect on conservation was detected amongst air-injected samples, except for the original difference obtained upon their production. Subsequent trend in stability followed the same pattern as the control syrup.

Status: All experimental work completed. A final report to follow. A presentation to industry and regulatory officials at the provincial and federal level is scheduled.

PROJECT 804 A SCIENTIFIC APPROACH TOWARDS A NEW CLASSIFICATION OF MAPLE SYRUP AS SUPPORT TO A REVISED NORTH AMERICAN REGLEMENTATION

- Phase 1: Analysis of data generated in development of maple flavor wheel project was used to verify color-taste link.

Findings: Color was related to the development of the confectionary and empyreumatic flavors, however, maple and vegetal (woody) flavors were independent of color. A 2 dimensional concept was required to adequately describe taste in maple syrup.

- Phase 2: Validation of Phase 1 results with more representative sampling across North America

Findings: Same results as Phase 1

- Phase 3: Support for the Consumer study to verify consumers ability to discriminate between taste (intensity and flavor) and to pick meaningful taste descriptors

Status: Currently in preparation

PROJECT 388 SCIENTIFIC BASES IN SUPPORT OF A NEW NORTH AMERICAN CLASSIFICATION OF MAPLE SYRUP

This project is the fundamental research component in identifying the chemical profiles of newly defined categories based on taste and color (Phase 4). These new categories will have previously been 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 and validation of consumer perceptions (Phase 1 to 3). 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 AAC and McGill University. Analysis of the second year of sampling is currently underway. This project will be completed by early 2009.

PROJECT 437: PRELIMINARY STUDY USING SPECTROSCOPY AS A RAPID TOOL TO EVALUATE PRODUCT ATTRIBUTES

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.

Status: Preliminary study is in completion phase. New project anticipated for 2008

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

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.

PROJECT 331: IMPROVING THE CONSERVATION OF MAPLE SAP BY MEANS OF MICROFILTRATION

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.

PROJECT 741 TOWARDS SUSTAINABLE DEVELOPMENT OF MAPLE SUGAR BUSHES: 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 is to validate and update the existing tapping guidelines. This will be done by comparing 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 will be determined. Recommendation for new guidelines will be made if need be from a sustainability point of view, to industry and regulating bodies.

The installation of the set up was put in place at Centre ACER's experimental maple bush in 2006. 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.

So far, although analysis is still incomplete, the use of three or four tapholes is questionable from a yield perspective.

The project will be pursued for a second year and final results and report will be available at the end of 2008.

PROJECT 517 STUDY OF THE RELATION BETWEEN TAPPING DATES ON MAPLE SAP VOLUME AND SUGAR PRODUCTION

This study examined the impact of tapping in January, February and March to asses the impact on maple sap volume, sugar content and total syrup production. This 4 year study has been completed and a final report is available.

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

The objective of this project was to examine the relation between tree dimensions such as diameter, height, crest volume and diameter, growth rates, etc. versus sap volume, sugar content and total syrup production. This 3 year study conducted on 2 separate sugar bush sites has been completed and a final report is available.

PROJECT 802 STUDY ON THE PRINCIPAL VARIABLES ASSOCIATED WITH THE MICROBIAL DETERIORATION ENCOUNTERED IN BULK MAPLE SYRUP

This study examined data pertaining to over 50,000 barrels of bulk maple syrup and was able to account for approximately 75% of the fermentation occurring during storage. A final report is available.

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

This is a joint project with University of Laval which initiated in 2005. The main objective of this fundamental research is to identify the sap microflora and relate it to sap composition and syrup properties. Results illustrate the progression of different classes of microorganisms in sap as a function of the season for sap from 23 producers in 6 regions in Quebec (corresponding syrup samples also collected). The aerobic psychotrope bacteria dominate the others classes studied. several new bacteria species never before detected were identified. With regards to the sap chemical composition, saccharose tends to diminish towards the end of the season, whereas other sugars increase proportionally beyond mid-season. These are the reducing sugars, glucose and fructose which come from microbial degradation of saccharose and one other unidentified sugar as of yet. The phenol analysis in the maple syrup samples, although still incomplete indicate that vaniline, coniferol and syringaldehyde are the main components. Vaniline concentration appears to diminish as the season advances while coniferol and syringaldehyde seems to increase. The organoleptic analysis of the syrup samples is currently being conducted.

PROJECT 433 EVALUATION OF RAPID ANALYSIS INSTRUMENTS FOR THE MEASUREMENT OF MICROBIAL CONTAMINATION OF MAPLE SAP

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 the application of the method and the interpretation of the results.

PROJECT 436 STUDY OF THE MICROFLORA OF MAPLE SAP AND BIOFILM RESISTANCE TO SANITATION TREATMENTS OF MAPLE SAP LINES

Several scientific publications have resulted from this study to date:

Lagacé et al, 2004 Identification of the bacterial community in maple sap by using amplified ribosomal DNA(rDNA) sequencing. Applied and Environmental Microbiology 70-2052-2060 (April 2004).

Lagacé et al, 2005 Biofilm formation and bacterial community dynamic in maple sap collection system evaluated by scanning electron microscopy and denaturing gradient gel electrophoresis. International Journal of Food Microbiology.

Lagacé et al. 2006 Biofilm formation and Biocides Sensitivity of Pseudomonas marginalis Isolated from a Maple Sap Collection System. Journal of Food Protection, Vol. 69, No. 10, Pages 2411 to 2416.

PROJECT 481 BIOFILM FORMATION ON THE SURFACE SAP COLLECTION SYSTEMS

The study has been completed and the final report is available.

PROJECT 482 EVALUATION OF THE EFFICIENCY OF VARIOUS ANTI-MICROBIAL AGENTS IN CONTROLLING MICROBIAL GROWTH ON TAPS

The study has been completed and the final report is available.

PROJECT 384 CHARACTERIZATION OF PHENOLIC AND FLAVONOID COMPOSITES IN MAPLE PRODUCTS AND THEIR HIGH VALUE-ADDED PROPERTIES

This project was conducted jointly between Center ACER, McGill University (Dr. S. Kermasha) and l'INRS-Institut Armand Frappier (Dr. Monique LaCroix). This fundamental research project has been completed, two Master theses have been completed and various conferences have been given. A scientific publication is in preparation. Both maple sap and syrup were analyzed and found to have antioxidant and anti-mutagenic properties.

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

This literature review is available.

PROJECT 641 STUDY OF THE INTENSITY AND DISTRIBUTION OF THE THERMAL FLUX PATTERN OF A MODEL EVAPORATOR AND ITS IMPACT ON MAPLE SYRUP PROPERTIES

The conception phase is complete and the fabrication of the model evaporator is 90% completed.

PROJECT 153 TRAINING PROGRAM FOR MAPLE CONSULTANTS AND EXTENSION PEOPLE

A series of 2 day workshops (7 in all) are scheduled to take place between 2005 and 2007 to update extension personnel with their expertise. The course material is based on the recently published technical manual entitled "Cahier de Transfert Technologique en Acériculture" (CTTA). To date, 5 modules have been given and the last session comprising of modules 6&7 will be delivered at year end.