Maple Syrup Digest

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Does Reverse Osmosis Change Syrup Flavor?

How Does NASS Work?

The Newsletter of the North American Maple Syrup Council


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Greetings from your President

As you read this issue of the *Maple Digest* the joint annual meeting of the North American Maple Syrup Council and the International Maple Syrup Institute will be upon us. Among the topics to be discussed will be the International Maple Month. Dave Chapeskie, Mike Girard and their committee have been formulating plans for this upcoming event to promote maple production.

NAMSC will be welcoming the maple producers of West Virginia as they will be joining our organization. I look forward to meeting these new faces in Pennsylvania. The next issue of the *Maple Digest* will report on the proceedings of our meetings.

During the past year the officers and directors of NAMSC have conducted periodic teleconferences to stay abreast of maple issues. These electronic meetings have allowed communication to continue beyond the annual October meeting. These beneficial teleconferences are convenient and less costly than meeting at a central location. Winton Pitcoff and Karl Zander have been instrumental in organizing these hook-ups.

With Best Regards,
Dave Hamilton, NAMSC President

Cover photo: Drawing off at Justamere Tree Farm in Worthington, Massachusetts. *Credit: Marian Welch.*

In this issue...

The Federation of Quebec Maple Syrup Producers presents
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Maple News

Effects of Sap Concentration with Reverse Osmosis on Syrup Composition and Flavor

A summary of experiments conducted at the University of Vermont Proctor Maple Research Center

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Sugar Processing Research Institute, Inc.

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Concentrating maple sap with reverse osmosis (RO) significantly increases the efficiency and profitability of processing sap into syrup by reducing the amount of both fuel and time required to concentrate the material to syrup density in the evaporator. However, because this also reduces the amount of time sap is processed in the evaporator, and since most of the reactions from which the flavor and color properties of maple syrup are ultimately derived occur as sap is processed with heat in the evaporator, it is possible that this could result in impacts on the finished syrup, causing it to differ from syrup produced with raw sap. Previous investigations of the effects of RO were limited to small quantities of syrup produced through batch boiling in the laboratory, conditions which do not necessarily well replicate those that occur during processing in an evaporator (Morselli *et al.* 1982, Sendak and Morselli 1984). It is imperative to determine the effects that RO might have under realistic processing conditions, as any gains in efficiency would be nullified by any possible negative impacts on syrup quality. Thus, between 2008 and 2011 we conducted a series of controlled experiments performed with commercial maple equipment to investigate the potential effects of the use of RO on the composition, properties, and flavor of the maple syrup produced. The following is a brief, general summary of these experiments and the results observed. More comprehensive descriptions of each study can be found in the scientific journal articles published for each.

All experiments were conducted in the Maple Processing Research Facility at the University (MPRF) of Vermont Proctor Maple Research Center in Underhill Center, Vermont (UVM-PMRC) (Figure 1).

Experiment 1 – Comparison of syrup made from raw sap and 8% concentrate

This experiment was conducted to investigate the fundamental effects of concentrating sap with RO on the properties, composition, and flavor of maple syrup, and to determine if any significant differences exist in syrup made from raw and concentrated sap. To accomplish this, we conducted an experiment in which syrup was produced simultaneously from raw sap and from

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8% concentrate made from this same raw sap, using identical equipment and processing conditions.

Methods

During each trial of the experiment, raw sap flowing into the sap collection area was collected and segregated into a separate tank. Once collected, 300 gallons of this raw sap was set aside, and another portion was immediately concentrated to generate 300 gallons of 8% concentrate using a CDL RO unit equipped with seven, 8″ × 40″ Fluid Systems TFC 8923 S-400 membranes. The raw sap and concentrate were then immediately transported to the MPRF at UVM-PMRC and placed into separate stainless steel tanks that each fed one of two identical, 3 × 10′ Dallaire Model Deluxe, raised-flue, oil-fired evaporators (Figure 1). Both evaporators were equipped with automatic draw-offs and sap level regulation, and were configured to process sap as similarly as possible, with equal oil burner and exhaust draft settings. The evaporators were started simultaneously and run continuously until the supply of available material for each was consumed (~3-3.5 hrs). All syrup produced by each evaporator after the first hour of processing was collected separately and filtered through synthetic cone filters. After the experiment was complete, samples of syrup produced with each treatment were frozen for subsequent analyses. This experiment was repeated on 6 days during the 2011 maple production season (3/18, 3/21, 4/1, 4/2, and 4/8). At the end of each trial, connections between evaporator pans were plugged with rubber stoppers to minimize disruption of the concentration gradient between trials.

Figure 1. Research evaporators at the University of Vermont Proctor Maple Research Center Maple Processing Research Facility. Evaporators are oil-fueled, 3 x 10' with cross-flow pans and raised flues.

The color, pH, conductivity, mineral, carbohydrate, and volatile flavor compound contents were determined for each syrup produced during the experiments. Syrup color was determined by measuring the percentage of light transmittance at 560 nm with a spectrophotometer using glycerol as a 100% transmittance standard. Electrical conductivity and pH were determined with a bench-top meter with an epoxy body electrical conductivity cell and a solid-state pH probe, respectively, both equipped with automatic temperature compensation. Density of sap and syrup was measured with a digital refractometer (Misco PA203X). The composition of inorganic mineral elements was determined by inductively coupled plasma-atomic emission spectroscopy (ICP-AES). The composition of sucrose, glucose, and fructose in each sample of syrup was determined by high-performance liquid chromatography (HPLC), and the composition of volatile flavor and aroma compounds in each syrup sample was determined by solid-phase microextraction (SPME) and gas chromatography time-of-flight mass spectrometry (GC-TOF-MS). Detailed descriptions of the analytical methods used can be found in van den Berg *et al.* (2014). For each parameter, a paired *t*-test was used to determine if averages differed significantly in the syrup produced simultaneously from raw sap and from the same sap concentrated to 8%. (Paired *t*-tests compare the composition of the pairs of syrup produced simultaneously with the two treatments.)

Sensory evaluation experiments were also conducted to examine potential effects on flavor. For sensory evaluation, triangle tests were conducted to determine if an overall difference could be detected in the flavor of syrup produced simultaneously with raw sap and the same sap concentrated to 8%. Triangle tests are a sensory evaluation method used to determine whether an overall difference in flavor exists between two samples. For example, in a triangle test designed to determine if an overall difference in flavor exists between the syrup produced with raw sap and the same sap concentrated to 8% during the experiment trial conducted on 3/18, each panelist would be presented with three samples of syrup. Two of the bottles would contain the syrup produced with raw sap during the 3/18 trial, and one of the bottles would contain the syrup produced with 8% concentrate during the 3/18 trial. (An equal number of panelists would receive two bottles of the syrup produced with concentrate and one bottle of the syrup produced with raw sap.) The panelists would then be asked to taste all three bottles of syrup and write down the number of the bottle they believe contains the one syrup that is different from the other two. If enough panelists correctly identify the 'odd' sample in the trio, then it is concluded that there is a difference in flavor between the pairs of syrup produced simultaneously with the two treatments.

Individual triangle tests were conducted for four of the six pairs of syrup produced during the experiment trials (to avoid sensory fatigue in the panelists) following the procedures described by Meilgaard *et al.* (2006). Twenty-six adult panelists with experience tasting and grading maple syrup participated in the test. Panelists were separated by cardboard partitions under fluorescent light during administration of the test, and sample presentation order was randomized for each panelist. Opaque sample bottles were used to eliminate any influence of syrup color on the panelists' perceptions. Pairs were considered significantly different ($p < 0.01$) if 15 of the 26 panelists positively identified the odd sample (Meilgaard *et al.* 2006).

Results

Syrup produced simultaneously with raw sap and the same sap concentrated to 8% sugar was very similar (Table 1). The most notable difference observed was with respect to syrup color: syrup produced with raw sap was slightly, but statistically significantly lighter in color than the syrup produced simultaneously with the same sap concentrated to 8%. The average difference in light transmittance between the pairs of syrup produced simultaneously with raw sap and concentrate was 11.8 percentage points, however only one

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pair fell within different grade classifications from one another (Figure 3). This result is particularly interesting, since it is the opposite of what might be expected: it is commonly hypothesized that syrup produced from concentrate will be lighter in color than syrup produced from raw sap due to the shorter processing times required with concentrate.

Besides color, few other statistically significant differences in composition or properties were observed between syrup produced with raw sap and concentrate. The conductivity did not differ significantly between the two types of syrup and, accordingly, almost no differences were observed in the composition of dissolved minerals between the syrup types (Table 1). The exception to this was magnesium (Mg), which was found in slightly lower quantities in syrup produced from raw sap, by approximately 20 ppm (Table 1). This is most likely due to the slight permeability of this membrane to Mg, which would result in the concentrate containing proportionally slightly less Mg than the raw sap.

Parameter measured	Raw Sap (2%)	Concentrated Sap (8%)	*p*-value
Brix (°)	67.1 ± 0.2	67.2 ± 0.1	0.4142
Conductivity (μS cm^{-1})	171.6 ± 11.5	162.9 ± 9.1	0.1572
Light transmittance (%)	57.7 ± 4.4	45.9 ± 3.8	**0.0001**
pH	7.1 ± 0.05	7.5 ± 0.09	**0.0091**
Calcium (ppm)	946 ± 77	939 ± 23	0.9164
Phosphorous (ppm)	2.3 ± 0.7	4.1 ± 1.2	0.1424
Potassium (ppm)	1948 ± 37	2009 ± 48	0.2694
Magnesium (ppm)	153.2 ± 7.7	133.1 ± 8.4	**0.0063**
Iron (ppm))	1.9 ± 0.5	1.9 ± 0.6	0.9171
Manganese (ppm)	27.2 ± 5.1	16.0 ± 2.4	0.1097
Boron (ppm)	1.2 ± 0.2	0.9 ± 0.1	0.0625*
Copper (ppm)	0.9 ± 0.1	1.0 ± 0.1	0.6274
Zinc (ppm)	3.2 ± 0.1	3.6 ± 0.2	0.1084
Sulfur (ppm)	17.5 ± 1.2	18.7 ± 1.2	0.5443
Sucrose (%)	65.4 ± 0.9	64.2 ± 0.7	0.2175
Glucose (%)	0.11 ± 0.004	0.09 ± 0.006	**0.0125**
Fructose (%)	0.69 ± 0.02	0.67 ± 0.02	0.4607
Total invert sugar (%)	0.79 ± 0.02	0.75 ± 0.02	0.0938*
Volatile flavor compounds (millions of peak area count)	2.4 ± 0.3	2.3 ± 0.3	0.9166

Table 1. Chemical composition and properties of maple syrup produced simultaneously from raw maple sap and the same sap concentrated to 8% with RO. Values are averages (± standard error) of 6 experiment trials. *p*-values are for statistical tests to determine whether average values for the two treatments were equal. Bold *p*-values indicate statistically significant differences (α = 0.05).

The pH of syrup produced with raw sap was slightly lower than that of syrup produced with concentrate, though the difference was small and the average values for both syrup types were near neutral (Table 1). Glucose was the only sugar that differed significantly between the two types of syrup, however the difference was also numerically quite small (0.11 vs. 0.09%, Table 1). From a practical perspective, these differences were very small, and would not impart any functional or quality difference between the syrups.

It is possible that the difference in the pH of syrup produced from raw sap and concentrate is simply a residual effect of the slight difference in pH between raw and concentrated sap – in reverse osmosis, the pH of the concentrate will always be slightly higher than the incoming material being concentrated. (This is because RO membranes are permeable to carbon dioxide gas, but not to the bicarbonate ions which typically balance the effects of CO2 on pH.) This can be seen in Table 2, which shows the composition and properties of the sap, concentrate, and permeate used in each trial of this experiment, and the average composition of the sap and concentrate. This slight difference in pH might also explain the small differences observed in glucose – sucrose, the primary sugar found in maple syrup, is comprised of a molecule each of glucose and fructose bonded together. The rate that sucrose is split (hydrolyzed) into glucose and fructose increases as the pH of a solution gets lower. Thus, it's possible that the slightly lower pH of the syrup produced with raw sap might result in slightly increased rates of sucrose hydrolysis, and thus also result in slightly higher concentrations of glucose relative to the syrup produced with concentrate.

Although color differed between the syrup made with the two treatments, the relative quantity of volatile flavor compounds did not differ significantly between syrup made simultaneously with raw sap and the same sap concentrated to 8% (Table 1). This suggests that

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Figure 2. Samples of maple syrup produced simultaneously with raw maple sap (bottom row) and the same sap concentrated to 8% by RO (top row) during 6 experiment trials. Percent values indicate the light transmittance (560 nm) of the samples. Light transmittance ranges for international standard maple syrup grades: ≥75.0% = Golden Color with Delicate Taste, 50.0-74.9%% = Amber Color with Rich Taste, 25.0-49.9% = Dark Color with Robust Taste, <25% = Very Dark Color with Strong Taste.

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producing syrup from sap concentrated by RO to 8% sugar does not significantly affect the overall development of flavor in maple syrup. However, because the total quantity of volatile flavor compounds doesn't always equate with the perceived level of flavor (Belitz *et al.* 2004), a sensory evaluation experiment was also conducted to investigate the potential impacts of RO on syrup flavor. For this experiment, we hypothesized that if concentrating sap with RO significantly affected syrup flavor, then an overall difference should be evident in the flavor of the syrup produced simultaneously with raw sap and the same sap concentrated to 8% with RO. We conducted triangle tests on the pairs of syrup produced during four of the experiment trials (3/18, 4/2, 4/4, and 4/8). However, for each of the four pairs of syrup tested, panelists did not detect a difference in the flavor of the syrups produced simultaneously with raw and concentrated sap (Table 3). For the syrup pair produced on 3/18, the number of panelists who correctly identified the odd sample was close to the critical value necessary to conclude that a difference existed, suggesting that some differences in flavor might be present, but that if present they are likely very subtle. Thus, taken together with the results of volatile flavor compound analysis, these results suggest that concentrating sap to 8% with RO does not significantly impact syrup flavor.

In conclusion, the results of this study indicate that concentrating maple sap to 8% with RO does not substantially affect syrup composition, properties, or flavor. Syrup produced simultaneously from raw maple sap and the same sap concentrated to 8% had similar properties and composition, and had flavor that was indistinguishable by both chemical profiles and by panelists in sensory experiments. The most notable effect observed was on syrup color, which was slightly darker in syrup produced with concentrate. However, the differences observed in color were quite small, with only one of the six sample pairs differing in color grade. Any decrease in syrup value due to this minor reduction in color would be more than offset by the lower fuel and labor costs required for processing concentrate.

Experiment 2 – Comparison of syrup made from sap at 2, 8, 12, and 15% concentration

Another experiment was conducted to investigate the effects of the level of concentration with RO on the properties, composition, and flavor of the syrup produced. In this experiment, syrup was produced simultaneously with sap at 2, 8, 12, and 15% sugar concentration, and its composition, properties, and flavor analyzed and compared.

Methods

Specifically, sap concentrated to 15% using a Springtech 1600 unit with a Hydranautics LSY-PVD-1 membrane and the permeate generated during concentration were obtained. Three hundred gallons of the 15% concentrate were retained, while the remainder was diluted with the appropriate quantity of the permeate necessary to generate 300 gallons of sap at each of three different sugar concentration levels: 2, 8, and 12%. Each treatment was placed in a separate stainless steel tank which fed one of four identical, 3 × 10′ evaporators (as described above), and the evaporators were started simultaneously and allowed to continue processing until

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																			Averages	
Experiment trial date	3/18/2011			3/21/2011			4/1/2011			4/2/2011			4/4/2011			4/8/2011			Treatment	
Material type	P	S	C	P	S	C	P	S	C	P†	S	C	P	S	C	P	S	C	Raw Sap	8% Concentrate
Brix (°)	0.0	2.3	8.4	0.0	2.4	7.7	0.0	2.4	8.1		2.5	7.8	0.0	2.5	8.2	0.0	2.2	8.0	2.4 ± 0.05	8.0 ± 0.11
pH	6.3	7.5	7.7	5.8	6.7	7.1	6.0	7.0	7.3		6.6	6.9	6.0	7.0	7.4	6.0	6.7	7.1	6.9 ± 0.09	7.2 ± 0.10
Conductivity (µS cm^{-1})	6.3	460.7	1218.0	6.5	504.7	1217.0	3.2	398.0	987.8		460.0	1083.0	3.3	456.6	1105.0	4.6	464.5	1203.0	457 ± 14	1136 ± 38
Calcium (ppm)	0.09	49.9	196.0	0.12	60.0	198.0	0.04	41.8	141.0		47.5	160.0	0.11	50.5	173.0	0.11	52.1	193.0	50.3 ± 2.4	176.8 ± 9.4
Phosphorous (ppm)	bdl	0.5	3.4	bdl	0.5	2.2	bdl	0.4	1.9		0.2	0.9	bdl	0.2	1.1	bdl	0.3	1.4	0.4 ± 0.1	1.8 ± 0.4
Potassium (ppm)	1.1	58.8	256.0	1.0	62.8	257.0	0.5	49.9	212.0		56.1	189.0	0.5	56.1	202.0	0.7	56.7	276.0	56.7 ± 1.7	232.0 ± 14.5
Magnesium (ppm)	0.012	5.6	20.5	0.013	6.7	20.5	0.004	4.5	14.5		5.4	16.8	0.009	5.7	18.1	0.010	6.0	20.6	5.6 ± 0.3	18.5 ± 1.0
Iron (ppm)	bdl	0.1	0.2	bdl	0.1	0.2	bdl	0.0	0.1		0.1	0.2	bdl	0.1	0.1	bdl	0.1	0.2	0.1 ± 0.01	0.2 ± 0.01
Manganese (ppm)	bdl	5.5	22.0	bdl	5.6	18.6	bdl	4.2	14.3		4.8	16.2	bdl	5.3	17.9	bdl	6.0	21.8	5.2 ± 0.3	18.5 ± 1.2
Boron (ppm)	bdl	0.1	0.1	bdl	0.1	0.1	bdl	0.0	0.1		0.1	0.2	bdl	0.1	0.1	bdl	0.0	0.1	0.05 ± 0.004	0.12 ± 0.009
Copper (ppm)	bdl	0.1	0.2	bdl	0.1	0.2	bdl	0.0	0.2		0.1	0.2	bdl	0.0	0.2	0.03	0.0	0.1	0.05 ± 0.01	0.18 ± 0.02
Zinc (ppm)	bdl	0.3	1.2	bdl	0.3	1.0	bdl	0.2	0.8		0.2	0.8	bdl	0.2	1.0	bdl	0.3	1.0	0.2 ± 0.0	1.0 ± 0.1
Sulfur (ppm)	bdl	0.8	3.7	bdl	1.0	3.9	bdl	0.7	2.5		0.9	3.7	bdl	0.9	3.5	bdl	1.0	4.0	0.9 ± 0.05	3.5 ± 0.22
Sucrose (%)	nm	1.8	7.1	nm	1.8	6.1	nm	2.0	7.0		1.9	5.4	nm	1.9	6.4	nm	1.6	6.4	1.8 ± 0.1	6.4 ± 0.2
Glucose (%)	nm	0.07	0.24	nm	0.09	0.25	nm	0.07	0.22		0.10	0.29	nm	0.10	0.26	nm	0.09	0.23	0.09 ± 0.006	0.25 ± 0.010
Fructose (%)	nm	0.04	0.12	nm	0.04	0.14	nm	0.03	0.11		0.04	0.16	nm	0.04	0.13	nm	0.04	0.13	0.04 ± 0.002	0.13 ± 0.007
Total invert sugar (%)	nm	0.1	0.4	nm	0.1	0.4	nm	0.1	0.3		0.1	0.5	nm	0.1	0.4	nm	0.1	0.4	0.13 ± 0.01	0.38 ± 0.02

Table 2. Composition of the sap and 8% concentrate used in each of the 6 experiment trials, and the permeate generated during sap concentration. Overall averages (± standard errors) of the composition and properties of sap and concentrate used in the 6 trials are also shown. S= raw sap, C= sap concentrated to 8%, and P = permeate generated during sap concentration.

Table 3. Number of correct responses in triangle tests conducted with 26 panelists to determine if differences in flavor were detectable between pairs of maple syrup produced simultaneously from raw sap and the same sap concentrated to 8% during 4 experiment trials. The flavor of each pair was considered significantly different ($p < 0.01$) with 15 or more correct responses

Experiment trial date	Number of correct responses
3/18	14
4/02	12
4/04	7
4/08	12

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the supply of available liquid for each was consumed. After the first 1.5 hours of processing, all syrup produced by each treatment evaporator was collected separately. After the experiment was complete, the syrup produced with each treatment was filtered with a plate filter press, then packaged and frozen for subsequent analyses. The experiment was repeated on four days during the 2008 production season (4/2, 4/3, 4/5, and 4/8).

Sample analyses for color, conductivity, pH, carbohydrate, mineral and flavor composition were performed as described in the previous experiment. Data were compiled and for each parameter, repeated measures analysis of variance procedures were used to determine if significant differences existed between the averages of syrup produced simultaneously with sap at the four treatment levels of sugar concentration. If an overall significant difference was found between the four treatments for a parameter, pairwise comparisons between the individual treatments were performed with orthogonal contrasts to determine if significant differences existed between any of the individual sap concentration treatment levels. For sensory evaluation, triangle tests were conducted to determine if an overall difference could be detected in the flavor of syrup produced simultaneously with sap at 2% and 15% concentration. Individual triangle tests were conducted for each of the syrup pairs produced during the four experiment trials, using 22 adult panelists with experience tasting and grading maple syrup. Pairs were considered different ($p < 0.01$) if 14 of the 22 panelists correctly identified the odd sample (Meilgaard *et al.* 2006). More detailed descriptions of the methodology and analytical methods used can be found in van den Berg *et al.* (2011).

Results

As in the first study, very few differences were observed in the composition or properties of syrup produced with the different sap concentration levels. The conductivity of syrup differed significantly between syrup produced with the four treatments, with a pattern suggesting lower conductivity in syrup produced with more concentrated sap. This pattern followed and was likely driven by that of the composition of manganese (Mn) in the samples, which was lower in syrup produced with more concentrated sap, and was the only mineral which differed significantly between the treatments (Table 4). Similar to Mg in the first study, the differences between the treatments were small, averaging approximately 30 ppm. Also similar to the first study, the pH differed significantly between the treatments, with slightly lower values in syrup made from less concentrated sap. In the first study, the quantity of glucose was slightly higher in syrup made from raw sap than in syrup made from concentrated sap; similar to this, in this study the quantity of total invert sugar (glucose + fructose) and fructose differed significantly between the treatments, also with slightly higher amounts found in syrup made from less concentrated sap. Like the first study, though statistically significant, all of these differences were numerically quite small, and unlikely to impart any functional or practical difference between the syrup made with the different concentration levels.

Syrup color also differed slightly, but significantly, between the treat-

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ments. However, the general pattern appears to be the opposite of what was observed in the first study – syrup produced with more concentrated sap tended to be *lighter* in color than syrup produced with less concentrated sap. However, looking at the data more closely, although this pattern is evident when comparing syrup made from 2% versus 15% sap, and 8% versus 12 and 15% sap, syrup made from 8% sap was actually *darker* than syrup made from 2% sap, the same result observed in the first study. Thus, although the data generally show a pattern of increasingly lighter syrup with increasing sap concentration, the results again show that syrup made from 8% concentrate was slightly darker than syrup made from 2% sap. It is important to emphasize that the differences in color between the treatments were extremely small in this study. For example, the difference between the average light transmittance of syrup produced with 2% and 8% sap was 3.1 percentage points, and the average difference in light transmittance between syrup samples produced with the different treatments in each trial was approximately 4 percentage points. Further, in three of the four trials, syrup produced with all four treatments fell within the same color grade classification (Figure 3).

Although an overall significant difference was detected in the total quantity of volatile flavor compounds between the syrup produced with the four concentration levels of sap, no significant differences were observed in the quantity of flavor compounds in pairwise comparisons between the individual treatments (2% *vs.* 8%, etc.)

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Parameter measured	Treamtent 2%	8%	12%	15%	Overall *p*-value	*p*-values for pairwise comparisons 2% vs 8%	2% vs 12%	2% vs 15%	8% vs 12%	8% vs 15%	12% vs 15%
Brix (°)	66.8 ± 0.4	67.1 ± 0.4	67.6 ± 0.1	67.2 ± 0.2	0.2107						
Conductivity (µS cm^{-1})	120.6 ± 5.7	106.0 ± 1.2	95.2 ± 4.5	98.0 ± 5.0	**0.0014**	0.0984	**0.0016**	**0.0109**	0.1352	0.2466	0.3078
Light transmittance (%)	46.4 ± 6.2	43.3 ± 6.9	46.4 ± 7.3	51.2 ± 6.1	**0.0088**	0.0659	0.9902	0.0630	0.1171	**0.0438**	**0.0419**
pH	6.0 ± 0.0	6.3 ± 0.1	6.5 ± 0.1	6.5 ± 0.1	**0.0001**	**0.0100**	**0.0047**	**0.0008**	0.3654	0.0985	0.8518
Calcium (mg kg^{-1})	1045 ± 59	1011 ± 86	944 ± 106	870 ± 141	0.3218						
Phosphorous (mg kg^{-1})	bdl	bdl	bdl	bdl							
Potassium (mg kg^{-1})	768 ± 47	764 ± 47	740 ± 47	751 ± 42	0.9271						
Magnesium (mg kg^{-1})	115.1 ± 8.6	120.5 ± 3.1	118.2 ± 3.3	114.9 ± 3.0	0.6540						
Iron (mg kg^{-1})	bdl	bdl	bdl	bdl							
Manganese (mg kg^{-1})	75.9 ± 7.0	39.1 ± 1.7	31.4 ± 1.8	26.4 ± 3.0	**0.0001**	**0.0168**	**0.0121**	**0.0118**	**0.0014**	**0.0073**	**0.0449**
Boron (mg kg^{-1})	bdl	bdl	bdl	bdl							
Copper (mg kg^{-1})	bdl	bdl	bdl	bdl							
Zinc (mg kg^{-1})	2.3 ± 0.3	2.3 ± 0.4	2.0 ± 0.4	1.8 ± 0.3	0.4660						
Sulfur (mg kg^{-1})	bdl	bdl	bdl	bdl							
Sucrose (%)	58.9 ± 0.5	59.1 ± 0.3	59.1 ± 0.4	59.1 ± 0.5	0.9021						
Glucose (%)	0.28 ± 0.05	0.24 ± 0.02	0.22 ± 0.02	0.23 ± 0.03	0.1084						
Fructose (%)	0.30 ± 0.04	0.24 ± 0.03	0.23 ± 0.03	0.23 ± 0.03	**0.0001**	**0.0184**	**0.0199**	**0.0097**	0.0747	0.0587	0.8033
Total invert sugar (%)	0.58 ± 0.09	0.48 ± 0.06	0.46 ± 0.06	0.46 ± 0.06	**0.0103**	0.1053	0.0568	0.0821	**0.0372**	**0.0153**	0.5668
Volatile flavor compounds (millions of peak area count)	9.1 ± 2.2	13.2 ± 0.9	18.3 ± 2.9	18.6 ± 2.1	**0.0494**	0.2417	0.1449	0.1093	0.1429	0.0557	0.9034

Table 4. Chemical composition and properties of maple syrup produced simultaneously from sap at 4 concentration levels: 2, 8, 12, and 15%. Values are averages (± standard error) of 4 experiment trials. Overall p-values are for statistical tests to determine whether the average values of the 4 treatments were equal and, where significant overall differences were detected, for pairwise comparisons to determine if significant differences existed between the averages of the individual treatments. Bold p-values indicate statistically significant differences (α = 0.05).

Experiment trial date	Number of correct responses
4/02	10
4/03	6
4/05	10
4/08	7

Table 5. Number of correct responses in triangle tests conducted with 22 panelists to determine if differences in flavor were detectable between pairs of maple syrup produced simultaneously from sap at 2% and 15% concentration during 4 experiment trials. The flavor of each pair was considered significantly different (p < 0.01) with 14 or more correct responses.


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(Table 4). This suggests that the overall statistical difference is not indicative of any actual differences between the individual treatments. Interestingly, the data suggest a trend for syrup made from more concentrated sap to contain more volatile flavor compounds than syrup produced with less concentrated sap (Table 4), which contrasts with the common anecdotal hypothesis that syrup produced from more concentrated sap might be less flavorful than syrup made from less concentrated sap. This also contrasts with the common assumption that the level of flavor is positively correlated with syrup color – in these syrups, lighter colored syrups contained *more* flavor compounds than darker colored syrups. Sensory evaluation experiments were conducted to further examine the flavor of the syrup produced with the different treatments. We hypothesized that if differences in flavor existed in syrup produced with the different concentration levels, that they would be most readily detectible in syrup produced with the two most extreme treatment levels, 2 and 15%. Thus, we conducted triangle tests to determine if differences could be perceived in the flavor of the pairs of syrup produced simultaneously with 2 and 15% sap on each of the four experiment trial dates. In the triangle tests, panelists were not able to detect differences in the flavor of syrup produced simultaneously with these treatments for any of the four pairs tested (Table 5). Together, these results suggest that producing syrup with different concentrations of sap did not result in significant impacts on syrup flavor.

In conclusion, the results of this study indicate that producing syrup with sap concentrated to between 8 and 15% does not substantially affect syrup composition, properties, or flavor. Syrup produced simultaneously from sap at 2, 8, 12, and 15% sugar concentration had similar properties and composition. In addition, no difference was detected in the flavor of syrup produced simultaneously with the same sap at 2 and 15% concentration. Very small

Reverse Osmosis: continued on page 24

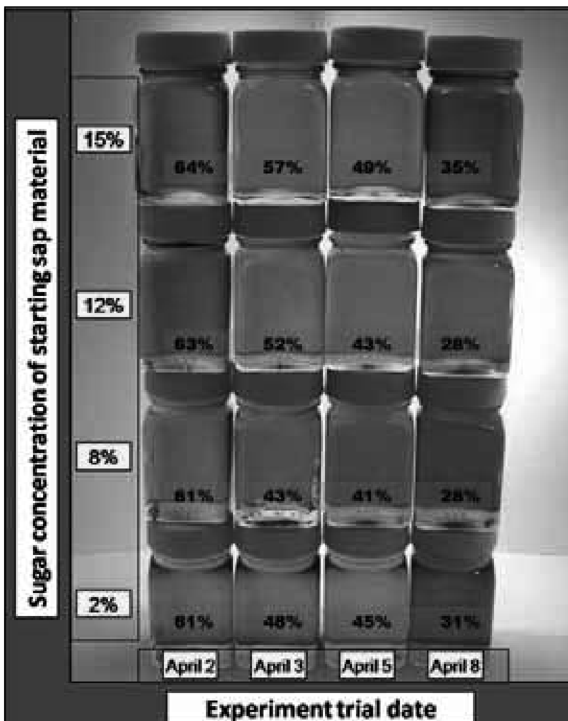

Figure 3. Samples of maple syrup produced simultaneously from sap at four sugar concentration levels (2, 8, 12, and 15%) during 4 experiment trials. Samples in vertical columns are the syrups produced simultaneously with the different concentration levels during each trial of the experiment. Percent values indicate the light transmittance (560 nm) of the samples.

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differences were observed in the color of syrup produced with the different treatments – the general, overall trend observed was for lighter colored syrup to be produced from more concentrated sap. However, consistent with the results of the first study, syrup produced from sap at 8% concentration was slightly darker than syrup produced from sap at 2%.

Experiment 3 – Comparison of syrup made from sap concentrated to moderate and high levels with RO

Although the first studies demonstrated that concentrating sap with RO up to 15% does not result in substantial impacts on the syrup produced, one remaining question was whether concentrating sap to higher levels might have greater impacts on syrup properties, composition, or flavor. Concentrating sap to levels greater than 15% increases efficiency and profitability by further reducing the time and cost of processing sap to syrup density. However, since it also further reduces the length of time sap is processed with heat in the evaporator, it is possible that syrup could be affected to a greater degree than when processing sap concentrated to more moderate levels (8-15%). Thus, a third study was conducted to investigate the potential impacts of concentrating sap with RO to a level higher than 15% on the properties, composition, and flavor of the syrup produced, and determine if any significant differences existed in syrup produced simultaneously with the same sap concentrated to either moderate or high levels.

Methods

To accomplish this, we conducted a study in which syrup was produced simultaneously from the same sap concentrated to either 8 or 21.5% sugar. Specifically, for each trial of the experiment, a common source of maple sap was concentrated sequentially to generate 300 gallons each of 8 and 21.5% concentrate using a CDL RO unit equipped with 8 × 40 Mark I membranes (Dow FilmTec, Midland, MI, USA). Each treatment was placed in a separate tank that fed one of two identical, 3 × 10′ evaporators (as described previously). The evaporators were started simultaneously and run continuously until the supply of concentrate for each was consumed. All syrup produced with each treatment after the first 1.5 hours of processing was collected. After processing was complete, the syrup produced with each treatment was filtered separately with a plate filter press, and was then kept frozen until subsequent analyses. Separate trials of the experiment were conducted on five individual days during the 2009 maple production season (3/17, 3/19, 3/28, 3/29, 4/2).

Sample analyses for color, conductivity, pH, carbohydrate, mineral, and flavor composition were performed as described in the previous experiment. Data were compiled and for each parameter, a paired Student's *t*-test was used to determine if significant differences existed in the means of the syrup produced simultaneously from the same sap concentrated to either 8 or 21.5%. For sensory evaluation, individual triangle tests with 28 panelists with experience tasting and grading maple syrup were conducted for each pair of syrup produced during the first four trials of the experiment to determine if an overall difference could be detected in the flavor of maple syrup produced simultaneously with the same sap concentrated to 8 and 21.5% sugar. Pairs

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Reverse Osmosis: continued from page 24

were considered different ($p < 0.01$) if 16 of the 28 panelists correctly identified the odd sample (Meilgaard *et al.* 2006). More detailed descriptions of the methodology and analytical methods used can be found in van den Berg *et al.* (2012).

Results

Syrup produced with sap concentrated to 21.5% was significantly lighter in color than the syrup produced simultaneously with the same sap concentrated to only 8% (Table 6). The difference in percent light transmittance ranged from 2.0 to 17.7 percentage points, with an average difference of 11.1 (Figure 4). Three of the five syrup pairs fell within different grade classes. Besides the difference in syrup color, there were no other significant differences in the properties, mineral, or carbohydrate composition of the syrup produced simultaneously with sap concentrated to either 8 or 21.5% sugar (Table 7).

The quantity of volatile flavor compounds also did not differ significantly between syrup produced simultaneously from the same sap concentrated to 8 and 21.5% sugar (Table 6). Further, in triangle tests, panelists did not de-

Parameter measured	8%	22%	*p*-value
Conductivity (µS cm^{-1})	222.7 ± 18.6	235.3 ± 14.8	0.1805
Light transmittance (%)	34.1 ± 6.5	45.2 ± 4.3	**0.0160**
pH	6.9 ± 0.1	7.1 ± 0.1	0.2640
Calcium (ppm)	1027 ± 170	862 ± 140	0.3016
Phosphorous (ppm)	bdl	bdl	
Potassium (ppm)	2138 ± 94	2142 ± 83	0.8975
Magnesium (ppm)	143.6 ± 21.9	128.6 ± 23.0	0.1492
Iron (ppm))	5.1 ± 1.4	2.9 ± 0.7	0.2864
Manganese (ppm)	19.7 ± 10.41	12.8 ± 5.3	0.1250 *
Boron (ppm)	bdl	bdl	
Copper (ppm)	bdl	bdl	
Zinc (ppm)	3.6 ± 0.1	3.6 ± 0.2	0.7917
Sulfur (ppm)	18.8 ± 3.2	15.5 ± 3.4	0.1875
Sucrose (%)	65.6 ± 0.4	64.9 ± 1.1	0.5298
Glucose (%)	3.0 ± 0.2	3.2 ± 0.3	0.6031
Fructose (%)	2.1 ± 0.2	1.6 ± 0.2	0.1210
Total invert sugar (%)	5.1 ± 0.2	4.8 ± 0.4	0.4902
Volatile flavor compounds (millions of peak area count)	5.0 ± 0.4	5.0 ± 0.6	0.9727

** Indicates mean comparison made with nonparametric Wilcoxon Signed Rank tests.*

Table 6. Chemical composition and properties of maple syrup produced simultaneously from the same sap concentrated with RO to either 8 or 21.5% sugar. Values are averages (± standard error) of 5 experiment trials. p-values are for statistical tests to determine whether average values for the two treatments were equal. Bold p-values indicate statistically significant differences (α = 0.05).

Experiment trial date	Number of correct responses
3/17	14
3/19	8
3/28	13
3/29	10

Table 7. Number of correct responses in triangle tests conducted with 28 panelists to determine if differences in flavor were detectable between pairs of maple syrup produced simultaneously from the same maple sap concentrated with RO to 8 and 21.5% sugar during 4 experiment trials. The flavor of each pair was considered significantly different ($p < 0.01$) with 16 or more correct responses.

tect differences in the flavor of syrup produced simultaneously from sap concentrated to 8 and 21.5% for any of the four pairs tested (Table 7). That no differences were detected in either the perceived flavor or the quantity of flavor compounds between the syrup produced with the two treatments strongly indicates that producing syrup from highly concentrated sap does not significantly affect syrup flavor.

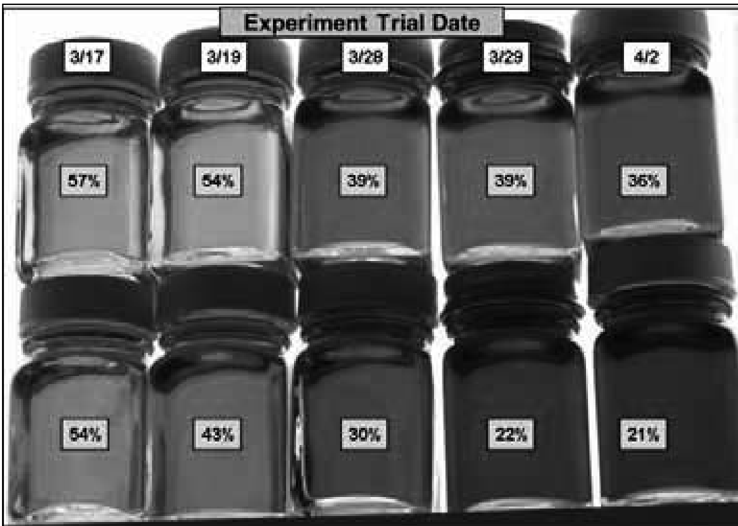

Figure 4. Samples of maple syrup produced simultaneously from the same sap concentrated with RO to either 8 (bottom row) or 21.5% (top row) sugar during 6 experiment trials. Percent values indicate the light transmittance (560 nm) of the samples.

In conclusion, the results of this study indicate that producing syrup with sap concentrated to very high levels by RO does not significantly affect syrup properties, composition, or flavor. Syrup produced with sap concentrated to 21.5% was slightly lighter in color than syrup produced from the same sap concentrated to only 8%, however there were no other significant differences in the composition, properties, or flavor of the two types of syrup.

Conclusions

Broadly, the results of these experiments indicate that the use of RO at any concentration level has no substantive impacts on the composition, properties, or flavor of the syrup produced. A few general observations of the results of these experiments can be summarized as follows:

<u>Color</u>: The most notable effect observed throughout the three experiments was on syrup color. In general, the results suggest that producing syrup from 8% concentrate is likely to result in slightly darker syrup than with raw sap, and that concentrating to levels above 8% is likely to result in progressively slightly lighter colored syrup. However, it's important to emphasize that the effects observed on syrup color were generally very small, often not large enough to cause the color grade to differ. Thus, the results of these studies suggest that producing syrup with concentrated sap is generally likely to have relatively minimal impacts on syrup color.

<u>Flavor</u>: The results of all three studies indicate RO does not significantly impact syrup flavor. No effects of RO on syrup flavor were observed, either

Reverse Osmosis: continued on page 30

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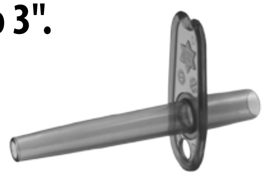

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by chemical composition analyses or panelists in sensory experiments, between syrup produced simultaneously from raw sap and the same sap concentrated to 8%, from the same sap at 2 and 15% concentration, or from the same sap concentrated to 8 and 21.5%. Thus, although given the slight differences in color observed it is reasonable to conclude that using RO has some impact on flavor development, these results indicate that any impact is quite subtle, and beyond what most people are able to perceive.

Other composition and properties: Very few other differences were observed in the composition of syrup. In all cases, the differences that were observed were numerically very small, and not likely to be of any practical significance. In addition, all values for all parameters measured in syrup produced with all treatments during the three experiments were within published ranges for the composition and properties of pure maple syrup (Stuckel and Low 1996, Perkins *et al.* 2006, van den Berg *et al.* 2006, Perkins and van den Berg 2009).

Concentrating sap with RO can provide very large savings in time, fuel, and energy use, increasing the profitability of syrup production substantially. The collective results of these experiments demonstrate that these benefits can be achieved without detriment to the quality of the syrup produced.

	Permeate	Sap	Concentrate	Calculated Concentration
Brix (°)	0.0	2.4	8.1	8.1
pH	6.0	7.0	7.3	
Conductivity (µS cm^{-1})	3.2	398.0	987.8	
Calcium (mg kg^{-1})	0.04	41.8	141.0	141.0
Phosphorous (mg kg^{-1})	bdl	0.4	1.9	1.3
Potassium (mg kg^{-1})	0.5	49.9	212.0	168.3
Magnesium (mg kg^{-1})	0.004	4.5	14.5	15.0
Iron (mg kg^{-1})	bdl	0.04	0.12	0.14
Manganese (mg kg^{-1})	bdl	4.2	14.3	14.2
Boron (mg kg^{-1})	bdl	0.04	0.09	0.14
Copper (mg kg^{-1})	bdl	0.04	0.15	0.14
Zinc (mg kg^{-1})	bdl	0.2	0.8	0.7
Sulfur (mg kg^{-1})	bdl	0.7	2.5	2.3
Sucrose (%)	nm	2.0	7.0	6.6
Glucose (%)	nm	0.07	0.22	0.24
Fructose (%)	nm	0.03	0.11	0.10
Total invert sugar (%)	nm	0.10	0.33	0.34

Table 8. Example composition of raw sap and the same sap concentrated to 8% with RO, the permeate generated during concentration, and the hypothetical concentration of the 8% concentrate when calculated by multiplying the composition of raw sap by the concentration factor used in the generation of the concentrate. In this sample, the concentration factor from raw sap to concentrate was 3.4. (Data from 4/1 trial of Experiment 1.)

The composition of invert sugar is of particular note. The concentrate does not contain any more glucose, fructose (or total invert sugar) than what is calculated by the concentration factor. One effect of concentrating sap with RO that is often presumed is that concentrate will have a proportionally greater invert concentration than the raw sap it was generated from (due to increased microbial activity with greater sugar concentrations). These data clearly demonstrate that this does not occur. Concentrate does not contain proportionally more invert than the raw sap; the invert content of concentrate was simply proportional to that of the sap.

Expanded Discussion

That the syrup produced with raw sap and sap concentrated to different levels with RO was very similar is not surprising, given that the primary difference between raw sap and concentrate is simply the concentration of the substances present. When RO's are functioning properly, very little else besides water passes through the membrane and into the permeate. This is illustrated well by the data in Table 8, which shows the composition of a sample of raw sap and the 8% concentrate made from that sap, along with the hypothetical composition of the concentrate calculated by multiplying the concentration of the substances in the raw sap by the concentration factor used in the concentration of the sap to 8%. The calculated concentrations are very similar to the actual concentrations measured in the 8% concentrate. So, RO concentrate is essentially concentrated sap. The differences between the actual and calculated concentrations of the concentrate are mostly in the ions that pass through RO membranes in very minute amounts, predominantly potassium (K), magnesium (Mg), and calcium (Ca). However, as you can see in Tables 8 and 2, permeate contains very little of even these ions; in fact, in the study of raw sap versus 8% concentrate, for example, over 99.8% of Ca and Mg, and 98.7% of K, were retained in the concentrate (Table 2). If we consider the reactions that occur during sap processing in a very simplified way, the rates of these reactions are influenced by temperature, the concentration of reactants, and the length of time they occur. With concentrated sap, the length of time for reactions to occur is reduced, but the concentration of reactants and temperature are both increased. Thus, it may simply be that the changes are somewhat balanced out, and processing raw sap or concentrate made from that sap, whether concentrated to 8, 15, or 20%, results in very similar syrup.

So why, then, do we see some differences in color between syrup produced with raw sap and different levels of concentrate? Concentrating sap to 8% is a much larger concentration step than concentrating from 8% to higher levels. Most of the water removed by RO, ~75%, is removed in in this step, and concentrating sap to higher concentrations than 8% removes proportionally much less water (Figure 5). It is possible that the large concentration step from 2 to 8% doesn't result in reductions in processing times large enough to balance the simultaneously large increases in concentration, and thus slightly more color development reactions occur with 8% concentrate than with raw sap. But when sap is concentrated to levels higher than 8%, the reductions in processing time may be sufficient to overcome the increased concentration, and fewer color development reactions occur during processing than with less concentrated sap.

This is a very simplified account of the reactions that occur as sap and concentrate are processed in the evaporator and doesn't take into account changes that the presence of particular types of reactants, like the reducing sugars glucose and fructose, or in processing conditions like pH, can have on the reactions that occur during processing. In reality, the reactions that occur when sap is processed with heat in the evaporator are so complex that it's unlikely to ever be possible to accurately or consistently predict the effects that changing a single variable will have on the syrup produced. In general, much of the color and flavor in maple syrup develops through reactions that occur when sug-

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ar solutions are processed with heat, termed "nonenzymatic browning reactions." These include sugar degradation reactions as well as Maillard reactions, which are reactions between reducing sugars, like glucose and fructose, and nitrogen-containing compounds, like amino acids. Nonenzymatic browning reactions yield colored pigments and flavor and aroma compounds, including both desirable and off-flavors. These reactions are enormously complex and occur both simultaneously and in series, so that a change in one variable at one point in processing is likely to result in a cascade of changes affecting all subsequent reactions. In addition, these reactions can be affected by even minute changes in numerous variables, including pH, moisture levels, and the concentration and types of reactants present. For example, different color and flavor compounds develop when glucose or fructose are heated with the same amino acid. Likewise, heating glucose with different types of amino acids results in a unique set of compounds for each of the different amino acids. Altering the pH of any one of these reactions would result in yet another unique set of colored pigments and flavor and aroma compounds. So even very small changes in processing conditions in the evaporator, such as pH, or in the types or proportions of reactants present, such as glucose and fructose (which are more reactive than sucrose in nonenzymatic browning reactions) can alter the nature and rate of reactions that occur during processing in very complex ways. However while this complexity makes specific prediction of the effects of any processing treatment on syrup difficult, despite this, the results of our experiments consistently demonstrated that effects of RO on syrup composition, color, and flavor were minimal.

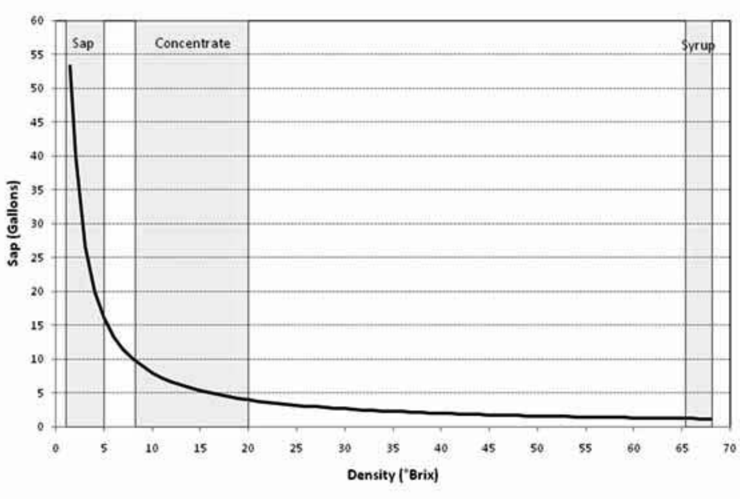

Figure 5. Relationship between sap sugar concentration (°Brix) and the number of gallons required to produce one gallon of maple syrup (Figure from Perkins and van den Berg 2009).

Acknowledgements

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Are NASS Maple Surveys Underestimating Production?

Gary R. Keough, State Statistician, USDA National Agricultural Statistics Service, New England Field Office

Some have questioned the accuracy of NASS's Maple Syrup estimates. The most common criticisms typically include: some producers don't return their report, some don't report accurately, and some don't receive a report. I will address each one separately.

First, let's start with producers that don't return their report. Our survey and estimation procedures are designed to account for all known producers. NASS maintains a list of farm operators for each state. This list contains information about each operation such as total acres operated, crop acreages, livestock inventories, etc. The number of maple taps are one of the items. NASS uses a random sample of producers with over 100 maple taps for our annual Maple Syrup Production Survey. The 100 maple tap minimum means we are excluding most of the "backyard sugarmakers" that don't sell their syrup. We use a random sample of producers instead of trying to contact all producers because doing so would be extremely expensive.

Prior to constructing our random sample, the producers are divided into groups by their number of taps. These groups are call strata. We then select a random sample of producers from each stratum. Thus, the sampling technique is called Stratified Random Sampling. Larger producers are selected more heavily than smaller producers because they have a greater impact on the accuracy of our estimate. The number of strata will vary by state, and depends on the number of producers and the number of taps for the largest producers. States have between three and six strata.

By example, a hypothetical state may have 100 producers on its list, with 20 large producers, 30 medium, and 50 small producers. For the sample we select all 20 large producers, 15 of the medium producers, and 20 of the small producers for a total sample of 55. Then we contact the producers in the sample by mailing each a questionnaire, and follow-up by phone with those that don't return their questionnaires by mail. At NASS we work to get an 80 or better percent response rate. Some producers will refuse to cooperate, others are available during our data collection period.

Say we got complete reports for 18 of the large producers, 11 of the medium producers, and 15 of the small producers for a total of 44 reports which is an 80 percent response rate: (44/55)x100. We now need to adjust the reported data to account for producers that were not in the sample and for those that didn't report. This is done by calculating an adjustment factor for each size calculated by dividing the number in the size group by the number of responses. For the large producers this factor is 20/18=1.11, for the medium producers it is 30/11=2.73, and for the small producers it is 50/15=3.33. The reported data is multiplied by the ap-

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propriate adjustment factor, and the resulting values are summed to make an estimate for all 100 producers. Thus we have accounted for producers that didn't report.

As for producers that don't report accurately, we don't believe this is a significant issue. Our experience indicates that the vast majority of producers do report as accurately as possible. There may be a few that respond falsely, but since we have what they reported on previous surveys we can follow-up if someone is reporting something significantly different from previous reports.

The criticism where I have to admit that we probably are underestimating taps and production is that we don't have all maple producers on our list. NASS maintains a list of farm operations in the US which includes maple producers. This list has been constructed over the years using sources such as other federal agencies, agricultural associations, information in the public domain, and farmers voluntarily providing their contact information. However, lists are very seldom complete, especially if the number of producers is increasing, which is the case with the maple industry.

Here is a simplistic example of our situation. Say you have a list of 100 maple producers and you collect data from 50 of them. If you multiply the results by two then you have an estimate for all 100 producers. But what if you know there are more than 100 producers but you don't know how many or how large they are? It is impossible to accurately include these operations in your estimate.

The easiest way to minimize the underestimation would be for all the maple associations to provide their membership lists and attendance at maple schools and conferences to NASS. I know some have and others have encouraged their member to provide NASS their contact information. Producers can provide their contact information on-line at https://www.agcounts.usda.gov/cgi-bin/counts/. The information provided is kept confidential by law, Title 7 of the U.S. Code, and will not be disclosed to any other government or private entity.

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International Maple Syrup Institute News

Dave Chapeskie R.P.F. Executive Director, IMSI

The most recent International Maple Syrup Institute Board of Directors meeting was held in Longueuil, Quebec on Tuesday, August 11, 2015. Board member attendees included associations, packers, packer cooperatives and equipment vendors/ manufacturer representatives.

CIE joins the IMSI

The Maple Industry Council (Conseil de l'Industrie de l'Érable, CIE) located in Granby, Quebec has joined the International Maple Syrup Institute as a Member. CIE represents about 65 authorized buyers of maple syrup and five buyers of maple sap. CIE is welcomed as a new member of the IMSI. This will provide a very important channel for two-way communications and to transfer IMSI information to the CIE membership.

Supply, Demand and Pricing

Production of maple syrup in 2015 was better than anticipated; overall, North American production was estimated to be down about 5-7% from the 2014 production level. The late start-up with attendant uncertainties regarding supply was quite stressful for producers and packers. Production in the Canadian Maritime provinces and in some areas along the eastern seaboard of the United States was negatively impacted by severe winter conditions, especially snowloads.

Estimates of expansion in production in the United States are as high as 1 to 1.5 million taps per year, suggesting that the US maple industry could double in size within a decade if the current pattern holds. Price in the bulk trade is affected significantly by the Canadian exchange rate and the outcome of pricing negotiations which take place in Quebec annually. Negotiations are currently underway regarding 2016 bulk prices in Quebec. It was suggested that the median North American price should stay at $2.30 per pound or higher to maintain economic viability. There is currently a shortage of certified organic syrup which represents 22% of the bulk production in Quebec. Increasingly, retailers are asking packers for certified organic syrup. The Federation of Quebec Maple Syrup Producers currently holds 60 million pounds in strategic reserve to help safeguard against supply shortfalls.

There was serious concern expressed regarding evidence of off-flavored syrups entering the marketplace. It is extremely important that off-flavored syrup be re-processed to mitigate the off-flavor problem or classified as Processing Grade syrup and excluded from retail sale. The sale of off-flavored syrup in retail markets is potentially very damaging to the maple syrup industry. This places accent on the importance of awareness and education programs designed to help small and medium sized producers identify the types and sources of off-flavours so that corrective action can be taken where required. The IMSI sponsored Grading School and courses offered by Centre Acer are very important training offerings. In addition, state and provincial associations are strongly encouraged to address the issue of off-flavours in their

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annual information transfer sessions for producers.

IMSI 40th Anniversary

The IMSI is currently celebrating its 40th Anniversary. Earlier in 2015, a new IMSI brochure was released to help raise awareness regarding the purpose, activities and important accomplishments of the Institute. Copies can be obtained upon request from Dave Chapeskie, Executive Director, IMSI.

IMSI North American Market Strategy and Implementation Plan

For over a year, the IMSI has had a committee working on a market study to develop a more global approach to marketing maple syrup, especially in the U.S. The strategy was approved in principle at the IMSI's quarterly Board of Directors meeting in Croghan, NY with unanimous support of all Board members. The strategy is founded on a belief that cooperative and collaborative marketing can significantly enhance and add value to ongoing individual marketing and promotion programs of associations, packers, retailers and others. The Goal of the strategy is:

• To grow maple syrup consumption by 10% per year for the next 7 years, effectively doubling the maple market size from about 1% to 2% share of the total sweetener market, currently dominated by corn syrup (55%) and cane/beet sugar (44%). This will be accomplished by:

1) emphasizing good forest management and production practices across the maple industry and
2) by working across maple's political, geographical, size and functional role (producers, packers, etc.) boundaries which have historically constrained cooperation in the marketing arena.

Neri Vautour, Executive Director (Canada) for the Wild Blueberry Association of North America (WABANA) joined the meeting by video conference and provided attendees with some background and perspective on the experience of WABANA in delivering collaborative marketing programs for the wild blueberry industry. WABANA's collaborative marketing programs were a significant factor in growing wild blueberry markets in North America and overseas. The IMSI will continue to explore and learn from the successful application of collaborative market strategies in other food industries.

After discussion, on August 11, the IMSI Board of Directors approved a motion to proceed with the development of an implementation plan following the objectives outlined in the IMSI market strategy. The plan will include a central slogan and key messaging regarding pure maple products and the maple syrup industry as well as a focused action plan for the next several years. Once an action plan is developed, potential sources of financing will be explored. IMSI and NAMSC members will have an opportunity to provide input into and review the implementation plan. The approved plan must be complementary and supportive of marketing and promotion activities already underway in the states and provinces. It must be emphasized that the investment in developing and subsequently implementing collaborative market strategy for the maple industry is to help ensure that the balance between supply and demand of maple

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syrup remains relatively stable and that prices for bulk syrup and syrup sold retail remain relatively stable.

The IMSI Market study group held a short meeting after the IMSI Board meeting to get started on the implementation plan.

North American Good Management Practices (GMP)

The GMP for eliminating lead in maple syrup production and packing equipment developed by the IMSI continues to be well received by producers and packers of maple syrup in Canada and the United States. A concerted effort to totally eliminate lead in equipment (and ultimately in maple syrup) is necessary. IMSI members and others will need to be vigilant to ensure that we meet a lead free goal over the next 5 years or sooner, if possible. Maple producers, maple packers, maple equipment developers/vendors all have a role to play in helping us achieve a lead free production and packing environment. It was stressed at the IMSI Board meeting that vendors of lead containing equipment have an important role in removing lead containing equipment from sale. The larger dealers are encouraged to help raise awareness among smaller equipment dealers regarding this imperative. Equipment developers have a role in ensuring that suitable lead-free alternatives are available (ie. bronze gear pumps). High quality is a foundational element in the production of pure maple products and is essential to growing the maple industry in the medium and longer term.

Standard of Identity for Maple Sap (Water) and Labelling Recommendations

The IMSI has also been active in facilitating discussion leading to the development of a research proposal to develop a standard of identity for maple (sap) water products. Dr. Navindra Seeram, University of Rhode Island and Dr. Luc Lagace Centre Acer are currently working on this draft research proposal. Once the proposal has been finalized, a concerted effort will be made to identify Canadian and US sources of financing to facilitate its implementation.

A committee of the IMSI chaired by Lyle Merle, IMSI Director representing the NY Maple Syrup Producers Association, has finalized recommendations pertinent to labelling maple sap (water) and other products where the water component was originally obtained from the maple tree (ie. RO water). Bottlers of maple (sap) water products were consulted in the development of these recommendations. The IMSI Board of Directors approved of the recommendations as a guideline for packers and for federal and state/provincial governments when labelling these products or setting labelling regulations respectively.

Misrepresentation of Maple in the Marketplace

Dave Chapeskie updated the Board regarding IMSI activities to help deal with the issue of maple misrepresentation in the marketplace. These included sharing of the Position Statement of IMSI on label misrepresentation with media and industry officials, inputting into the Canadian Food Inspection Agency and the Ontario government regarding IMSI's position on label misrepresentation as they consider amendments to labelling laws and outreaching to companies believed to be misrepresenting real maple.

Standard International Maple Grades Implementation

The board was provided with an update of the status of implementation of the new International Maple Grades Standard. Dave Chapeskie reported that progress is being made in Ontario and in Quebec with both provincial governments targeting to have the new regulations in place for January 2016. A representative from Ohio indicated that the State was moving to incorporate the new USDA Regulations into their State Regulations to be effective for January 2016. The Wisconsin State government is also moving to incorporate the new USDA Standard into grade regulations at the State level. States without their own Maple Regulations (ie. smaller producing States) will reference the USDA Standard directly.

Asian Long Horned Beetle Update

Ray Bonenberg, IMSI Director for the Ontario Maple Syrup Producer's Association has offered to lead the development of a North American Maple Industry Action Plan to help address the very serious Asian Longhorned Beetle (ALB) threat. This proposed action plan will be consistent with the IMSI's Strategic Plan for containment of this insect which was shared with Canadian and US government officials earlier.

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Maple Grading Schools

Offerings of the IMSI sponsored maple grading school was offered in Vermont on June 16-17, 2015 and will be offered again in the lead-up to the NAMSC-IMSI annual meetings in Seven Springs, Pennsylvania October 17-18, 2015. You may access further information on the University of Maine Cooperative Extension website http://extension.umaine.edu/register/product/2015-maple-syrup-grading-school/

Centre Acer in Quebec also offers high calibre training courses covering the maple grading component. If the demand were there, Centre Acer may consider offering maple grading schools outside of Quebec to complement the IMSI sponsored grading school and other maple grades training hosted by state or provincial Associations.

Maple Month Proposal

The North American Maple Syrup Council (NAMSC) and IMSI are proposing that the month of March be declared as International Maple Month. This would be a very good opportunity to showcase maple and to get politicians involved and supporting the maple industry. The implementation of Maple Month is intended to be fully complementary to ongoing maple promotion activities in the states and provinces and will be complementary to the IMSI's Market Strategy.

First International Birch Conference a Success

Michael Farrell, Director, The Uihlein Forest, Cornell University

In June nearly 70 current and potential birch sap and syrup producers from all over the world gathered for three days at Paul Smiths College in the heart of the Adirondacks to network and share information. The conference was a remarkable gathering with many new contacts made and lots of knowledge spread among the attendees. There were plenty of existing maple sugarmakers from the northeast who are already producing birch syrup or thinking of doing so along with birch sap and syrup producers from Alaska, nearly every Canadian province, eastern Europe, and Russia.

The conference kicked off on Friday evening with the Tastes of Birch event. Twenty-three producers brought some of their birch sap, syrup, or other birch-based products to sample among the entire group. In addition to a wide selection of birch syrups, other products included different flavors of birch water, birch beer, birch wine, birch caramels, birch bacon jam, birch BBQ sauce, and so on. Although many sugarmakers have preconceived notions that birch syrup and other birch products don't taste very good, everyone who got a chance to try the various products that evening came away impressed with the wonderful diversity of flavors from the different producers.

There isn't an established grading system for birch syrup at this time. The color and flavor of birch syrup changes throughout the course of the season in a similar manner to maple syrup, so many birch syrup producers classify their syrups in to first run, mid-run,

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and late run. Thus, we had three different categories of birch syrup as well as birch sap beverages and specialty birch products categories.

Saturday and Sunday provided a mixture of technical sessions, networking opportunities, and a tour of Cornell University's Uihlein Forest, a center primarily devoted to maple syrup research and extension that has also gotten heavily involved with birch over the past few years.

On Saturday morning John Zasada gave an overview of everything birch trees have to offer in his presentation entitled Celebrating Birch: A Minnesota Perspective. John is a retired US Forest Service research forester and spent many years working with all users of birch trees in North America. I then presented an overview of the potential for birch syrup production in North America, highlighting the opportunities and challenges of incorporating birch syrup production into an existing sugaring operation.

The remainder of the morning included several speakers from Alaska, and Maaria Kortesniemi provided an overview of the research projects in birch syrup chemistry at the University of Turku in Finland.

Everyone traveled to Lake Placid on Sunday morning for a tour of Cornell University's Uihlein Forest. We looked at the tubing system for birch, demonstrated installation of a new birch tubing system, and boiled down some birch sap that had been frozen and then thawed for this event in our 2x6 evapo-

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rator. Steve Caccamo from Next Generation Maple Products demonstrated concentration of birch sap with reverse osmosis on one of the new 'hobby-size' 100 GPH units he had just produced.

On Sunday afternoon, Ihor Soloviy, a visiting fellow at UVM from Ukraine, gave a very interesting presentation on traditional and current uses of birch sap as a beverage in eastern Europe. Val Jerdes, founder of Byarozavik birch water, discussed the lessons learned from starting a birch water company and selling birch water in the U.S. Brent Lehouiller from Chippers discussed many of the details on the logistics of buying sap and leasing taps for people looking to expand their birch operations. Brett McLeod, a forestry professor at Paul Smiths College, rounded out the conference with an outside workshop on tips and tricks for tending the sugarbush.

This was the first conference to ever bring together both academics and producers in the birch sap and syrup industry. It certainly won't be the last. The group that came was very interested in having more conferences in the future and hopefully making this an annual event that rotates around the world wherever birches thrive. If you are a maple producer who has a large birch resource and have ever considered also tapping these trees, stay tuned for more developments and conferences in the future.

This conference was supported by the Northern NY Agricultural Development Program and the Cornell University Agricultural Experiment Station.

State News: Ohio

Ohio Maple Syrup Producers Annual Meeting and Tour

The Ohio Maple Producers Association held their Annual Meeting and Tour in District #3 at the Der Dutchmen Restaurant in Bellville Ohio, on July 11. This year's annual meeting took on an entirely new format. The meeting was moved to summer, the tour and the meeting were held in one day, on a Saturday and there was an educational component to the tour. The OMPA Members seemed to like this format because attendance was up with 63 members and guest enjoying a beautiful summer day.

The meeting started with a delicious breakfast buffet and a brief business meeting followed. After the introductions OMPA President Dan Brown highlighted some of the events of the past year. Dan thanked the 2015 Maple Madness Trail Coordinator Terese Volkmann and Tour Chairman Nate Bissell for their hard work putting together another successful Tour. This year the OMM Trail Committee received an ODA Grant to enhance the tour. The result was 50 stops in 22 counties stretching from the Ohio River to Lake Erie. Included in the effort was the publishing of The Ohio Maple Magazine which served as a tour guide and a consumer's guide to maple production and events across Ohio. It was also noted that the Ohio legislature and Governor John Kasich designated the month of March as Maple Month in Ohio.

Featured speaker at this year's annual meeting was Ohio Maple Syrup Specialist Dr. Gary Graham. Gary discussed the new Maple Syrup Grading Standard and how it will affect Ohio Maple Producers. He also discussed other issues that might bring additional regulations to the production of maple syrup in Ohio. Gary outlined some commonsense approaches that producers can use to deal with increased regulation. He reminded everyone that they are producing a food product and are not being singled out. Most of the regulations are designed to make our entire food supply safer and will affect all sectors of the food production industry.

Following the presentation the producers and guests toured three locations: The Brown Family Sugarhouse; Erlsten Brother Maple Products; and Edie Lou and Jim Meimer's – Pleiades Maple Products. Joining the program was ODA Food Inspector Dan Milo. At each stop Dan and Gary went over the current regulations and possible future regulations. They also gave instruction and constructive criticism on what each one of the tour stops needed to do to meet the Ohio voluntary standard for sugarhouse certification and how they could improve their facilities.

Industry News: Trade Associations

Organizational Growth and Development *or* Is Your Maple Association Working?

Kathryn Hopkins, Extension Professor, University of Maine Cooperative Extension

Organizations grow and develop like children, animals or plants. Understanding organizational growth can help make sense of what is happening in maple producer organizations. The common maxim about volunteer groups is that 10% of the people do 90% of the work. Is that happening in your group? Is your association composed of worker bees or socialites or some combination of members filling various roles? Is the association working efficiently and effectively?

Organizational experts describe three or more stages of growth for most organizations. Most agree that there is a first, beginning or start-up stage that leads to a juvenile or growth stage, and eventually to a relatively stable mature stage. In any organization run with volunteers, like most maple producer organizations, members are likely to be at different developmental stages depending on the length of time they have participated in the group. This can create stressful situations if members are unaware that this is natural. One common factor at any stage is a member's desire for meaningful involvement and recognition.

At the beginning stages of many maple organizations, there may be only a few passionate people developing the vision of the organization and performing the tasks required to move the idea from concept to establishment. The organizers serve as both the members and the worker/leaders of the association. Because the immediate needs are obvious there is little need or time for long range planning and most activities are reactive rather than proactive.

As groups develop and move into an intermediate stage of development, they need more clarity and consensus building about both member and leader roles especially as they acquire more people. At this stage, association leaders may begin to feel burnout or may be unwilling to make changes especially if they feel they are experiencing success on behalf of their producers. They may

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not realize that they have outgrown their initial organizational framework and need to move toward a new organizational model. Association leadership and fundraising issues may arise as well as a need for longer range or strategic planning to guide producers' organizations. Most people have been or are involved in a number of work or volunteer organizations and may recognize some of these stages.

During an intermediate developmental stage there is an opportunity for growth or decline or sometimes both growth and decline at the same time. This period of change can be stressful as the maple association provides services to its members and the public, addresses governance issues, fundraises, provides financial oversight, and conducts strategic planning. It is during this phase of development that an organization may shift from being only a programming organization to adding policy and fundraising tasks, requiring an official board of directors and possibly paid staff. This may result in people leaving an association if they feel their talents do not fit well with policy issues and fundraising. Retention of a wide range of talent is more likely if the maple association's members and board of directors understand that service to the group requires both policy management and programming in order to be successful. The successful maple producer association will offer a range of policy, service and programming opportunities that complements its mission and makes the most of its members' various talents.

When an association reaches a mature stage, members and leaders have clear and established roles and itemized responsibilities. A clear mission has been established, high quality programs and a positive public reputation are developed, and leaders and members hold each other accountable for agreed upon responsibilities. Systems are in place to both grow the organization and maintain and support the existing parts of the organization. Has your maple association reached this point?

At each stage of development organizations are as effective as the collective experience level and awareness of the members. Producer association development is messy and time consuming and few associations develop in a straight line. Every organization must be aware of and meet the challenges of growing and maintaining its programs while also remaining relevant to its members. They must meet the challenge of developing the board of directors, volunteers, paid staff, and the financing they need to be successful.

How does an organization find out where it is and where its members are? Michael Burns of BWB Solutions suggests a five-step process for finding an organization's place(s). The first step is to take stock of both tangible and intangible assets. Tangible assets are finances, equipment and members. Intangible assets include reputation and support from non-member community leaders. The second step is to assess local, regional, national and international external circumstances that impact the association's growth. The third step is to identify internal needs and activities by cataloguing time spent on different tasks and prioritizing who is responsible for what tasks and which tasks have priority. The fourth step is to identify where needs are not being met between programs and projects, policies and

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actual practices, budgets and actual expenses. The fifth step is to assemble the information and then take action on what has been discovered. Reviewing the information can show where the organization needs to move forward, step backward or reorganize.

Understanding growth stages will help to understand how the organization commits to its mission and how the important work of the organization is conducted especially when things don't go smoothly. Different parts of the organization may be in different phases of organizational development as they work through different projects. Understanding this strengthens and empowers the directors and members of any group to move in a positive direction and achieve the mission to which the organization is committed.

For a checklist of how your organization is working, see the example created by the Greater Twin Cities United Way located here: http://bit.ly/1LNWdux It can be completed online if you want to submit your name to a business company or the sections can be printed off for your use. Not every item on the checklist is relevant to maple producer associations but most of the sections will help show the strengths of and the opportunities for your maple association. Reviewing this checklist should generate useful discussions for your association and should streamline its work and possibly lighten the load.

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The First International Maple Symposium

On November 20 and 21, 2015, the very first International Maple Symposium and Érable en ville Salon (Downtown Maple Show) will be held in Québec City. This major event will bring together maple industry players from all over the world at the Québec City Convention Centre, a few steps away from the beautiful historical district of Old Québec.

The goal of the Symposium is to create a major event in order to disseminate international expertise in the field and inform maple producers, collaborators, and producer associations about the latest research and technological developments, potentials for further development, the challenges inherent to farm transfers, the industry's economic impact, and much more.

As for the Downtown Maple Show, it targets residents of the Greater Quebec City area especially families and people searching for artisan-crafted gifts for Christmas. Booths will be available to producers and businesses seeking to reach new audiences or take advantage of the holiday season to promote their products. The show is meant to provide an exceptional platform for presenting and disseminating information on maple products and all its facets. With the large-scale promotional campaign being planned, the target is to draw 10,000 visitors.

Proceedings will kick off on Friday the 20th with a presentation on business transfers and succession, within the family and without. Our speaker, Brigitte Paré, has been advising maple producers on this topic for years and will look at the challenges and opportunities inherent to this milestone event.

We will then discuss product authenticity and quality, starting with the organic certification process, with Monique Scholz from the International Organic Inspectors Association, and the new grading system, with Dave Chapeskie, executive director of the International Maple Syrup Institute (IMSI). Mark Harran, president of IMSI, will follow with a look at the steps industry can and does take in the fight against maple syrup adulteration and misrepresentation, while Yves Bois from Centre Acer will introduce a new tool to address the problem.

On Saturday the 21st, Michael Farrell of Cornell University, Dan Plamadeala of the Federation of Quebec Maple Syrup Producers (FPAQ), and Ihor Soloviy of the Ukrainian National Forestry University will present different trends and initiatives in the growing plant waters sector (maple, birch, coco and such).

We will follow with a panel of equipment manufacturers before turning our attention to the development of our industry. Geneviève Béland of the FPAQ, will give us an update on consumer tastes and perceptions worldwide, while Gilbert Lavoie, an economist at Forest Lavoie, will tell us more about the latest economic data on worldwide production as well as export opportunities.

Throughout the Symposium, simultaneous interpretation will be provided. For more information and for registration, please visit our website at maplesymposium.com

2015-16 New York Calendar of Upcoming Schools and Workshops

2015

November 6-7: Lake Erie Maple Expo, Northwestern High School, Albion, PA. The event starts at 9:00 am on Friday morning November 6th with a series of producer workshops and a companion tour. Friday evening will feature the maple equipment trade show from 5-8. On Saturday the seminar programs will start at 9:00 am after the opening ceremony by the Albion FFA Chapter. This year's program features an all-star cast of speakers, including Dr. Tim Perkins from the Univ. of Vermont Proctor Research Center, NY Maple Specialists Steve Childs and Dr. Mike Farrell from Cornell University, Leader Evaporator's Bruce Gillilan, and others. For more information, contact sheetstool@zoominternet.net; 814-337-0103.

December 5: Southern Tier Maple School, Contact: Brett Chedzoy, Cornell Cooperative Extension - Schuyler County, Agriculture and Natural Resources, office: 607-535-7161; cell: 607-742-3657; bjc226@cornell.edu

2016

January 8-9: New York State Maple Conference, Verona NY, Contact: Keith Schiebel; kschiebel@vvsschools.org or go to cornellmaple.com

January 16: Western NY Maple School, Contact: Deb Welch, Cornell Cooperative Extension of Wyoming County, 401 North Main Street, Warsaw NY 14569; 585-786-2251; djw275@cornell.edu

January 22: Lewis County Maple Production for the Beginner, Contact: Michele Ledoux, Cornell Cooperative Extension Lewis County, 5274 Outer Stowe Street, P.O. Box 72, Lowville, New York 13367; 315-376-5270; mel14@cornell.edu

January 23: Lewis County Maple School, Contact: Michele Ledoux, Cornell Cooperative Extension Lewis County, 5274 Outer Stowe Street, P.O. Box 72, Lowville, New York 13367; 315-376-5270; mel14@cornell.edu

January 30: Maple Expo- St. Lawrence County, Contact: Cornell Cooperative Extension, 1894 State Highway 68, Canton, NY 13617-1477; 315-379-9192

February 6: Oswego County Maple School, Contact: JJ Schell, Cornell Cooperative Extension of Oswego County, 3288 Main St., Mexico, NY 13114-3499; 315-963-7286; jjs69@cornell.edu

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