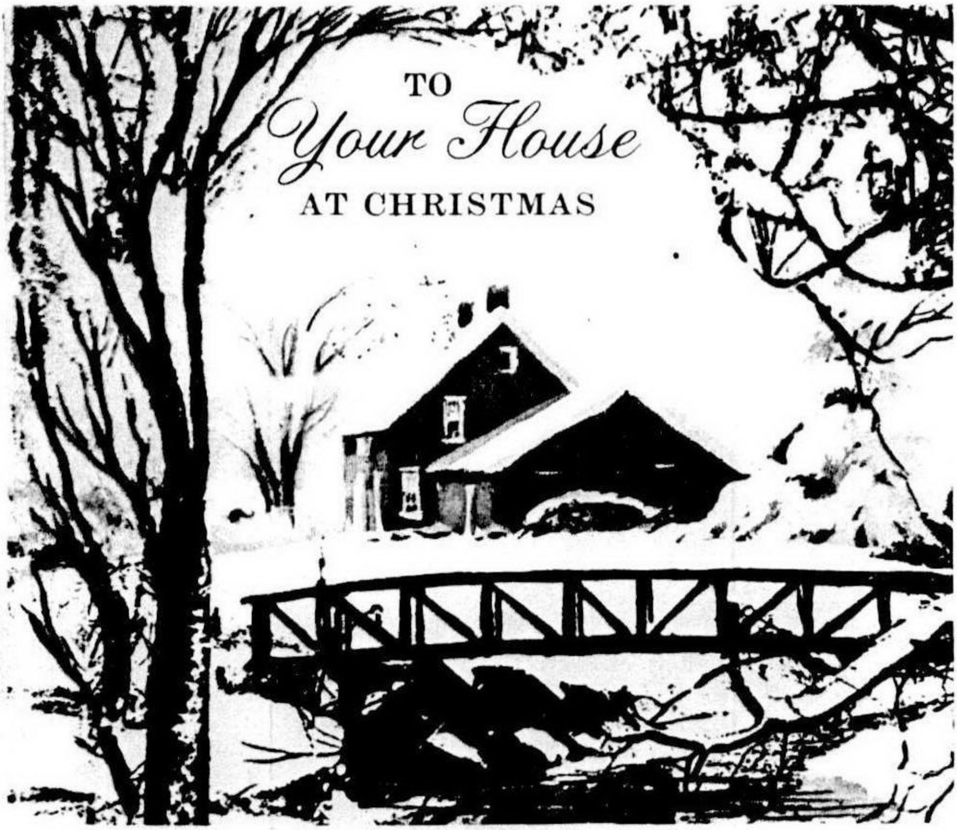
NATIONAL MAPLE SYRUP DIGEST



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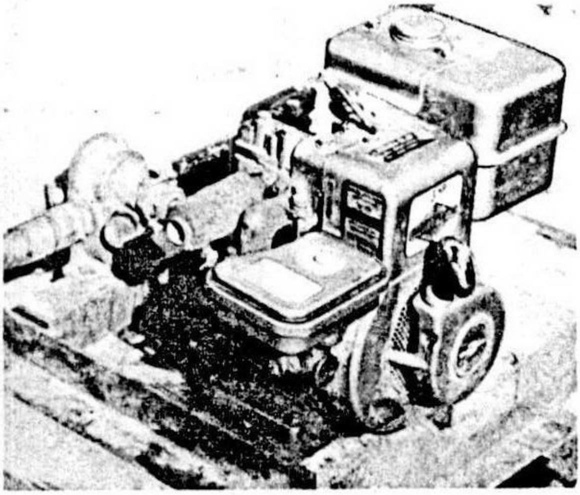

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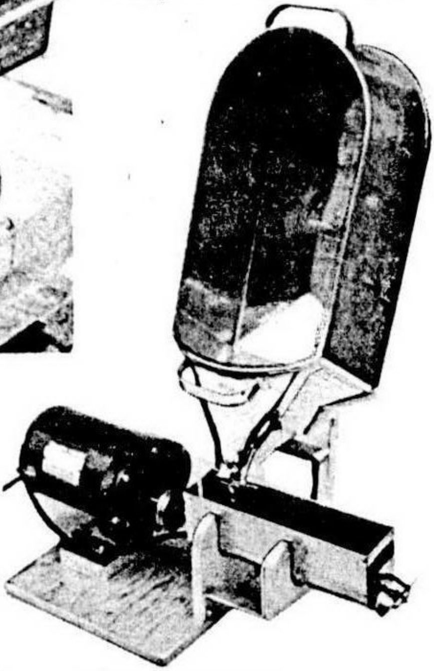

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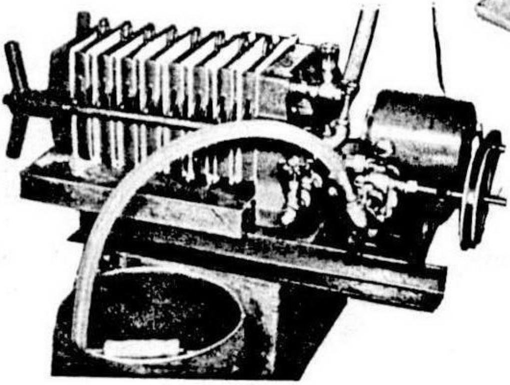

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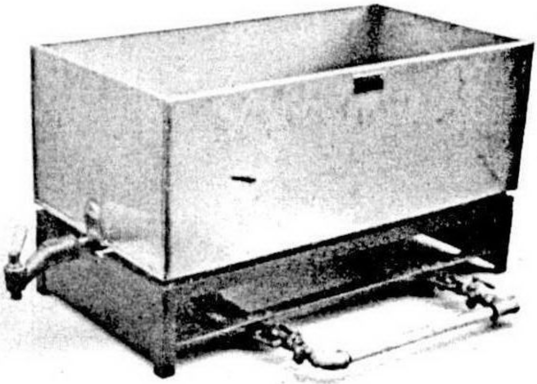

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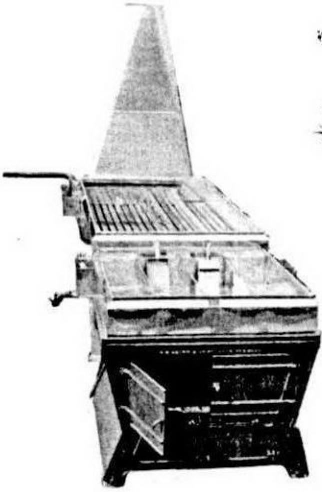

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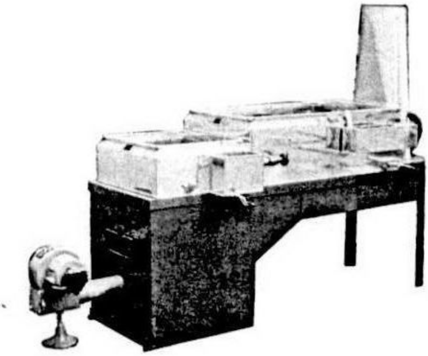

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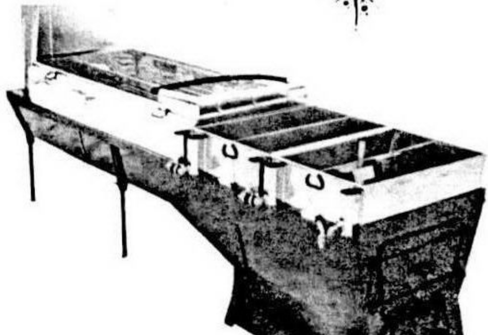

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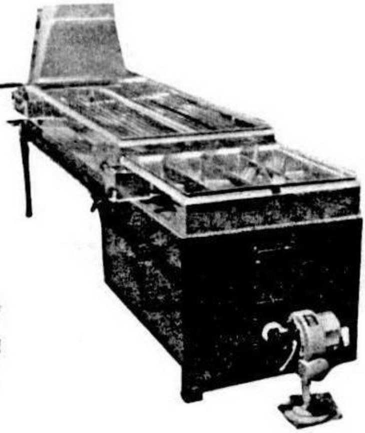

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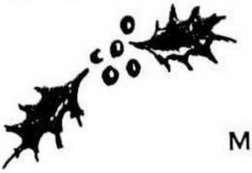

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Editorial

Many aspects of the maple industry continue to amaze me. One example is the dedication of some maple producers.

On October 21st, the North American Maple Syrup Council held its 15th annual meeting at Winding Brook Lodge in Keene, N. H. and for the 15th year, every member state was represented. I doubt if many organizations can boast 100% attendance for that length of time.

Kenneth Bascom, Alstead, N. H., was elected to succeed himself as chairman of the Council and Rex Alwin, Mound, Minn., continues on as vice-chairman. Gordon Gowen, also of Alstead, was elected secretary-treasurer to succeed Floyd Moore, Ocqueoc, Mich., who has served the council so well in that capacity for several years. Gordon is not new to the Council. He was, if I'm not mistaken, the first director from New Hampshire, has alternated with Mr. Bascom many times and has been a main-stay in the New Hampshire Maple Producers Association for more years than I can remember.

One of the highlights of the Council meeting was the continued support of the sugar maple pesticide problem (see Pesticides and the Sugar Maple Industry, Maple Syrup Digest, Oct. 1974). The Council also held a lengthy discussion on the dark syrup problem. Nothing was settled on, but the door was opened for an attack on the problem. Two meetings have been scheduled since then, one in Montreal, Can., on November 18, where possible action will be taken to set up a maple instititute to promote the use of dark syrup financed by a tax on the sale of dark syrup in bulk. The other meeting will be held December 4th in Burlington, Vt., by the Departments of Agric. & Mkts. of the Northeastern states in regard to the possibility of exporting syrup.

Many producers, including myself, find it hard to realize there is a surplus of syrup, especially in the darker grades. Living in an area where the crop has been sub-par for several years and the demand is good, there is no surplus of good syrup and the commercial companies have always bought the dark stuff. This may no longer be the case because of the small amount of dark syrup used in the blends. There just isn't as large a market for dark syrup as there used to be.

What can we do about it? There are already steps being taken to dispose of more of this grade but all producers can help by making less dark syrup. This is probably more difficult to do than to talk about but it can be done with better production methods - like gathering oftener, washing equipment during the season, sterilizing sap and above all, don't hang on at the end until the last drop comes out.of the tree. It's probably buddy anyway.

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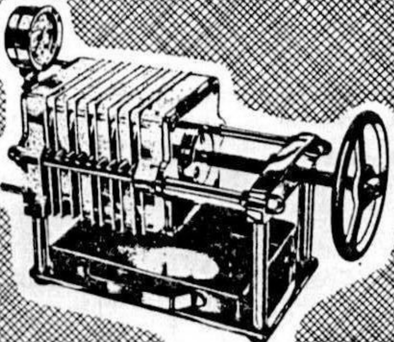

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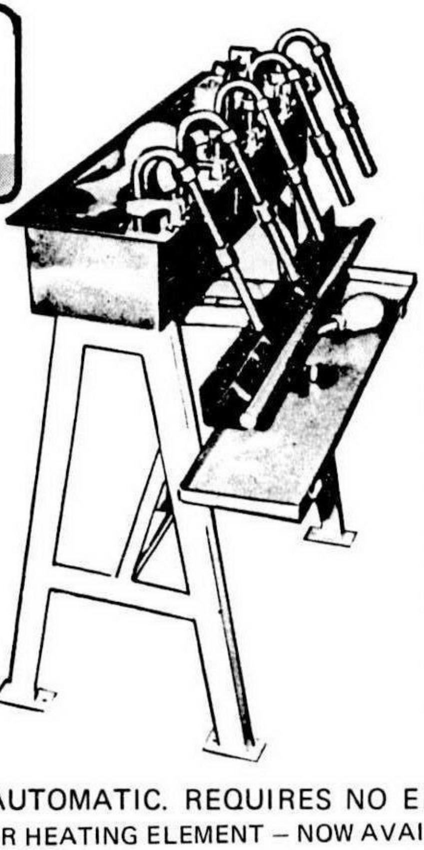

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OUR CATALOG SHOWS LOTS OF THINGS!

HERE'S HOW I DO IT

Russ Davenport
Davenport's Sugar House
RFD 1, Shelburne, Mass. 01370

There probably are as many ways and systems for heating and canning maple syrup as there are syrup makers. I have tried several and have finally come upon one that works well for me. As we all know it is very important to have the syrup at least 180 degrees Fahrenheit. With the extensive use of plastic jugs it is even more important that this temperature be maintained throughout the canning process. This temperature should not be just a guess, but a fact proved with a thermometer. I heated syrup in 10-quart kettles on the kitchen stove for years after drawing it from the drum by means of a gate turned in the end bung hole. This not only made many chances for spilling and boiling over, but was time consuming and rugged work as the drum could not be taken into the kitchen. Also it is not proper to can syrup in the same place as the family food is prepared.

With the need to process the syrup more efficiently and faster, my wife, Martha, and I decided to turn an old kitchen into a room for canning syrup and candy making. I had a stainless steel 10-gallon canning tank made with three faucets for filling cans. I found it necessary to have a quarter turn valve immediately outside the tank. The best faucet I know is a milking machine stall cock. The ones I use are brass and have a hole about a quarter inch in diameter. With the valve, the flow of hot syrup can be regulated when one or more faucets are being used to cut down on the foam in the syrup cans. I open the canning faucets wide and then open the quarter turn valve enough to get an even full flow that is not under pressure in the tank. This is even more important when the canning tank is full.

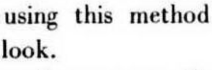
We purchased a two unit commercial electric hot plate to place under the canning tank with the draw-off faucets high enough to fill gallon cans. A shallow tray, stainless steel, one inch deep is placed under the cans to catch drips and spills. Spilled syrup is not lost as it can be dumped back into the canning tank. For smaller size cans and jugs the tray is raised by blocks of wood to the proper height.

This hot plate system worked well as the hot syrup did not have to be moved by hand to the filling tank. Still the syrup had to be done in batches, a tank at a time. The hot plate is also used for boiling down the syrup for maple sugar in a 10 quart kettle.

I use a ½-inch bronze gear pump run by an electric motor to move the syrup from the drum to the canning tank. On the suction side of the pump I have three feet of clear plastic ½-inch hose connected to three feet of ½-inch copper tube which is inserted in the side opening of the drum. A simple flick switch makes operation of the pump easy.

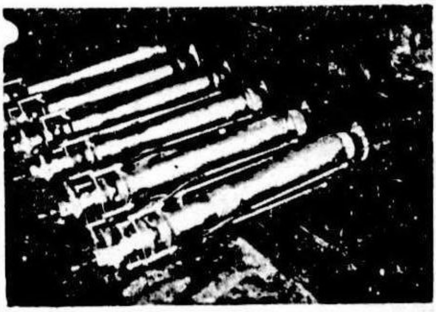
We still wanted a faster, continuous means of heating syrup so I considered the hot water bath type where a coil of tubing is submerged in a tank of electrically heated water with the syrup pumped through the coil. Others had told me that it was hard to get syrup hot enough using this method so I continued to look.

This summer I came upon the idea of using the oil-fired hot water heater in our home as a source of heat. This heater can be adjusted up to 200 degrees Fahrenheit. I found a large compressor coil at a defunct milk bottling plant. It is a double coil of ¾-inch copper tubing about 50 lineal feet, 14 inches across and 17 inches high. Inside the ¾-inch tubing is a 3/8-inch copper tubing. This allows me to pump the hot 200-degree water through the ¾-inch coil from top to bottom by means of a water circulator such as on any hot water furnace. The water goes back into the supply side of the water heater requiring less oil to reheat. The syrup is pumped through the inside coil from bottom to top and out through a filter into the canning tank. I found the syrup pump must be slowed down to about 200 RPM's to have the syrup 180 degrees in the canning tank. Even so the pump cannot be run continuously and it is impossible to can the syrup this fast. I find it takes about three hours to put 2 drums into pints, quarts, half gallons and gallons. I draw off the syrup into the cans or jugs and my wife or one of the kids cap, sticker and put them aside to cool.



Clean-up is easy as the system is flushed by putting the intake pipe from the drum into a large pail of the 200-degree water until it runs clear. This leaves only the canning tank and tray to be washed in the nearby sink.

I am sure there are other ways to can syrup and maybe some are better, but "this is how I do it".



PENNSYLVANIA MAPLE TOUR IN ENDLESS MOUNTAINS

Both new and old, large and small maple camps were visited by an enthusiastic group in early October with the fall foliage at its peak of beauty. Weather conditions were perfect and the hills and mountains of Bradford and Sullivan Counties provided the setting for Pennsylvania's largest and most successful maple tour.

Vernalder Farms near Le Raysville was the first stop. This partnership of two young men features an 8000 tap operation on pipeline and vacuum with two large and one small evaporators almost completely automated.

The "Maple Madness" sugar camp was visited next. This operation has been in the Ford family and in continuous production, over 100 years with young Rodney Ford now in charge. It is a 2200 tap operation which is mostly on pipeline. The present cabin containing a candy kitchen-sales room is only three years old and well located adjacent to the farm homestead.

A dairy farmer near the New York state line was the next stop. Bill Brown built a maple camp and 1974 was his first year of making syrup. The 600 taps are all on tubing with gravity flow to the camp which is located at the lower end of the bush.

The banquet crowd filled the Rome Methodist Church Hall with 176 people.

E. P. Farrand, Ext. For.; James Bochy, Somerset Co. Agent; Lynn Frank, Pa. Bureau of Forestry; Orville Yoder, Bradford Co. Agent.

James Bochy, Somerset County Extension Agent as M.C. kept the group in a jovial mood, while John Varny played the organ. Further entertainment was provided by a quartet made up mostly of maple producers followed by two slide presentations.

Clifford Robinson, a local science teacher, showed how some of his students carried on a maple syrup operation using some maples on the school property.

Lynn Frank of the Harrisburg office of the Pa. Bureau of Forestry gave an illustrated lecture on the Water Transportation Era in Pennsylvania featuring the log rafting days of a century ago on the Susquehanna and Allegheny river systems.

There were guests on the tour from all parts of Pennsylvania as well as six other states and Canada.

The Saturday program began with a visit to the Towanda Sylvania plant where tungsten and molybdenum components for light bulbs, T.V. tubes and welding torches are produced.

A beautifully scenic trip to the Forksville area of Sullivan County brought the group to the maple camp of the Robert Woodheads - another century maple farm - which features 1200 taps, mostly tubing, and a 4x14, wood-fired evaporator.

The last maple camp stop was the new Randall Brothers' facility with an oil-fired evaporator to handle the 800-bucket operation.

The ladies of St. Peters United Church of Christ provided an all-you-can-eat pancake, maple syrup, sausage, egg and donut dinner. This prepared the group for the final scenic part of the tour. It included visits to the Lincoln Falls, High Knob Lookout, and Loyalsock Canyon Vista.

The Endless Mountains Maple Producers Association along with the Bradford and Sullivan County Extension Agents are commended for a beautiful, informative and well conducted program.

NOTICE:–

Due to changes in personnel at the printers, we must adhere to our closing date for all copy in the future.

The closing date for all copy is thirty (30) days in advance of scheduled issue.

Example: Closing date for the February issue will be January 1.

CONTROL OF FANCY MAPLE SYRUP QUALITY IN THE RETAIL PACKAGE

PAUL E. SENDAK
Northeastern Forest Experiment Station
Forest Service, U.S. Dept. of Agriculture
Burlington, Vermont
and
MARIAFRANCA MORSELLI
Proctor Maple Research Farm
University of Vermont
Burlington, Vermont

What effects do containers have on the quality of pure maple syrup? A simple question; yet a recent study by the University of Vermont Proctor Maple Research Farm and the USDA Forest Service resulted in some complex answers. The purpose of this article is to discuss some of the results of that study.

Maple syrup producers want containers that will protect their product, ship well, and appeal to the consumer. But above all, they want containers that will preserve the flavor and appearance of the syrup.

Maple syrup containers are made of glass, metal, or plastic. They may range in price from an inexpensive glass bottle to a piece of glazed pottery worth more than the syrup in it. Each type of container has advantages and disadvantages, depending on the market the producer intends to sell in.

An experiment was designed to determine the effects of containers on the quality of fancy grade pure maple syrup. Storage temperature, light, and storage time were varied to test their effects on the syrup.

Eight different types of syrup containers were evaluated under four controlled temperature and light conditions at 3-month storage intervals for 1 year. The experiment was duplicated once to provide a measure of experimental error so that the data could be analyzed statistically.

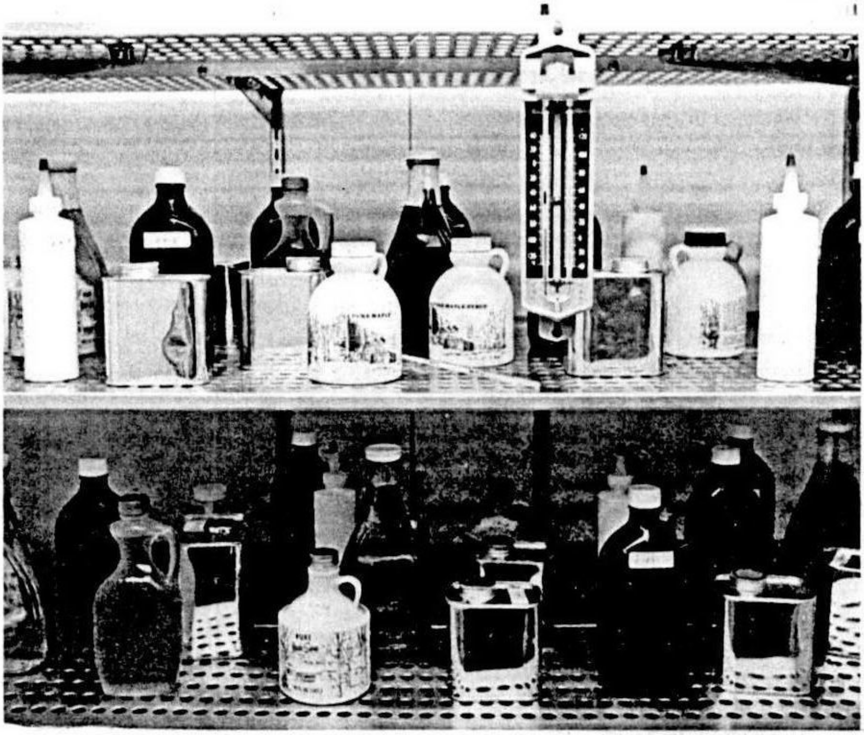
The temperature and light conditions and the containers and storage times tested were as follows:

Temperature-Light Conditions:

1. 39° F in the dark.
2. 75° F in the dark.
3. 75° F under fluorescent lights at 200 foot-candle intensity.
4. 86° F in the dark.

Containers:

1. Clear glass (1 pint size).
2. Amber glass (1 pint size).
3. Polypropylene plastic (3/4 pint).
4. XT-Polymer plastic (1 pint).
5. High-density polyethylene plastic (1 pint).
6. PLAX plastic (1/2 pint).
7. Tinned steel can (1 pint).
8. Tinned steel can (1 pint) with some tin scraped away.



Syrup containers in one of the controlled storage areas.

Storage Times:

1. 3 months.
2. 6 months.
3. 9 months.
4. 12 months.

About 30 gallons of syrup were required for this study. A fancy grade syrup was used, which was well within the grade limits set by Vermont law. We obtained all the syrup from one producer and stored it in a drum for a month between production and packing.

The syrup was thoroughly mixed in a large vat and hotpacked in a commercial maple syrup packing plant. Once the syrup reached room temperature, the containers were placed in storage under the controlled temperature-light conditions and were not disturbed until selected at the end of one of the storage-time intervals. Once a container was opened for analysis, it was removed from the study.

QUALITY MEASUREMENTS

Maple syrup quality is set by grading law, which specifies measurable standards such as density and color and sets descriptive standards for flavor. Eight samples of the syrup were analyzed at the time of packing to provide a comparison for measurements of quality. Changes in these measurements were evaluated statistically and were attributed to container, temperature-light conditions, or time, to indicate what effect these had on syrup quality.

Syrup density was measured by refractometer, and color was measured by light transmittance. In addition, measurements were made of conductivity, pH (acidity), phenols, invert sugars, amino nitrogens, iron, zinc, and tin. Flavor was evaluated by a panel of four expert maple syrup tasters in a controlled tasting experiment.

The syrup was analyzed in a 4-day period every 3 months. Each day, eight containers and their duplicates were removed from one of the four temperature-light conditions and were allowed to reach room temperature. The container head space was inspected for mold growth, then the container was closed and shaken, and the syrup was divided into samples for the various analyses, which were performed immediately.

TEMPERATURE-LIGHT

The speed at which chemical and physical changes take place in the syrup is related directly to temperature. Increasing temperature accelerates change in the syrup, independent of time and container. Although light probably had some effect on the syrup in certain containers, we have not been able to determine this effect.

The most favorable temperature condition was 39° F. At this temperature, the changes in the syrup were not statistically significant, and all containers performed about the same through the full 12 months of the study. The taste panel was not able to differentiate changes in flavor in samples from the different containers, even after 12 months in storage.

The poorest temperature condition was 86° F. In general, changes occurred in less time at the higher temperature, and the changes were greater. There were differences between containers for specific factors. But the differences were impossible to evaluate when related to syrup quality; thus the containers could not be ranked fairly.

Intuition tells us that a container that will minimize change in syrup quality would be considered the best container. Two problems arise. First, the containers do not consistently perform the same in all quality measures. Containers that are good at maintaining the original iron content of the syrup may perform worst in maintaining the original pH. Second, the relationship of one quality measure to any other is unknown. That is, how does a change in pH from 7.2 to 6.2 compare to a change in iron content of 9 ppm (parts per million) to 27 ppm? And how do the quality measures interact with each other to produce a total effect on syrup quality?

The flavor panel was designed to test for consistency among panel members' ranking flavor of the samples taken from different containers from one storage condition at a time. The panel's rankings were statistically significant after 9 months' storage at 75° F and 86° F. However, rankings among storage conditions and time of storage were not consistent. This indicates that flavor differences were slight and probably would have little effect on retail sales of the syrup.

In general, flavor scores decreased over time and with increasing storage temperature. All plastic containers, as a group, averaged slightly lower flavor scores than did glass and metal containers combined. This may indicate a preference by the expert tasters and may not necessarily reflect consumer preference.

TIME

Time between production and consumption of syrup is a factor that the producer can seldom control. The condition of the syrup changes with time. Unlike wine, syrup does not improve with age. However, the producer can minimize the impact of time by storing syrup in large containers such as drums and keeping it cool. At 9 and 12 months, trends in response began to emerge for several of the quality measures.

CONTAINERS

Few statements can be made about the effects of containers on the syrup. The following results refer to the syrup stored for 12 months at 86° F. It was at this temperature and time period that the greatest average changes had occurred. Results at other temperatures are specifically noted.

Acidity. The pH generally decreased more in plastic containers than in the metal and glass containers. The pH reading at the start of the study was 7.2, slightly basic. The pH for the plastic containers averaged 6.2, and for the glass and metal containers, it averaged 6.9.

Iron. The iron content of the syrup remained about constant at the initial value of 9 ppm in the glass and plastic containers. However, in the metal containers (tinned steel) the iron content increased to an average of 19.8 in an undamaged can and to 23.7 ppm in a damaged can.

Density. There was virtually no change in syrup density except in one contamer. Syrup in plastic containers made of XT-polymer increased in density from the initial 66.4° Brix to an average of 68.5° Brix after 12 months storage. Water had somehow been removed from the syrup, leaving a higher concentration of sugar. This did not occur in containers made of other materials.

Color. Color change led to some definite response patterns that are attributable to containers. Syrup may become either lighter or darker in storage, and it did both in different containers. The containers that maintained the original color best after 12 months storage at 86° F were the polypropylene and PLAX plastic containers and the amber glass. The syrup in the metal containers became considerably lighter in color, with a slightly green cast to the amber color. This change appears to be associated with the increase of tin in the syrup. The syrup in the XT-polymer plastic became sufficiently darker after 12 months to be graded grade A on color alone. The syrup in clear glass and in the high-density polyethylene plastic became darker.

The darkening that occurred in the XT-polymer plastic is statistically and significantly correlated with the increased density observed in that container. Thus the darker color may be partially explained by the increased density.

The other quality measures, conductivity, invert sugars, amino nitrogens, phenols, and zinc, changed only slightly and showed no consistent patterns that might help at this point to judge the performance of the containers. Tin, measured only in syrup from the metal containers and in the control, increased from 6 ppm at the time of packing to 37 ppm in the undamaged metal containers and 33 ppm in the damaged metal containers.

CONCLUSIONS AND RECOMMENDATIONS

In choosing a container, the producer must consider his marketing needs. Weight, durability, and attractiveness will help determine the choice. If a good quality fancy syrup is to be stored no longer than 6 months in the retail container, at room temperature, and has been properly hotpacked, the quality of the syrup will be maintained satisfactorily in all the containers we evaluated.

Sufficient darkening of the syrup to cause a change in grade from fancy color to grade A occurred in only one container, XT-polymer plastic, after 12 months storage. Syrup in clear glass and the high-density polyethylene plastic also became darker, but not enough to change grade. Syrup in tin became lighter, but the original amber color took on a green cast. If the producer finds that color change has a negative effect on his syrup sales, then it is apparent that color maintenance can be controlled somewhat by choice of container.

The following general recommendations can be made:

1. Store syrup in bulk containers until you are ready to put it on the shelf for retail sales or to sell it to a retail outlet.
2. Devise a packing-date system to protect syrup in retail containers from being stored on the shelf too long at room temperature.
3. Keep the syrup as near 39° F as possible, no matter what container it is in.
4. Recommend to the consumer that he keep the syrup refrigerated even before opening the container.

This study is to be expanded to include evaluation of grade A and B syrups and additional containers under similar storage conditions.

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Dept. of Natural Resources
Cornell University

The flow of maple sap through plastic tubing is influenced in two ways. Friction between the sap and tube wall slows sap flow, can cause air locks, may cause back pressure, and can seriously reduce sap production. Under certain conditions a natural vacuum is made which increases tree pressure differences, resulting in more sap flow. Vacuum can also be created by pumps. The actual sap flow obtained depends on the producer's ability to reduce friction and create vacuum.

Friction. Friction depends on slope and tube size. It increases on level or uphill flows, and with small tubing. It decreases on steep downhill flows and with larger tube diameter. For five-sixteenth inch tubing[1] on level ground, 500 feet is sufficient to cause much back pressure and can reduce yields to half or less. On 5 percent slopes, careful installation to maintain a constant grade greatly reduces friction. Aerial tubes with minimal sag are often best.[2] On steep slopes friction may be of no practical importance. However, alternating steep and shallow slopes are troublesome because friction is primarily determined by the lesser slopes. Economic considerations dictate small tube size; therefore the producer's primary concern is with adaptation of tube lines to topography to take advantage of slope and reduce friction.

Natural Vacuum. Natural vacuum is caused by the weight of sap in closed, leak-free tube lines on slopes. High columns of sap, rising vertical distances of 30-50 feet or more in tubes, make good heads. Fast flow rates are also needed for good vacuums. Thus numerous tapholes on sloping land are necessary. Large numbers of tapholes provide the sap needed for both high sap columns and fast flow rates. Other factors that promote sap flow, such as suitable climate and weather and vigorous trees, also increase vacuum to create even more sap flow.

There are relationships between slope, tube capacity, and the flow rate necessary for good vacuums. Tubing on steep slopes has little friction, a high sap carrying capacity, a potential for high vacuum, but a need for very fast flow rates to obtain high vacuum. On shallow slopes, there is more friction, less carrying capacity, lower potential vacuum, and lower needed flow rates. Our tests indicate the following:

15% slope – 100 or more taps per line needed for high vacuums; may be difficult to find enough taps.
10% slope – 50 to 80 taps; highest vacuums were found on this slope.
5% slope – 40 to 50 taps; more taps may overload line.

2-4% slope – probably 15 to 40 taps; difficult to install and maintain even slopes; only limited vacuum possible.

It is likely that attempts to obtain natural vacuum on slopes of less than 2 to 3 percent may be impractical. On the other hand tube networks on steep slopes can often be angled across hillsides to obtain the optimum 10 percent slope with little or no increase in the amount of tubing used.

The number of tapholes per tube line is based on tests of single lines without tees. If 100 tapholes are desired for natural vacuum, it is assumed that a portion could be placed on short tee lines at upper levels. However, a pair of 50-tap lines joined near the base would have lower sap columns, slower flow rates, and less vacuum.

Natural vacuum is maximized by maintaining near-constant slopes, usually with aerial lines. Sag between trees should be minimized and tube lines should not be run into low spots to pick up extra taps. Alternating steep and shallow slopes reduce vacuum. The friction in a 100-foot level stretch of tubing, especially at or near the bottom of a hillside line, can reduce vacuum to less than half.

The lower half of tube lines is usually more critical than the upper half in determining flow rates and vacuum. Thus a tube line of 10 percent slope at the base and 15 percent at the top may be quite acceptable. It is especially important that the base of tube lines be located where there is still sufficient slope to avoid friction and vacuum loss. If necessary, half inch pipe can be used to carry sap further down the hill to collection tanks.

Natural vacuum tends to increase sap flow in proportion to the amount of vacuum. Seasonal sap gains appear to be at least one quart per taphole for each inch of mean vacuum. This may amount to some 20 to 50 percent more sap without noticeable change in quality and with no added equipment. The higher gains are associated with good seasons and sugar bushes.

Pumped vacuum. While natural vacuum can produce excellent results with ideal slopes and good sap flow conditions, pumps make vacuum and more flow in a variety of circumstances. Pumped vacuum can occasionally induce flows that would not otherwise occur, and it is especially useful on adverse slopes and in low flow situations.

Pumped vacuum can also overcome tube friction on low slopes, pump uphill for short distances, and eliminate air locks. However, vacuum used to overcome friction is not available to induce more flow at the taphole. On slopes of more than 3 - 5 percent, vacuum may increase near the end of the tube line. On the level, however, vacuum decreases rapidly with distance and the number of tapholes when sap is in the tubing. As few as 50 tapholes can dissipate all the vacuum. Thus few taps and near-empty tubes are best for pumped vacuum in the absence of good slopes. Pumped vacuum, like natural vacuum, is improved by careful design of tube networks that take advantage of slopes to minimize friction and strengthen vacuum.

Pumping, by removing much of the sap from tube lines at the end of flows, can reduce losses that might occur from freezing or reabsorption. Pumping has also aided sap collection by bringing more sap to a central point and can reduce road or trail construction and maintenance.

Yields of sap from pumped vacuum can be doubled under some conditions, but average gains are usually less. It is necessary to distinguish between gains from increased sap from the taphole and increased flow through tubing on flat land.

The problem of balancing sap gains with equipment costs remains. Theoretically there should be a vacuum pump at each tap hole for maximum sap flow. For minimum cost, there should be one centrally located vacuum source where electricity is available for minimum capital, maintenance, and sap transport expense. Each producer has his personal constraints in such matters as topography, location of sugar house and power, and road systems. He must make his own compromise between sap gains and pumping costs.

Vacuum transfer. Just as friction in tube lines reduces vacuum, so does friction in main pipe lines. Even when suspended and well-graded pipe lines are pumped, little vacuum may reach the tap hole. Vacuum transfer is a means of by-passing the main pipeline. The vacuum pump may be located away from the woods at a convenient power supply. Vacuum has been transferred effectively for long distances through half inch plastic pipe to dump units located at the upper end of the main pipe line. Sap goes from the dump unit into a small vent tank and then into the suspended and graded pipe line. Vacuum transfer gets the vacuum supply near the tapholes at little expense; the one disadvantage is the location of the dump unit in the woods where it is less easily checked and maintained.

Flat land, no vacuum. There are good reasons for not applying vacuum on land with little slope – non-availability of power, inexperienced workers, too few taps to warrant pumping expense, etc. Mr. Lloyd Sipple recently published a pictorial pamphlet, entitled "Flat Land Tubing", which describes a vented tube system for gathering sap on flat land. Limited to 50 taps, requiring careful layout and adjustment to tap heights, and utilizing either aerial or ground tubing, the system is a viable alternative. Other alternatives may include buckets, provided there are sufficient access roads, or expending time on other more favorable tap areas.

Summary. The amount of sap obtained from tube networks is influenced by vacuum and friction. Natural vacuum, pumped vacuum, and non-vacuum systems all have a place in sap collection. They are very different; yet they have much in common. Suitable and near-constant slopes are most important in maximizing vacuum and minimizing friction. Aerial tubes with minimal sag are usually superior. Trees in depressions are seldom worth tapping.

Where slopes are suitable, natural vacuum can increase sap without added equipment. Pumped vacuum offers the most sap, but with added costs. Level ground offers the poorest opportunity for tube networks.

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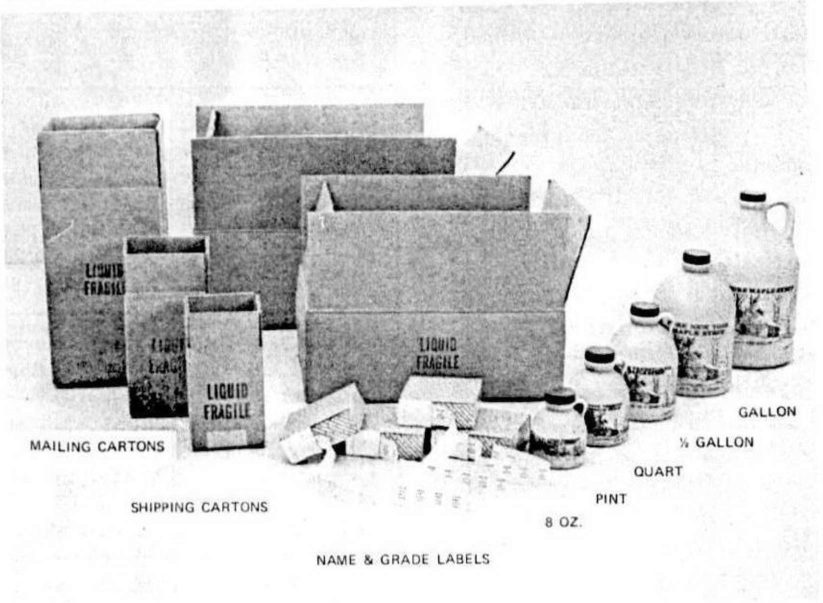
[1] All of our experiments were made with 5/16 inch tubing. Quarter inch tubing has more friction.

[2] Aerial tubes also seldom need lifting from the snow.



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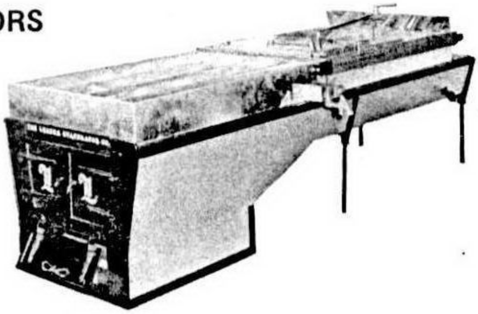

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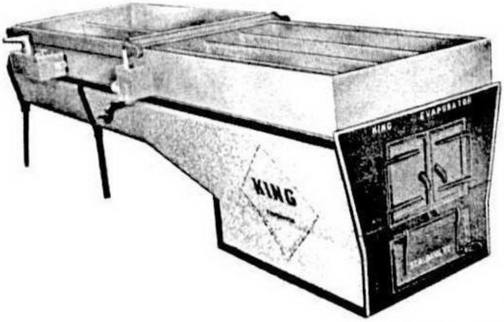

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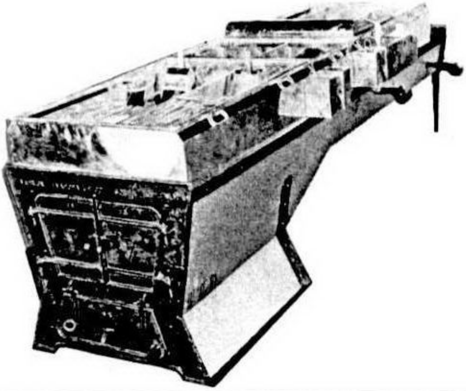

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