CHAPTER 5

SAP AND RESIN

SYRUPS, SUGAR AND CONFECTIONERY PRODUCTS

MAPLE SYRUP AND RELATED PRODUCTS

The sap of most maples (*Acer* spp.) contains relatively high levels of sugar (2–5 percent). In eastern Canada and the northeastern United States, maple sap is harvested and evaporated for production of syrup and sugar and is an important regional non-wood forest product.

Historical aspects

Indigenous tribes in eastern North America knew of the high sugar content of maple sap, calling it "sweet water." They harvested the sap using primitive methods such as piercing the trunk of a maple with an axe (tomahawk) and inserting a piece of bark or wood to collect the sap. When the first European explorers and colonists arrived on the North American continent, the local indigenous tribes introduced them to the sweet flavoured maple sap. The pottery of the indigenous tribes did not withstand heat, however. Consequently, they were unable to boil the sap down to produce syrup or sugar. The harvesting of maple products in North America by European settlers is believed to have begun in about 1680. Blocks of maple sugar were first exported from Quebec, Canada, to France in 1691.

When the French settlers arrived in eastern Canada, tapping of maple trees was done with a small axe. A wooden spile was inserted to channel the sap into a receptacle made from the bark of paper birch (*Betula papyrifera*). Around 1885, the wooden spout was replaced by one made of metal and tapping was done with a steel gouge. Roughly five years later, wooden pails suspended by a nail made their appearance and reduced the amount of sap lost.

The first European settlers produced just enough syrup and sugar to meet their own needs. In early spring, when the sap begins to flow in the maple trees, they would sometimes travel considerable distances to reach sugaring sites. Once they arrived, they would build a temporary shelter, install spouts and pails and wait for the sap to flow. Barrels of maple sap were transported by means of an ox-driven sleigh to the boiling shack where it was boiled down in a cast iron cauldron. After 1900, flat-bottomed pans that were placed on enclosed stonewall fires replaced the cauldrons. Later a decantation siphon was added to the flat-bottomed pans and evaporators were developed. Today's systems include integrated thermometers, floaters that control the intake and level of maple sap, a hood to evacuate the steam and oil burners that are replacing wood as a heat source.[11]

Species

Sugar maple (*Acer saccharum*) is the species most frequently tapped for sap production. This tree is a major component of temperate broadleaf forests in eastern Canada and the northeastern of the United States. Black maple (*A. nigrum*) is so similar to sugar maple that it is often not differentiated from sugar maple and is also tapped. The so-called "soft" maples – red maple (*A. rubrum*) and silver maple (*A. saccharinum*) – are also occasionally used for syrup production. However, a major drawback of using these species is that bud development occurs earlier in the spring and the sap becomes unusable before the end of the sap flow season. Studies indicate that Manitoba maple (*A. negundo*) and the European "Norway" maple (*A. platanoidesl*) are also considered to be potential maple syrup producers [Walters, 1982b], and there has been some interest in tapping big-leaf maple

[11] Source: Institut Québécois de l'Érable, Quebec, Canada (http://www.erable.org)

(*Acer macrophyllum*), a tree indigenous to the Pacific Coast of North America [Sednak and Bennick, 1985].

Products

The principal product produced from the sap of maple trees is maple syrup (Figure 5.1). Quite simply, maple syrup is sap that has been boiled until much of the water has evaporated and the sap has become thick and syrupy. At the beginning of the sugar season, when the sap is concentrated, it takes about 20 litres of sap to make 1 litre of syrup. Toward the end of the season, it may take up to 50 litres of sap to make one litre of syrup. Maple sugar, which is about twice as sweet as granulated white cane or beet sugar, is the result of continuing to boil the sap until all of the liquid has evaporated. In-between these two stages, at least two other products can be made: maple honey, which is thicker than syrup but still a liquid, and maple cream or butter, which is thick and spreadable. A less expensive product is maple-flavoured syrup, which is a combination of corn or molasses syrup with a small amount of maple flavouring.[12]

Figure 5.1 Grade A, dark amber maple syrup produced in Vermont and packaged for retail sale.

Maple syrup has about the same calories as an equivalent amount of white cane sugar and contains potassium and calcium along with trace amounts of sodium, iron and phosphorus (Table 5.1).

Table 5.1 Nutritional value of a tablespoon of maple syrup

Nutrient	Amount
Potassium	35 mg
Calcium	21 mg
Sodium	> 2 mg
Iron	Trace
Phosphorus	Trace
B vitamins	Trace
Calories	50*

* Approximately equal to an equivalent amount of cane sugar.

12 Source: Epicurious Food (http://www.epicurious.com/db/dictionary/terms/m/maple-su.html)

Sap collection

Forests where maple sap is collected are referred to as "sugar bushes." Sugar bushes are generally found on privately owned woodlots and consist of maple stands of natural origin. Differences in past cutting practices and land use have resulted in wide variation in the age, density, form and composition of these stands. Most have originated from second or third growth forests or from young stands of sugar maple that naturally seeded on abandoned agricultural lands. Another type of sugar bush is referred to as a non-forest sugar bush. These are individuals or small groups of trees growing in the pasture of small dairy farms or trees growing along roadsides and fence lines [Walters, 1982b]. Under the best conditions, sugar maples reach a tappable size in about 40 years. The number of taps per tree varies by the tree's diameter at breast height (dbh). A guideline for the number of taps is: 25–38 cm, one tap; 39–50 cm, two taps; and 51–64 cm, three taps [Thomas and Schumann, 1992]. A carefully tapped tree will give, drop by drop, about 12 litres of sap on a warm spring day, and could continue to produce sap for a century. During the maple sugaring season, which lasts about six weeks, an average maple tree will yield between 35 and 50 litres of sap. This will produce between 1 and 1.5 litre of pure maple syrup.

The maple tapping season generally lasts from mid-March to mid-April, during the thawing of the ground after winter, but before the buds burst on the maple trees. A good maple season has warm days, but nights below freezing point. Maple sap does not flow during the night.[13]

Sap collection is a labour-intensive process and accounts for more than 40 percent of the total labour involved in syrup and sugar production. Metal buckets are the traditional collection utensils and are still widely used. The most commonly used metal buckets are zinc-coated and hold about 15 litres of sap. Minute amounts of zinc dissolve in the sap and dissolve microbial growth. Aluminium buckets are popular in Canada.

Plastic bags have replaced buckets as sap collectors to some extent and have the advantage of keeping the sap cleaner because they have narrow, covered openings. Moreover, because the plastic bags are transparent, the sterilizing effect of ultraviolet (UV) light from the sun improves sap quality. Plastic bags are lightweight and, because they lie flat, require a minimum of storage space. On the other hand, plastic bags are less durable than metal buckets and are subject to splitting and tearing.

Regardless of whether metal buckets or plastic bags are used, the sap must be collected at regular intervals during the tapping season. Most often, a gathering tank mounted on a sled or wagon is drawn through the sugarbush and the buckets or plastic bags are emptied into the tank. Sap loss from spillage or missed buckets can be a significant factor in the efficiency of a sap-collecting operation.

Figure 5.2 A traditional sugaring-off party in Quebec, Canada (photo courtesy of Victor Brunette, La Fédération des Producteurs de Bois du Québec, Longueuil, Québec, Canada*).*

Box 5.1 The sugaring off party: A maple country tradition

In both Canada and the United States, the maple syrup industry is dominated by owners of small woodlots, who have managed to carry on many of its colorful traditions.
One of the more colourful traditions is the "sugaring off" party that takes place after the final boiling of the sap has been completed. Friends and neighbours, especially young children are invited to participate. The party usually consists of a hearty feast followed by the making of maple taffy. The steaming hot syrup is taken from the evaporators and poured over clean, fresh snow. The end product is cold and chewy and is a memorable taste experience (Figure 5.2).

[13] Source - Canada Maple Products, Plessisville, Quebec, Canada (http://www.ivic.gc.ca)

Plastic pipeline systems of various configurations and pumping systems have been used by sap producers with varying degrees of success although many still use metal buckets or plastic bags for sap collection [Walters, 1982a]. The collected sap is boiled down into syrup in flat metal tanks or evaporators in buildings known as sugar camps or sugar houses and must be boiled the same day it is gathered (Figures 5.3 and 5.4).

Figure 5.3 An evaporator in a sugarhouse in Quebec, Canada (photo courtesy of Victor Brunette, La Fédération des Producteurs de Bois du Québec, Longueuil, Québec, Canada).

Plastic pipelines, that are attached to tapped trees and run to a collecting station or directly to the sugarhouse, were developed during the 1950s and are a means of improving the efficiency of sap collecting. Advantages of a plastic pipeline system include:

1. It permits a better distribution of labour during sugaring;
2. Results in less labour during sap collection;
3. Achieves more sanitary collection and transportation of the sap;
4. Eliminates road building and maintenance in sugar bushes.
5. Increases yields by reducing infection in the taphole by airborne microorganisms.

Figure 5.4 A sugarhouse in Quebec, Canada (Photo courtesy of Victor Brunette, **La Fédération des Producteurs de Bois du Québec, Longueuil, Québec, Canada*).***

Production and trade

The world's supply of pure maple syrup is produced in a relatively small area, including parts of Quebec, Ontario and the Maritime Provinces of Canada and the New England, mid-Atlantic and northern mid-western United States [Sendak and Jenkins, 1982]. Canada accounts for about 75 percent of world production with the remainder being produced in the United States. In Canada, there are about 13 000 maple syrup producers and the Province of Quebec accounts for about 90 percent of all Canadian production. Maple syrup production is Quebec's fourth leading agri-food industry in terms of exports. During the period 1985-1995, average annual production of maple syrup in Canada was 13 851 000 litres (Table 5.2). Approximately 68 percent was exported, valued at 120 million CDN dollars. Eighty-five percent of Canadian exports go to the United States, 10 percent to Europe and 5 percent to Asia. Exports have been increasing at a steady rate as new markets and trading opportunities develop in Asia and Europe for this uniquely North American product.[14] Maple syrup production in Canada has seen an upgoing trend. In 1999, it reached 33 523 t, which represents an increase of 20.9 percent over the previous year.[15]

The marketing of maple products in Canada is centred in a few large cooperatives and marketing syndicates which purchase almost 70 percent of the syrup produced. The largest of these is located in Plessisville, Quebec. This facility purchases all or part of the production of some 5 000 syrup producers. The cooperatives and syndicates are oriented toward a few large buyers of dark maple syrup in Canada and the United States but they also market large quantities of table-grade syrup in bulk lots and small retail containers [Sendak and Jenkins 1982].

During 1991, total maple syrup production in the United States was approximately 6 180 000 litres with a market value of US$ 39 279 000 [Thomas and Schumann, 1992]. Approximately two-thirds of the maple syrup is produced in Vermont and New York. Other states, which produce maple syrup, are Maine, Massachusetts, Michigan, New Hampshire, Ohio and Pennsylvania. In 1999, maple syrup production totalled 1.18 million US gallons.[16] As of the early 1980s, there were about

[14] Source: Agriculture Canada (http://aceis.agr.ca)
Natural Resources Canada (http://nrcan.gc.ca/cfs/proj/iepb/nfdp/cp95/data_e/tab56e.htm)
[15] Source: 1999/2000 Canadian maple products situation and trends (www.agr.ca)
[16] Source: 1999/2000 Canadian maple products situation and trends (www.agr.ca)

4 900 maple producers in the United States with an average of slightly less than 1 000 taps each. Roughly, 60 percent of the syrup produced in the United States is packaged and sold in retail containers by producers. The remainder is sold in bulk drums to processors or packers who package it for retail sales as pure maple syrup or further process it for use in blended maple products or as a flavouring in other products. Marketing cooperatives handle only a small portion of the maple syrup produced in the United States [Sendak and Jenkins, 1982].

Grading

Federal grading systems for pure maple syrup exist in both Canada and the United States. In addition, the states of Vermont and Wisconsin have their own grading systems (Table 5.4). These are based on syrup colour. The highest grades are assigned to the lighter coloured syrups. The Canadian system is based on spectrophotometric values relative to three caramel-glycerine solutions. In the United States, the method of grading is based on the glass colour comparator. Research has shown that these two systems do not yield consistent results. The reason for this is that the colouring agents in maple syrup are somewhat different from pure caramel. A syrup and a caramel-glycerine solution that are visually the same colour will yield different percent transmittances when measured at a single wavelength in a spectrophotometer. Syrups are consistently graded higher using the colour comparator than they are in the spectrophotometer [Sednak and Jenkins 1982).

Table 5.2 Maple Syrup Production – Canada 1985-1995 (thousands of litres)

Year	Province						
	Prince Edward Island	Nova Scotia	New Brunswick	Quebec	Ontario	Manitoba	Total
1985		68	50	9 201	1005		10 324
1986		64	118	9 274	614		10 070
1987		45	100	8 001	536		8 682
1988		95	164	13 274	714		14 247
1989		91	145	14 720	686		15 642
1990	1.36	95	155	12 956	764	0.60	13 972
1991	0.85	82	164	12 515	850	0.28	13 612
1992	1.13	118	768	15 984	1 364	0.74	18 236
1993	1.13	91	374	10 697	936	0.80	12 100
1994	1.10	151	374	18 684	986	1.00	20 197
1995	1.10	117	367	13 727	1 062	3.80	15 278
Average	1.00	92	253	12 639	865	1.00	13 851

Source: Natural Resources Canada

Table 5.3 Canadian exports of maple syrup and sugar 1988-1995

Year	Maple syrup(thousands of litres)	Maple sugar (kg)
1988	5 258 051	1 707 810
1989	5 507 624	1 014 329
1990	7 874 763	577 192
1991	8 233 233	582 794
1992	9 564 950	210 564
1993	11 570 441	385 116
1994	13 973 267	289 864
1995	14 119 877	405 277
Average	9 512 776	646 618

Source: Natural Resources Canada

Table 5.4 Grades of maple syrup in Canada and the United States

Country/State	Standard				
Canada (Federal and Quebec)	*Number 1* *Extra Light* Transmittance not less than 75%	*Number 1* *Light* Transmittance between 60.5 and 75%	*Number 1* *Medium* Transmittance between 44.0 and 60.5%	*Number 2* *Amber* Transmittance between 27.0 and 44.0%	*Number 3* *Dark* Transmittance less than 27%
United States (USDA)[1]	*Grade A* *Light Amber* Not darker than light amber colour standard (NDLA)	*Grade A* *Medium Amber* Not darker than medium amber colour standard (NDMA)	*Grade A* *Dark Amber* Not darker than dark amber colour standard (NDDA)	*Grade B* *For reprocessing* Darker than dark amber colour standard (DDA)	Substandard
Vermont	*Fancy* NDLA	*Grade A Medium Amber* NDMA	*Grade A Dark Amber* NDDA	*Grade C* DDA	
Wisconsin	-	*Fancy* NDMA	*A* NDDA	*Manufacturing Grade* DDA	

[1]The states of New Hampshire, New York, Maine, Massachusetts and Pennsylvania have adopted the USDA standard grades with minor definitional changes. Michigan and Ohio do not have state grades.

Source: Sendak and Jenkins 1982

Pests and diseases

Maple decline, characterized by branch dieback, chlorotic foliage, premature fall colouring and occasional tree mortality, is caused by a variety of factors including drought, defoliation by insects, road salt and root fungi [Houston, 1981; Manion, 1991]. A regional decline of sugar maple over portions of Ontario and Quebec began to appear during the late 1970s and increased in intensity during the early 1980s. This condition caused a great deal of concern about the future of the maple syrup industry, especially in Canada. Many hypotheses were suggested for the cause of this decline including timber-harvesting techniques, tree age, tapping for syrup, livestock grazing, soil and air pollution, weather anomalies and insect defoliation. A popular causal hypothesis was that the condition was caused by acid rain. Studies confirmed that the region receives high acid deposition [Linzon, 1988], however a causal relationship between acid rain and maple decline was never established. A cooperative Canadian and American study on sugar maple decline showed an apparent improvement in the health of this species after about 1988 [NAPAP, 1982].

BIRCH SYRUP AND RELATED PRODUCTS

The sap of various species of birch (*Betula* spp.) is also sweet and is tapped in spring for syrup production in the northern forests of Europe and North America. Birch syrup differs from maple syrup in that the natural sugar found in birch is fructose instead of sucrose. The sap flow in birches occurs somewhat later than with maples but is said to flow more copiously. Birch sap is only about half as sweet as maple sap and approximately 100 litres of sap are required to produce one litre of syrup [Peyton, 1994].

Fresh birch sap is said to have just a hint of sweetness, with a slightly minty, wintergreen flavour. In late spring, birch sap can be a good source of moisture for someone travelling through marshy areas where there is no pure water available. Birch syrup resembles molasses and has no hint of wintergreen flavour. Oil of wintergreen is a volatile essential oil and is driven off during the boiling process.[17] In parts of Europe, a beer, wine, spirit and vinegar are prepared from birch sap. Birch wine is produced from birch sap collected in March. Honey, cloves and lemon peel are added and then it is fermented with yeast to make a pleasant tasting cordial [Grieve, 1931].

In Belarus, 2583 t of birch sap were harvested in 1996. This represents only 0.6 percent of the possible resource of 369 000 t. The commercial utilization of sap is directly depending on the birch felling areas and their accessibility [Ollikainen, 1998]. Birch syrup is produced from *Betula papyrifera* in Alaska, United States, where it is used as a sweetener in coffee, on vegetables, pancakes and in breads and desserts.

Birch beer is made from the sap of *Betula lenta* in the southern Appalachian Mountains of the eastern USA. The trees are tapped in the spring when the sap begins to flow. The sap is stored in a ceramic jug and a small quantity of shelled corn is added to promote fermentation [Wigginton, 1973].

Containing same acids and minerals found in some fruits and berries, the birch sap is considered as a healthy product in a growing number of countries. For instance, in eastern Europe and Asian countries, fresh birch sap is pasteurized, bottled and sold as a health drink.

The curative properties of birch sap were referred to already by Baron Pierre-François Percy, the army surgeon and inspector general to Napoleon. His observation was as follows:

> *Throughout the whole of northern Europe ... birch water is the hope, the blessing, and the panacea of rich and poor, master and peasant alike .... It almost unfailingly cures skin conditions such as pimples, scurf, acne, etc., it is an invaluable remedy for rheumatic diseases, the after-effects of gout, bladder obstructions, and countless chronic ills against which medical science is so prone to fail.*[18]

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17 Source: Maple sugar boiling month (http://indy4fdl.cc.mn.us/~isk/food/maple/html)

18 Source:Marlene Cameron. 1999 Alaska birch syrup at http://www.birchsyrup.com/aboutbs.html#nutrition

Figure 5.5: (above) A birch-rich forest stand in Alaska. Birch trees are connected with blue hoses to collect the sap to one central location instead of tapping each individual tree. (right) A jar of birch syrup. (Photos courtesy of: http://trailmastersgifts.com).

Box 5.2 Alaskan birch syrup industry

Birch syrup derived from the sap of the paper birch *Betula papyrifera* is commercialized in Alaska. The industry that was initiated ten years ago is today of great potential since the demand for birch syrup and for the value added birch products is growing.

The basic process to make birch syrup is the same as maple though there are some major differences between the two syrups. Compared to the maple, the birch trees tapped are smaller in diameter than maple, the life span of the birch is shorter and the birch is susceptible to heart rot early in life. In addition, the sap season is much shorter for birch than maple. In the south-central part of Alaska the sap run lasts an average of 19-20 days. Since tapping only takes 10-15 percent of the total sap production of the tree, it does not injure the trees.The average sugar content of birch sap is 11 Brix while that of maple ranges from 2 to 41 Brix.[1]

Birch sap contains several acids such as malic, phosphoric, succinic and citric. Further, inorganics including significant amounts of potassium, calcium, manganese and thiamin are present. There is also a difference regarding colour and flavour of the two syrups.

Value-added products with birch syrup as a base are candies, marinade, salad dressing, popcorn, reindeer jerky, coated nuts and flavoured birch syrup.

[1] Brix = percent sucrose by weight at 20^{o}C.

STYRAX

Styrax or storax is a balsamic oleoresin extracted from the inner bark and wood of species of *Liquidambar*.[19] This material is a semi-solid, sticky, brown-coloured material and appears in response to wounds. When the young wood is injured, oil-ducts are formed in which the styrax is produced [Grieve, 1931].

USES

Steam distillation of styrax yields an essential oil that is widely used in the fragrance industry. For instance, it is used as fumigant in mosques and churches. Further more, styrax oil is widely used by the drug and cosmetic industry. For instance, the cosmetic properties of styrax are used in the production of soap and detergents and in perfume manufacturing. Due to its medical properties such as antiseptic and anti-parasitic, styrax is used to boost asthma and bronchitis, as well as to soothe dermatitis and fungal infection [Coppen, 1995; Moussouris and Regato, 1999].

COMPOSITION

The most abundant constituent of styrax is storesin. It exists in two forms, alpha and beta, both free and in the form of a cinnamic ester. Styrax is an amorphous substance, melting at 168^{o}C when it is readily soluble in petroleum benzin. Various esters of cinnamic acid have been identified, including ethyl, phenylpopyl and benzyl esters and cinnamyl cinnamate, the so-called styrasin. The yield of cinnamic acid varies from 6 to 12 percent or even as much as 23 percent of crystallized cinnamic acid can be obtained. Another analysis gives free cinnamic acid, vanillin, styrol, styracin, cinnamic acid-ethyl ester, cinnamic acid-phenylprophyl ester and storesinol, partly free and partly as cinnamic acid ester.

Crude styrax contains from 1 to 9 percent of matter insoluble in alcohol, and up to 30 percent of water. When purified, it is brownish-yellow; viscous and transparent in thin layers; entirely soluble in alcohol (90 percent) and in ether. Boiled with a solution of potassium chromate and sulphuric acid, it evolves an odour of benzaldehyde. It loses not more than 5 percent of its weight when heated in a thin layer on a waterbath for one hour [Grieve, 1931].

SPECIES

Two trees are important commercial sources of styrax. *Liquidambar orientalis*, native to eastern Mediterranean Europe and the Near East, is the source of the product known as Asian styrax; and the sweetgum (*L. styraciflua*), a tree native to the southeastern United States, Mexico and Central America is the source of American styrax. *L. formosana* occurs in southeastern China, where it is used locally but is not important in world trade [Coppen, 1995].

HARVESTING

Styrax is found in the sapwood and inner bark of *L. orientalis*. Asian styrax is harvested by removing pieces of bark and boiling them in water. Additional styrax is obtained by pressing the bark that has been “extracted” to remove any residual material. Some styrax is also harvested by making incisions into the exposed stem wood and collecting the exudate in small cans or scraping it off directly. American styrax is collected by tapping the trees (*L. styraciflua*). A small gutter and a cup are fixed on the tree and a cut is made in the stem where pockets of styrax occur.

Preliminary cleaning of Asian styrax is done by rinsing the crude material in boiling water. The dirty water is removed by decantation and the soft, fluid resin is separated from a lower layer of sand and other foreign materials [Coppen, 1995].

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[19] Please note that there exists another internationally traded resin, benzoin, which is obtained from South-East Asian Styrax species. This resin should not be confused with styrax/storax from *Liquidambar.* (see NWFP Series no. 6 “*Gums*, *Resins and Latexes* of *Plant origin*, FAO 1995*)*

PRODUCTION AND TRADE

Turkey is the only source of Asian styrax traded internationally. The geographical distribution of the tree in Turkey is southwestern Anatolia. During the decade of the 1960s, exports of Turkish styrax ranged from 50 t/a to 70 t/a. The largest importer was the United Kingdom, followed by Germany, France, Italy and the United States. The United States is the largest importer of American styrax coming from *L. styraciflua*, most of which is produced in Honduras. It can also be found in other parts of Central America and in Mexico [Coppen, 1995].

Exports of styrax from Turkey have declined since its peak in the 1960s. In order to determine the development potential of styrax, a better knowledge is required. If styrax oil production in Turkey becomes uneconomic due to increased labour costs, there is a potential for the production to expand in Southeast Asia (from *L. Formosan*) and Central America [Moussouris and Regato, 1999].

MASTIC GUM

Mastic gum is a natural resin that is extracted from one of the most characteristic evergreen species in the Mediterranean maquis,[20] the *Pistacia lentiscus* var*. Chia* tree. The tree is a slow-growing, cold-sensitive species that grows in limestone soil. In order to obtain oleoresin, it is necessary to make incisions in the trunk. The exuded oleoresin soon solidifies and becomes hard and brittle. At an age of 12–15 years, gum production reaches its full potential. However, gum can be already extracted after the fifth or sixth year.

Even though, *P. lentiscus* is a common species in the Mediterranean region, it is only on the Greek island of Chios, just offshore from Izmir in Turkey, that large-scale production takes place. Smaller quantities of mastic gum are collected in Algeria, Morocco and the Canary Islands.

HARVESTING, PRODUCTION AND TRADE

In Chios, the harvesting period is between June and mid-October. According to regulations regarding mastic gum production, all collection activities have to terminate after 15 October.

Preparations start by cleaning the tree, followed by sweeping and levelling the ground beneath the tree. Subsequently, the first vertical and horizontal cuts are marked on the bark, twice a week for a period of five to six weeks. Collection follows crystallization of the first secreted gum. After that, the second cut is inflicted, and the gums are collected once again.

After collection, the gum is sieved and then given to the cooperative for quality control. The cooperative sends the product to the Union of Mastic Producers, where final processing takes place. Production has fluctuated with an average of 250 000 kg a year during the first half of this century.[21]

The trade in mastic gum is worth US$ 14.4 million per year to the 21 villages involved on the Greek island of Chios, who have monopoly of production. The mastic gum is exported to 50 countries, among which Saudi Arabia is the biggest importer [Moussouris and Regato, 1999].

USES

There are many products of mastic gum, such as mastic oil and rosin, both of which are derived from mastic gum distillation. Further gumdrops, which have a unique pleasant flavour, are sold as chewing gum. Since 1995, a processed packed product in the form of a confection is produced and marketed. In addition, mastic gum is a culinary ingredient in the Mediterranean cuisine and patisserie and is also used in ouzo flavouring.

By-products of mastic gum are used in varnishes and coatings and in a type of cement called asphalt mastic. Moscholivano, a solid essence derived from mastic gum, releases a pleasant odour when

[20] Maquis are evergreen short tree and shrub communities.
[21] Source: Mastic gum resin (http://www.execpc.com/~goodscnt/data/rs1008031.html)

being burned. Moreover, mastic is used in wood coatings, lacquers, adhesives, and printing inks. Artists have used it for many centuries to protect both oil paintings and watercolours.

Moreover, mastic gum is provided with medical properties. Already many ancient writers such as Theophrastus, Pliny the Elder, Galenos and Dioscorides considered it as a panacea for many maladies. Current research confirms the gum's medical properties.[22]

[22] Source: Mastic (http://www.plthomas.com/Resinsfram/Mastic.htm)