Soap Making:
Practical and Artistic Chemistry for the Waldorf School Curriculum

compiled and written by
Gary Ward
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“The soul undergoes a change from doing things. Abstract teaching of manual skill is really no substitute.” --Rudolf Steiner
Introduction

- Soaps and Oils - This workshop and booklet are designed to give basic soap making processes and show how to apply it as practical science in the Waldorf Curriculum.
- The chemistry of soap making involves processes developed thousands of years ago and some of the most modern industrial processes.
- Because it is both practical chemistry and a beauty product, soap can be used to establish interest in both male and female students.
- As a finished product, soap can be an artistic medium.
  - Gary Ward has taught Grades 9 and 10 Waldorf chemistry, developed a soap making workshop for educating special needs youth, and was a partner in a soap making company in England.
Considerations

1st Consideration: History of Soaps and Oils, and Preparations for Soap Making
- The chemistry of fire and ash—from traditional methods and understanding of the lye process to modern methods
- Extraction of oils and their uses from days past to now
- Soap—completion of the circle, combining the mineral element of plants with the rarefied essence, or acid and base chemistry

2nd Consideration: Making Soap
- How to make soap
- Preparing the space for making soap—equipment, space, and safety
- Getting the fats ready
- Lye water—caution
- The first seconds of soap
- Trace—what are we looking for?
- Enhancements and moulding

3rd Consideration: Finishing the Process and Curriculum Applications
- Removing the soap from the moulds
- Cutting and setting up for curing
- Curing
- Finishing and packaging
- The Waldorf Curriculum, chemistry, ashes, oils, salts and soap
1st Consideration: Objectives

- Understand some of the qualitative aspects of the chemistry of life
- Have a resource for more information on alkaline and acid chemistry
- Understand some ways that soaps are made and how this fits into the chemistry of living things
- Learn about the methods for making soap and extracting oils and fats
- Begin to get a living picture of how the chemistry and making of soap can enhance teaching of chemistry in the Grade 7, 8, 9, and 10 Waldorf school curriculum
The natural history of fire is vast. We can begin to see some of the vastness and gain a sense of wonder about the process of fire from two books, both coming from Michael Faraday. The first book, written by Faraday, is *The chemical History of a Candle*, and the second is a publication of a series of lectures that he gave to children, published as *On the Various Forces of Nature*.

Burning a substance is mesmerizing. We, as humans, have been fascinated by burning ever since we found fire: it is part of our being. But it took centuries and millennia to begin to understand what is left over from burning—what is the remainder of something in the form of ash.

The use of ash to manufacture products form a chemical reaction is over 3,000 years old. The ability to make soap and to make glass depended on the production of potash for centuries. Since the middle 1800’s, when the industrial revolution was moving into full swing, we have developed other methods to obtain the chemicals that previously had come from burning plants.

Potash is the name of the chemical that produces a very strong alkaline solution, called lye, used for making soap and for other processes.

### Combustion Products of Beech Wood

<table>
<thead>
<tr>
<th>Substance</th>
<th>Pounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beech Wood</td>
<td>1000.0</td>
</tr>
<tr>
<td>Flammable Compounds</td>
<td>994.2</td>
</tr>
<tr>
<td>Ash</td>
<td>5.8</td>
</tr>
<tr>
<td>Insoluble Ash</td>
<td>4.6</td>
</tr>
<tr>
<td>Crude Potash</td>
<td>1.2</td>
</tr>
<tr>
<td>Potassium Carbonate</td>
<td>0.9</td>
</tr>
<tr>
<td>Sodium Carbonate</td>
<td>0.2</td>
</tr>
<tr>
<td>Potassium Sulfate</td>
<td>0.1</td>
</tr>
</tbody>
</table>
Making and Purifying Potash

- In making potash your ashes must have never been wet. The ashes must come from a fire that has been allowed to burn out, not from one which has been doused with water, otherwise the potash will have been washed away. But if your ashes were dry, the charcoal skimmed off the water, and the minerals have settled completely, the water with dissolved potash can be poured off and concentrated. Finally, if all the water is boiled away, a nice, pure, white, crystalline layer will appear. This is the potash.

- If you give this crystalline substance a taste, it will be bitter. This is the bitter taste of alkali, or base. It would be irresponsible of me, of course, to suggest that you should go around tasting everything. Some things are extremely toxic, but you can taste this. Of course, we have developed pH test paper to serve as a virtual tongue to test for acidity and alkalinity. Bitter things (alkaline) turn pH test paper blue and sour things (acidic) turn it red. Salty and sweet things leave pH test paper a neutral yellow color. If you have never used pH test paper before, use a few strips to test materials whose flavors you already know. Good choices are lemon juice, vinegar, baking soda, and soap. From this experience you will be able to use pH test paper to distinguish bitter things from sour things, alkalis from acids, without risking your health.

- Before we go too much farther, potash, or potassium carbonate, is not the only soluble component of wood ash. Depending on the soil conditions, sodium carbonate may also be present. As a matter of fact, when the ashes come from burning seaweed, there may be more sodium carbonate than potassium carbonate, and in this case we refer to the product as soda ash. The Table on the previous page shows what happens to 1000 pounds of Beech wood when it is burned. Most of it is consumed in the fire, of course, producing gaseous water and carbon dioxide. Less than six pounds of ash remain. Most of this ash is not soluble. When the water is boiled from the soluble bit, a little over a pound of crude potash remains. Most of this crude potash is potassium carbonate, but some of it will consist of sodium carbonate, potassium sulfate, and other soluble compounds. A fairly simple method can remove most of these other compounds.

- Solubility is not a black-and-white issue; some “soluble” compounds are more soluble than others. The Table opposite shows that potassium carbonate has a much higher solubility than the other compounds we might expect to be present in wood ashes. If, instead of boiling away all the water, we were to boil away only most of the water, the less soluble compounds would precipitate, that is, they would sink to the bottom of the solution as solids, and the potassium carbonate would stay in solution until the last possible moment. If we were to pour off this solution and boil it to dryness, the resulting solid would have fewer contaminants than the crude potash.

- In both the case of removing the ash and charcoal and removing the insoluble impurities, we are physically separating compounds that differ in their solubility. This process, known as recrystallization, remains the most widely-used technique for purifying solids.

- The other form of ash, used to make soda ash, was obtained from plants that have a higher concentration of sodium in them than potassium. Soda ash was obtained from burning seaweeds or a plant called barilla. The difference between potash and soda ash is the metal in each chemical substance. Potash has a base metal of potassium, while soda ash has a base metal of sodium. Modern soaps are mostly made from a sodium compound called sodium hydroxide. Sodium hydroxide is a very strong alkaline substance. The following Wikipedia article gives a good description of sodium hydroxide. Source: http://en.wikipedia.org/wiki/Sodium_hydroxide

We find the same chemical compounds from ash in dynamic environments on the earth, such as around volcanoes and hot spots. Pools of high acidity and high alkalinity are common around these areas.
Sodium hydroxide (NaOH), also known as lye or caustic soda, is a caustic metallic base. An alkali, caustic soda is widely used in many industries, mostly as a strong chemical base in the manufacture of pulp and paper, textiles, drinking water, and detergents. Worldwide production in 1998 was around 45 million tonnes. Sodium hydroxide is also the most common base used in chemical laboratories, being able to test for quite a number of cations (this is called Qualitative Inorganic Analysis), as well as to provide alkaline mediums for some reactions that need it, such as the Biuret test.

**General properties**

Pure sodium hydroxide is a white solid, available in pellets, flakes, granules, and also 50% saturated solution. It is deliquescent and also readily absorbs carbon dioxide from the air, so it should be stored in an airtight container. It is very soluble in water with liberation of heat. It also dissolves in ethanol and methanol, though it exhibits lower solubility in these solvents than does potassium hydroxide. It is insoluble in ether and other non-polar solvents. A sodium hydroxide solution will leave a yellow stain on fabric and paper.

**Chemical properties**

Sodium hydroxide is completely ionic, containing sodium ions and hydroxide ions. The hydroxide ion makes sodium hydroxide a strong base which reacts with acids to form water and the corresponding salts, e.g., with hydrochloric acid, sodium chloride is formed:

\[
\text{NaOH}(aq) + \text{HCl}(aq) \rightarrow \text{NaCl}(aq) + \text{H}_2\text{O}(l)
\]

In general such neutralization reactions are represented by one simple net ionic equation:

\[
\text{OH}^-(aq) + \text{H}^+(aq) \rightarrow \text{H}_2\text{O}
\]

This type of reaction releases heat when a strong acid is used. Such acid-base reactions can also be used for titrations, and indeed this is a common way for measuring the concentration of acids. Related to this is the reaction of sodium hydroxide with acidic oxides. The reaction of carbon dioxide has already been mentioned, but other acidic oxides such as sulfur dioxide (SO2) also react completely. Such reactions are often used to "scrub" harmful acidic gases (like SO2 and H2S) and prevent their release into the atmosphere.

\[
2\text{NaOH} + \text{CO}_2 \rightarrow \text{Na}_2\text{CO}_3 + \text{H}_2\text{O}
\]
Sodium hydroxide slowly reacts with glass to form sodium silicate, so glass joints and stopcocks exposed to NaOH have a tendency to "freeze". Flasks and glass-lined chemical reactors are damaged by long exposure to hot sodium hydroxide, and the glass becomes frosted. Sodium hydroxide does not attack iron or copper, but many other metals such as aluminium, zinc and titanium are attacked rapidly. In 1986 an aluminium road tanker in the UK was mistakenly used to transport 25% sodium hydroxide solution, causing pressurisation of the contents and damage to the tanker. For this same reason aluminium pans should never be cleaned with lye.

\[ 2\text{Al(s)} + 6\text{NaOH(aq)} \rightarrow 3\text{H}_2(g) + 2\text{Na}_3\text{AlO}_3(aq) \]

Many non-metals also react with sodium hydroxide, giving salts. For example phosphorus forms sodium hypophosphite, while silicon gives sodium silicate.

Unlike NaOH, the hydroxides of most metals are insoluble, and therefore sodium hydroxide can be used to precipitate metal hydroxides. One such hydroxide is aluminium hydroxide, used as a gelatinous floc to filter out particulate matter in water treatment. Aluminium hydroxide is prepared at the treatment plant from aluminium sulfate by reaction with NaOH:

\[ 6\text{NaOH(aq)} + \text{Al}_2(\text{SO}_4)_3(aq) \rightarrow 2\text{Al(OH)}_3(s) + 3\text{Na}_2\text{SO}_4(aq) \]

Sodium hydroxide reacts readily with carboxylic acids to form their salts, and it is even a strong enough base to form salts with phenols. NaOH can also be used for the base-driven hydrolysis of esters (as is saponification), amides and alkyl halides. However, the limited solubility of NaOH in organic solvents means that the more soluble KOH is often preferred.

Basic hydrolysis of an ester
**Manufacture**

In 1998, total world production was around 45 million tonnes. Of this, both North America and Asia contributed around 14 million tonnes, and Europe produced around 10 million tonnes.

**Methods of production**

Sodium hydroxide is produced (along with chlorine and hydrogen) via the chloralkali process. This involves the electrolysis of an aqueous solution of sodium chloride. The sodium hydroxide builds up at the cathode, where water is reduced to hydrogen gas and hydroxide ion:

\[ 2\text{Na}^+ + 2\text{H}_2\text{O} + 2\text{e}^- \rightarrow \text{H}_2 + 2\text{NaOH} \]

To produce NaOH it is necessary to prevent reaction of the NaOH with the chlorine. This is typically done in one of three ways, of which the membrane cell process is economically the most viable.

- **Mercury cell process** – sodium metal forms as an amalgam at a mercury cathode; this sodium is then reacted with water to produce NaOH. There have been concerns about mercury releases, although modern plants claim to be safe in this regard.[1]

- **Diaphragm cell process** – uses a steel cathode, and reaction of NaOH with Cl₂ is prevented using a porous diaphragm. In the diaphragm cell process the anode area is separated from the cathode area by a permeable diaphragm. The brine is introduced into the anode compartment and flows through the diaphragm into the cathode compartment. A diluted caustic brine leaves the cell. The caustic soda must usually be concentrated to 50% and the salt removed. This is done using an evaporative process with about three tonnes of steam per tonne of caustic soda. The salt separated from the caustic brine can be used to saturate diluted brine. The chlorine contains oxygen and must often be purified by liquefaction and evaporation. [2][3]

- **Membrane cell process** – similar to the diaphragm cell process, with a Nafion membrane to separate the cathode and anode reactions. Only sodium ions and a little water pass through the membrane. It produces a higher quality of NaOH. Of the three processes, the membrane cell process requires the lowest consumption of electric energy and the amount of steam needed for concentration of the caustic is relatively small (less than one tonne per tonne of caustic soda). [4][5]

An older method for sodium hydroxide production was the LeBlanc process, which produced sodium carbonate, followed by roasting to create carbon dioxide and sodium oxide. This method is still occasionally used. It helped to establish sodium hydroxide as an important commodity chemical.
Major producers
In the United States, the major producer of sodium hydroxide is the Dow Chemical Company, which has annual production around 3.7 million tonnes from sites at Freeport, Texas, and Plaquemine, Louisiana. Other major US producers include Oxychem, PPG, Olin, Pioneer Companies, Inc. (PIONA), and Formosa. All of these companies use the chloralkali process[6].

Uses
General applications
Sodium hydroxide is the principal strong base used in the chemical industry. In bulk it is most often handled as an aqueous solution, since solutions are cheaper and easier to handle. It is used to drive for chemical reactions and also for the neutralization of acidic materials. It can be used also as a neutralizing agent in petroleum refining.

Experiment
Sodium hydroxide has also been used in conjunction with zinc for creation of the famous "Gold pennies" experiment. When a penny is boiled in a solution of NaOH together with some granular zinc metal (galvanised nails are one source), the colour of the penny will turn silver in about 45 seconds. The penny is then held in the flame of a burner for a few seconds and it turns golden. The reason this happens is that granular zinc dissolves in NaOH to form Zn(OH)₄²⁻. This zincate ion becomes reduced to metallic zinc on the surface of a copper penny. Zinc and copper when heated in a flame form brass.

Use in chemical analysis
In analytical chemistry, sodium hydroxide solutions are often used to measure the concentration of acids by titration. Since NaOH is not a primary standard, solutions must first be standardised by titration against a standard such as KHP. Burettes exposed to NaOH should be rinsed out immediately after use to prevent "freezing" of the stopcock.

Soap making
Soap making via saponification is the most traditional chemical process using sodium hydroxide. The Arabs began producing soap in this way in the 7th century, and the same basic process is still used today.

Biodiesel
For the manufacture of biodiesel, sodium hydroxide is used as a catalyst for the transesterification of methanol and triglycerides. This only works with anhydrous sodium hydroxide, because water and lye would turn the fat into soap which would be tainted with methanol.

It is used more often than potassium hydroxide because it costs less, and a smaller quantity is needed for the same results. Another alternative is sodium silicate.

Aluminum etching
Strong bases attack aluminium. This can be useful in etching through a resist or in converting a polished surface to a satin-like finish, but without further passivation such as anodizing or allodizing the surface may become corroded, either under normal use or in severe atmospheric conditions.
**Food preparation**

Food uses of lye include washing or chemical peeling of fruits and vegetables, chocolate and cocoa processing, caramel color production, poultry scalding, soft drink processing, and thickening ice cream. Olives are often soaked in lye to soften them, while pretzels and German lye rolls are glazed with a lye solution before baking to make them crisp.

Specific foods processed with lye include:
- The Scandinavian delicacy known as lutefisk (from lutfisk, "lye fish").
- Hominy is dried maize (corn) kernels reconstituted by soaking in lye-water. These expand considerably in size and may be further processed by cooking in hot oil and salting to form corn nuts. Nixtamal is similar, but uses calcium hydroxide instead of sodium hydroxide.
- Hominy is also known in some areas of the Southeastern United States, as the breakfast food grits, dried and ground into a coarse powder. They are prepared by boiling in water, with the addition of butter and other ingredient to suit the tastes of the preparer.
- Sodium hydroxide is also the chemical that causes gelling of egg whites in the production of Century eggs.
- German pretzels are poached in a boiling sodium hydroxide solution before baking, which contributes to their unique crust.

**Delignification of Cellulosic Materials**

Sodium Hydroxide, in addition to Sodium Sulfide, is a key component of the white liquor solution used to separate lignin from cellulose fibers in the Kraft process. It also plays a key role in several following stages of the process of bleaching the brown pulp resulting from the pulping process. These stages include oxygen delignification, oxidative extraction, and simple extraction, all of which require a strong alkaline environment with a pH > 10.5 at the end of the stages.

**Domestic uses**

Sodium hydroxide is used in the home as an agent for unblocking drains, provided as a dry crystal (e.g. "Drāno") or as a thick liquid gel. The chemical mechanism employed is the conversion of grease to a form of soap, and so forming a water soluble form to be dissolved by flushing; also decomposing complex molecules such as the protein of hair. Such drain cleaners (and their acidic versions) are highly caustic and should be handled with care.

Beginning in the early 1900s, lye has been used to relax the hair of African-Americans (and persons of African descent in other countries as well). Among men, this treatment was often called a process. However, because of the high incidence and intensity of chemical burns, chemical relaxer manufacturers began switching to other alkaline chemicals (most commonly guanidine hydroxide) during the latter quarter of the 20th Century, although lye relaxers are still available, usually under use by professionals.

**Tissue Digestion**

This is a process that was used with farm animals at one time. This process involves the placing of a carcass into a sealed chamber, which then puts the carcass in a mixture of lye and water, which breaks chemical bonds keeping the body intact. This eventually turns the body into a coffee-like liquid, and the only solid remains are bone hulls, which could be crushed between one's fingertips. It is also of note that sodium hydroxide is frequently used in the process of decomposing roadkill dumped in landfills by animal disposal contractors.[citation needed]

In this framework, sodium hydroxide has also been used by criminals and serial killers to dispose of their victim's bodies.
Illegal drugs
Because it is a key ingredient in the process of making Methamphetamine, it is now impossible to purchase pure Sodium hydroxide as a consumer product in much of the United States. Products containing pure Sodium hydroxide, such as Red Devil, are no longer available for sale. As a result, many amateur soapmakers must now purchase Sodium hydroxide in bulk.

Safety
Solid sodium hydroxide or solutions containing high concentrations of sodium hydroxide may cause chemical burns, permanent injury or scarring, and blindness.
Solvation of sodium hydroxide is highly exothermic, and the resulting heat may cause heat burns or ignite flammables.
The combination of aluminium and sodium hydroxide results in a large production of hydrogen gas: 
\[ 2\text{Al}(s) + 6\text{NaOH}(aq) \rightarrow 3\text{H}_2(g) + 2\text{Na}_3\text{AlO}_3(aq). \]
Mixing these two in a closed container is therefore dangerous.
For more information, consulting an MSDS is suggested.

Trivia
This danger was shown in a scene of the 1999 movie Fight Club, where the character Tyler Durden puts it on the protagonist's freshly kissed hand to create a lip-shaped scar, symbolizing their commitment to the plan that makes up the movie's plot. This is the only scene in the movie which Brad Pitt's parents have seen - he showed it to them before its release to convince them not to watch the movie.
Lye is used as an assault weapon in an episode of US crime drama CSI: New York, in which the victim has the chemical thrown over his face, causing a chemical burn, and his eventual death.
Mythbusters episode 20 tested the theory that jawbreakers mixed with sodium hydroxide would explode under heat. Unofficial Mythbusters Guide: Episode 20

See also
Common chemicals
Soda lime

External links
International Chemical Safety Card 0360
NIOSH Pocket Guide to Chemical Hazards
European Chemicals Bureau
The Chlorine Institute, Inc. website
Sodium hydroxide products of Bayer MaterialScience in North America
Titration of acids with sodium hydroxide – freeware for data analysis, simulation of curves and pH calculation
Links to external chemical sources.
1st Consideration:
Topic 2-Oils and Fats

- Fats and oils are obtained from both animal and plant sources, but the main soap making fats now are from plant sources because of the lathering, astringent, and moisturizing qualities of the fatty acids in various plant fats, and the costs to produce them are less than for animal fats.
- Fats are solid at room temperature, while oils are liquid. That is the only difference between the two. Both fats and oils are fatty acids, or tri-glycerides. Most soaps are reactions of palmitic, lauric, or oleic acids with a base. Animal fats are less easily produced in a clean form and have become more expensive to make, especially since the advent of bovine spongiform encephalopathy (mad cow disease) and its derivatives.
- The most common fats and oils used to produce soaps are now palm oil, palm kernel oil, coconut oil, and olive oil. Of course, most of us have heard of the soap brand “Palmolive,” which has been around for decades. The first three of the above oils are actually fats, while olive oil is a liquid at room temperature, and thus a true oil.
- So far, we have only considered the base oils, or bulk oils, used in making soap. Soaps have become a beauty product in most cultures, and as such, we have learned to add shape, colour, and fragrance to soaps. Most scents in soaps come from oils as well. These are either essential oils extracted directly from plants, or fragrance oils that are synthesized artificially from coal tar chemicals. Coal tar chemicals come from the production of charcoal or from crude oil.
- The following pages outline the basic chemistry, sources, and processing of fats and oils. The place to start is with a holistic picture of the chemistry of plants.

Top left: raw palm oil has a red colour, it appears white after it is bleached and deodorized; top right: a jar of coconut oil; center: olive oil; bottom: The Manufacture of Oil, drawn and engraved by J. Amman in the Sixteenth Century.
The substances occurring at the top of the plant are the natural scents, colours, flavours, and cosmetics. These are the rarefied oils, esters, aldehydes, and simple sugars. Moving down the plant into the stem, we find more complex sugars, transforming into starches and cellulose. As the plant substance is transformed into earth substance by oxidation or burning, coal tar and its products can be made. These substances are the artificial colours, scents, flavours, sweeteners, and medicines.
Essential Oil extraction methods

- http://www.naturesgift.com/extraction.htm
- **Distillation:**
  - The vast majority of true essential oils are produced by distillation. There are different processes used, however. In all of them, water is heated to produce steam, which carries the most volatile chemicals of the aromatic material with it. The steam is then chilled (in a condenser) and the resulting distillate is collected. The Essential Oil will normally float on top of the Hydrosol (the distilled water component) and may be separated off.
- **Steam Distillation**
  - True Steam distillation uses an outside source of steam which pipes the steam into the distillation unit, sometimes at high pressure. The steam passes through the aromatic material, and exits into the condenser.
- **Hydrodistillation**
  - The botanicals are fully submerged in water, producing a "soup", the steam of which contains the aromatic plant molecules. This is the most ancient method of distillation and the most versatile. It's the method most often used in primitive countries. The risk, of course, is that the still can run dry, or be overheated, burning the aromatics and resulting in an EO with a burnt smell. Hydrodistillation seems to work best for powders (ie, spice powders, ground wood, etc.) and very tough materials like roots, wood, or nuts.
- **Water & steam distillation**
  - A water and steam distillation arrangement can be compared to a kitchen steamer basket, with the botanicals supported in a "basket" over boiling water, thus exposing the plant material only to the rising steam vapors. This is the best method for distilling leafy materials, but doesn't work well for woods, roots, seeds, etc.
- **Absolutes and Concretes: Solvent Extraction**
  - Very delicate aromatics, Jasmine, Linden Blossom, etc. can not survive the process of distillation. To capture their magical aromas, a process of solvent extraction is used.
  - An extracting unit is loaded with perforated trays of blossoms. The blossoms are washed repeatedly with a solvent (usually hexane.) The solvent dissolves all extractable matter from the plant which includes non-aromatic waxes, pigments and highly volatile aromatic molecules. The solution containing both solvent and dissolvable plant material is filtered and the filtrate subjected to low pressure distillation to recover the solvent for further use. The remaining waxy mass is what is called the concrete and it contains in the case of J. grandiflorum as much as 55% of the volatile oil.
  - The concentrated concretes are processed further to remove the waxy materials which dilute the pure essential oil. To prepare the absolute from the concrete, the waxy concrete is warmed and stirred with alcohol (usually ethanol.) During the heating and stirring process the concrete breaks up into minute globules. Since the aromatic molecules are more soluble in alcohol than is the wax an efficient separation of the two takes place. But along with the aromatic molecules a certain amount of wax also becomes dissolved and this can only be removed by agitating and freezing the solution at very low temperatures (around -30 degrees F) In this way most of the wax precipitates out. As a final precaution the purified solution is cold filtered leaving only the wax-free material (the absolute.)
  - This solvent extraction actually yields three usable products; first the concrete (as in rose concrete, my favorite solid perfume), the precious absolutes, and the floral waxes, for addition to candles, thickening creams and lotions as a softly floral scented alternative to beeswax.
Essential Oil extraction methods-p. 2

- **Carbon Dioxide Extraction**
  - When CO2 (carbon dioxide) is subjected to high pressure, the gas turns into liquid. This liquid CO2 can be used as a very inert, safe, "liquid solvent." which will extract the aromatic molecules in a process similar to that used to extract absolutes (above.) The advantage, of course, is that no solvent residue remains, since at normal pressure and temperature, the CO2 simply reverts to a gas and evaporates.
  - CO2 extraction has given us essences of some aromatics that don't yield essential oils, Rose Hip Seed, and Calendula, for examples. In my experience (or opinion!) if the same essential oil is available both as a steam distilled EO and a CO2 extracted essence, the CO2 seems to have a richer, more intense scent, since more of the aromatic chemicals are released through this process.

- **Cold Pressing**
  - We are all familiar with the spray of orange essential oil that can be released by scoring or zesting the skin of the fruit. The cold pressed citrus oils are commercial produced just this way, by machines which score the rind and capture the resulting oil. Although many citrus oils are also produced by steam distillation, they seem to lack the vibrancy of the cold pressed oils.

- **Florasols/Phytols**
  - This extraction method uses a new type of benign gaseous solvents. In the late 1980s Dr. Peter Wilde first recognized the unique properties of these solvents for the extraction of aromatic oils and biologically active components from plant materials, for use in the food, pharmaceutical, aromatherapy and perfume industries. "Florasol" (R134a), is the solvent upon which the process is based.
  - Extraction occurs at or below ambient temperatures, hence there is no thermal degradation of the products. The extraction process utilizes the selectivity of the solvent and produces a free flowing clear oil free of waxes.
  - At the current time, the sole US distributor of Dr. Wilde's Florasols is The Essential Oil Company. However, we are researching a source for bulk Florasols at a more appealing price.
<table>
<thead>
<tr>
<th>Essential Oils</th>
<th>Latin Names</th>
<th>Origin</th>
<th>Essential Oils Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anise Star</td>
<td>Illicium verum</td>
<td>China</td>
<td>Rejuvenation, sensuality, respiration</td>
</tr>
<tr>
<td>Balsam (Wild Fir)</td>
<td>Abies sibirica</td>
<td>Siberia</td>
<td>Skin care</td>
</tr>
<tr>
<td>Basil*</td>
<td>Ocimum basilicum</td>
<td>Italy</td>
<td>Concentration, clarity, trust</td>
</tr>
<tr>
<td>Bay</td>
<td>Pimenta racemosa</td>
<td>West Indies</td>
<td>Communication, creativity, energy</td>
</tr>
<tr>
<td>Benzoil</td>
<td>Stryax benzoin</td>
<td>Sumatra</td>
<td>Confidence, deep sleep</td>
</tr>
<tr>
<td>Bergamot</td>
<td>Citrus bergamia</td>
<td>Italy</td>
<td>Anti-depressant, motivation, joy</td>
</tr>
<tr>
<td>Birch Sweet *</td>
<td>Betula Alba</td>
<td>USA</td>
<td>Anti-inflammatory, mental clarity</td>
</tr>
<tr>
<td>Black Pepper**</td>
<td>Piper nigrum</td>
<td>India</td>
<td>Clarity, security, endurance</td>
</tr>
<tr>
<td>Cajeput</td>
<td>Melaleuca cajeputi</td>
<td>Indonesia</td>
<td>Mental stimulant, respiration, energy</td>
</tr>
<tr>
<td>Camphor**</td>
<td>Cinnamomum camphora</td>
<td>China</td>
<td>Not commonly used in aromatherapy</td>
</tr>
<tr>
<td>Carnation Absolute</td>
<td>Dianthus caryophyllus</td>
<td>Holland</td>
<td>Self-esteem, imagination</td>
</tr>
<tr>
<td>Carrotseed</td>
<td>Daucus carota</td>
<td>France</td>
<td>Skin care</td>
</tr>
<tr>
<td>Cedarwood*</td>
<td>Cedrus deodora</td>
<td>India</td>
<td>Inner strength, confidence</td>
</tr>
<tr>
<td>Chamomile German Blue*</td>
<td>Matricaria chamomilla</td>
<td>E. Europe</td>
<td>Relaxation, sleep, balance, peace</td>
</tr>
<tr>
<td>Chamomile Moroccan*</td>
<td>Ormensis multicaulis</td>
<td>Morocco</td>
<td>Relaxation, sleep, balance, peace</td>
</tr>
<tr>
<td>Chamomile Roman*</td>
<td>Chameamelium nobile</td>
<td>E. Europe</td>
<td>Relaxation, sleep, balance, peace</td>
</tr>
<tr>
<td>Cinnamon-Cassia</td>
<td>Cinnamomum cassia</td>
<td>Vietnam</td>
<td>Warmth, digestion, security, awareness</td>
</tr>
<tr>
<td>Cinnamon Leaf**</td>
<td>Cinnamomum verum</td>
<td>France</td>
<td>Warmth, digestion, security, awareness</td>
</tr>
<tr>
<td>Citronella**</td>
<td>Cymbopocon nardus</td>
<td>Sri Lanka</td>
<td>Insect repellant, inspiration</td>
</tr>
<tr>
<td>Clary Sage*</td>
<td>Salvia scarea</td>
<td>Bulgaria</td>
<td>Creativity, vitality; reduces PMS</td>
</tr>
<tr>
<td>Clove Bud**</td>
<td>Syzygium aromaticum</td>
<td>India</td>
<td>Alertness, memory, pain relief</td>
</tr>
<tr>
<td>Coriander</td>
<td>Coriandrum sativum</td>
<td>Russia</td>
<td>Creative inspiration, honesty</td>
</tr>
<tr>
<td>Cypress*</td>
<td>Cupressus sempervirens</td>
<td>France</td>
<td>Strength, acceptance, decisiveness</td>
</tr>
<tr>
<td>Elemi</td>
<td>Canarium luzonicum</td>
<td>France</td>
<td>Deep calm, reduces wrinkles</td>
</tr>
<tr>
<td>Eucalyptus</td>
<td>Eucalyptus globulus</td>
<td>China</td>
<td>Respiration, spontaneity</td>
</tr>
<tr>
<td>Fennel Sweet</td>
<td>Foeniculum vulgare dulce</td>
<td>France</td>
<td>Ambition, courage, perseverance, joy</td>
</tr>
<tr>
<td>Fir Balsam (wild)</td>
<td>Abies siberica</td>
<td>Siberia</td>
<td>Skin care</td>
</tr>
<tr>
<td>Frankincense*</td>
<td>Boswellia carteri</td>
<td>Ethiopia</td>
<td>Spirituality, meditation</td>
</tr>
<tr>
<td>Geranium*</td>
<td>Pargoneum graveolens</td>
<td>Egypt</td>
<td>Contentment, security; reduces PMS</td>
</tr>
<tr>
<td>Ginger**</td>
<td>Zingiber officinalis</td>
<td>France</td>
<td>Clarity, memory, endurance</td>
</tr>
<tr>
<td>Grapefruit Pink</td>
<td>Citrus paradisi</td>
<td>France</td>
<td>Anti-depressant, mentally enlivening</td>
</tr>
<tr>
<td>Grapefruit White</td>
<td>Citrus racemosa</td>
<td>France</td>
<td>Cooperation, creativity, joy</td>
</tr>
<tr>
<td>Helichrysum</td>
<td>Helichrysum italicum</td>
<td>Slovenia</td>
<td>Rejuvenation, Skin care</td>
</tr>
<tr>
<td>Hyssop*</td>
<td>Hyssopus officinalis</td>
<td>Europe</td>
<td>Relaxation, focus, alertness</td>
</tr>
<tr>
<td>Jasmine Absolute*</td>
<td>Jasminum grandiflorum</td>
<td>France</td>
<td>Sensitivity, romance, self-worth</td>
</tr>
<tr>
<td>Juniper Berry*</td>
<td>Juniperus communis</td>
<td>India</td>
<td>Balance, openness; reduces PMS</td>
</tr>
<tr>
<td>Lavender Bulgarian*</td>
<td>Lavandula angustifolia</td>
<td>Bulgaria</td>
<td>Calming, balancing, restful sleep</td>
</tr>
<tr>
<td>Lavender Croatian*</td>
<td>Lavandula officinalis</td>
<td>Croatia</td>
<td>Restores emotional balance, soothing</td>
</tr>
<tr>
<td>Lavender French*</td>
<td>Lavandula dentata</td>
<td>France</td>
<td>Relaxing, conflict resolution, acceptance</td>
</tr>
<tr>
<td>Lemon**</td>
<td>Citrus limonum</td>
<td>Italy</td>
<td>Alertness, joy, awareness</td>
</tr>
<tr>
<td>Lemon Eucalyptus**</td>
<td>Eucalyptus citriodora</td>
<td>Australia</td>
<td>Insect repellant, respiration</td>
</tr>
<tr>
<td>Lemongrass**</td>
<td>Cymbopocon flexus</td>
<td>India</td>
<td>Rejuvenation, insect repellant</td>
</tr>
<tr>
<td>Lime**</td>
<td>Citrus aurantiifolia</td>
<td>Italy</td>
<td>Decisiveness, vitality, fun</td>
</tr>
<tr>
<td>Marjoram Wild*</td>
<td>Thymus mastichina</td>
<td>Spain</td>
<td>Restful sleep, determination</td>
</tr>
<tr>
<td>Melissa Leaf</td>
<td>Melissa officinalis</td>
<td>Egypt</td>
<td>Enthusiasm, hope, sensitivity</td>
</tr>
<tr>
<td>Mullein**</td>
<td>Verbascum thapsus</td>
<td>India</td>
<td>Not commonly used in aromatherapy</td>
</tr>
<tr>
<td>Myrrh*</td>
<td>Commiphora myrrha</td>
<td>Africa</td>
<td>Spirituality, faith, calmness</td>
</tr>
<tr>
<td>Myrtle</td>
<td>Myrtus communis</td>
<td>France</td>
<td>Expectorant, soothing</td>
</tr>
<tr>
<td>Essential Oils</td>
<td>Latin Names</td>
<td>Origin</td>
<td>Essential Oils Properties</td>
</tr>
<tr>
<td>---------------------</td>
<td>------------------------------</td>
<td>-------------</td>
<td>----------------------------------------------------------------</td>
</tr>
<tr>
<td>Neroli</td>
<td>Citrus aurantium</td>
<td>France</td>
<td>Empathy, love, sensuality</td>
</tr>
<tr>
<td>Niaouli</td>
<td>Melaleuca viridiflora</td>
<td>New Caledonia</td>
<td>Respiration, mental clarity</td>
</tr>
<tr>
<td>Nutmeg*/**</td>
<td>Myristica fragrans</td>
<td>Indonesia</td>
<td>Enthusiasm, inspiration, joy</td>
</tr>
<tr>
<td>Orange Sweet**</td>
<td>Citrus sinensis</td>
<td>Brazil</td>
<td>Sensuality, joy, creativity</td>
</tr>
<tr>
<td>Origanum*/**</td>
<td>Origanum vulgare</td>
<td>France</td>
<td>Self-confidence, courage, balance</td>
</tr>
<tr>
<td>Palmarosa</td>
<td>Cymbopogon martini</td>
<td>India</td>
<td>Emotional strength, vitality, clarity</td>
</tr>
<tr>
<td>Parsley</td>
<td>Petroselinum sativum</td>
<td>Egypt</td>
<td>Digestion, calmness; reduces PMS</td>
</tr>
<tr>
<td>Patchouli</td>
<td>Pogostemon cablin</td>
<td>Indonesia</td>
<td>Endurance, peace, sexuality</td>
</tr>
<tr>
<td>Pennyroyal*</td>
<td>Mentha pulegium</td>
<td>France</td>
<td>Skin care</td>
</tr>
<tr>
<td>Peppermint***</td>
<td>Menthe arvensis</td>
<td>USA</td>
<td>Respiration, direction, self-confidence</td>
</tr>
<tr>
<td>Petitgrain</td>
<td>Petitgrain bigarde</td>
<td>France</td>
<td>Inspiration, hope, friendship</td>
</tr>
<tr>
<td>Pine (Long Leaf)</td>
<td>Pinus pinaster</td>
<td>USA</td>
<td>Concentration, empathy, wisdom</td>
</tr>
<tr>
<td>Pine (Scotch)</td>
<td>Pinus sylvestris</td>
<td>Hungary</td>
<td>Respiration, expectorant</td>
</tr>
<tr>
<td>Rose Damask Abs.*</td>
<td>Rosa damascena</td>
<td>Turkey</td>
<td>Sensuality, love, compassion</td>
</tr>
<tr>
<td>Rose Maroc Absolute*</td>
<td>Rosa centifolia</td>
<td>Morocco</td>
<td>Sensuality, love, compassion</td>
</tr>
<tr>
<td>Rose Geranium*</td>
<td>Pelagonium graveolens</td>
<td>France</td>
<td>Balance; emotionally uplifting, PMS</td>
</tr>
<tr>
<td>Rosemary*</td>
<td>Rosmarinus officinalis</td>
<td>Spain</td>
<td>Decisiveness, remembrance</td>
</tr>
<tr>
<td>Rosewood</td>
<td>Aniba rosaedora</td>
<td>Brazil</td>
<td>Serenity, focus, spirituality</td>
</tr>
<tr>
<td>Sage</td>
<td>Salvis officinalis</td>
<td>Croatia</td>
<td>Rejuvenation, alertness</td>
</tr>
<tr>
<td>Sandalwood</td>
<td>Santalium album</td>
<td>East Indian</td>
<td>Tranquility, spirituality</td>
</tr>
<tr>
<td>Sassafras**</td>
<td>Ocotea symbarum</td>
<td>Brazil</td>
<td>Not commonly used in aromatherapy</td>
</tr>
<tr>
<td>Tangerine</td>
<td>Citrus reticulata</td>
<td>Italy</td>
<td>Inspiration, empathy, peace</td>
</tr>
<tr>
<td>Tea Tree</td>
<td>Melaleuca alternifolia</td>
<td>Australia</td>
<td>Cleansing, energizing, confidence</td>
</tr>
<tr>
<td>Thyme White*</td>
<td>Thymus vulgaris</td>
<td>France</td>
<td>Self-confidence, satisfaction</td>
</tr>
<tr>
<td>Vanilla</td>
<td>Vanilla planifolia</td>
<td>Brazil</td>
<td>Security, romance, sensuality</td>
</tr>
<tr>
<td>Vetiver</td>
<td>Vetiveria zizaniodes</td>
<td>Java</td>
<td>Intuition, serenity, self-confidence</td>
</tr>
<tr>
<td>Violet Leaf Absolute</td>
<td>Viola odorata</td>
<td>France</td>
<td>Cleansing, respiration</td>
</tr>
<tr>
<td>Wintergreen**</td>
<td>Gaulgheria procumbens</td>
<td>India</td>
<td>Not commonly used in aromatherapy</td>
</tr>
<tr>
<td>Ylang Ylang</td>
<td>Cananga odorata</td>
<td>France</td>
<td>Exuberance, acceptance, sensuality</td>
</tr>
</tbody>
</table>
**Coconut oil**, also known as coconut butter, is a vegetable oil extracted from copra (the dried inner flesh of coconuts) with many applications. Coconut oil constitutes seven percent of the total export income of the Philippines, the world's largest exporter of the product.

Coconut oil was developed as a commercial product by merchants in the South Seas and South Asia in the 1860s.

**Physical properties**

Coconut oil is a fat consisting of about 90% saturated fat. The oil contains predominantly medium chain triglycerides, with 86.5% saturated fatty acids, 5.8% monounsaturated fatty acids, and 1.8% polyunsaturated fatty acids. Of the saturated fatty acids, coconut oil is primarily 44.6% lauric acid, 16.8% myristic acid and 8.2% palmitic acid, although it contains seven different saturated fatty acids in total. Its only monounsaturated fatty acid is oleic acid while its only polyunsaturated fatty acid is linoleic acid.

Unrefined coconut oil melts at 20-25 °C and smokes at 170 °C (350 °F), while refined coconut oil has a higher smoke point of 232 °C (450 °F).

Coconut oil has a long shelf life compared to other oils, lasting up to two years due to its resilience to high temperatures. Coconut oil is best stored in solid form - i.e. at temperatures lower than 24.5 °C (76 °F) in order to extend shelf life. However, unlike most oils, coconut oil will not be damaged by warmer temperatures.

Among the most stable of all vegetable oils, coconut oil is slow to oxidize and thus resistant to rancidity.

Coconut oil is excellent as a skin moisturiser. A study shows that extra virgin coconut oil is as effective and safe as mineral oil when used as a moisturiser, with absence of adverse reactions.

Coconut oil can also help in healing Keratosis pilaris by moisturising the affected area. The coconut oil should be applied in the shower, and may cause the KP bumps to disappear.

In India and Sri Lanka, coconut oil is commonly used for styling hair, and cooling or soothing the head (stress relief). People of coastal districts of Karnataka and Kerala bathe in warm water after applying coconut oil all over the body and leaving it as is for an hour. It is suggested by elders that this ritual must be done at least once in a week, to keep body, skin, and hair healthy.

While coconut oil is widely available in some countries, it can be hard to find in others. In the UK it is not generally available in big supermarkets, but can be easily obtained from smaller convenient stores at very cheap prices (from £1 to £2 for 500ml). Some people are unaware of this and resort to buying it online or from health food shops, which generally charge a lot more (from £5 to £20 for 500ml). Some sellers explain their prices by saying that their product is not refined (e.g. "extra virgin"). However, as saturated fats do not contain any double bonds, they are highly heat stable, and as coconut oil is about 90% saturated fat, the quality of the oil itself is not affected very much by the processing. Interestingly enough, some sellers even advertise their product as being both "made without heat processing" and as being heat stable. The main difference between these two oils is the amount of extra nutrients that may remain in the unrefined oil, and the taste which in the refined oil is nearly non-existent.

Compiled from http://en.wikipedia.org/wiki/Coconut_oil
Palm oil is a form of edible vegetable oil obtained from the fruit of the oil palm tree. Previously the second-most widely produced edible oil, after soybean oil,[1] it may have now surpassed soybean oil as the most widely produced vegetable oil in the world[2].

The palm fruit is the source of both palm oil (extracted from palm fruit) and palm kernel oil (extracted from the fruit seeds). Babassu oil is extracted from the kernels of the Babassu palm.

Palm oil itself is reddish because it contains a high amount of betacarotene. It is used as cooking oil, to make margarine and is a component of many processed foods. Boiling it a few minutes destroys the carotenoids and the oil becomes white.

Palm oil is one of the few vegetable oils relatively high in saturated fats (such as coconut oil) and thus semi-solid at room temperature.

Palm oil was long recognized in West African countries, and amongst West African peoples, is of widespread use as a cooking oil. European merchants trading with West Africa occasionally purchased palm oil for use in Europe, but as the oil was bulky and cheap, and due to the much higher profits available from slave-trading, palm oil remained rare outside West Africa. During the early nineteenth century, the decline of the Atlantic slave trade and Europe's demand for legitimate commerce (trade in material goods rather than human lives) obliged African countries to seek new sources of trade revenue. In the Asante Confederacy, state-owned slaves built large plantations of oil palm trees, while in the neighbouring Kingdom of Dahomey, King Ghezo passed a law in 1856 forbidding his subjects from cutting down oil palms. Palm oil became a highly sought-after commodity by British traders, the oil being used as industrial lubricant for the machines of Britain's ongoing Industrial Revolution, as well as forming the basis for different brands of soap such as Palmolive. By c.1870, palm oil constituted the primary export of some West African countries such as Ghana and Nigeria. By the 1880s, cocoa had become more highly sought-after, leading to the decline of the palm oil industry and trade within these countries.

The palm oil and palm kernel oil are composed of fatty acids, esterified with glycerol just like any ordinary fat. Both are high in saturated fatty acids, about 50% and 80%, respectively. The oil palm gives its name to the 16 carbon saturated fatty acid palmitic acid found in palm oil; monounsaturated oleic acid is also a constituent of palm oil while palm kernel oil contains mainly lauric acid. Palm oil is the largest natural source of tocotrienol, part of the vitamin E family. Palm oil is also high in vitamin K and dietary magnesium.

Napalm derives its name from naphthenic acid, palmitic acid and pyrotechnics or simply from a recipe using naphtha and palm oil.

The proximate concentration of fatty acids (FAs) in palm oil is as follows:[3]

Saturated (total : 49.9%)
- Palmitic C16:0 44.3%
- Stearic C18:0 4.6%
- Myristic C14:0 1.0%

Monounsaturated
- Oleic C18:1 38.7%

Polyunsaturated
- Linoleic C18:2 10.5%
For palm kernel oil the fatty acid content is:

- **Saturated** (total: 82%)
  - Lauric C12:0 48.2%
  - Myristic C14:0 16.2%
  - Palmitic C16:0 8.4%
  - Capric C10:0 3.4%
  - Caprylic C8:0 3.3%
  - Stearic C18:0 2.5%

- **Monounsaturated**
  - Oleic C18:1 15.3%

- **Polyunsaturated**
  - Linoleic C18:2 2.3%

Demand for palm oil is rising and is expected to climb further, particularly for use in biodiesel (see below). Biodiesel is promoted as a form of renewable energy that greatly reduces net emissions of carbon dioxide into the atmosphere, and therefore its use is being touted as a way to decrease the impact of the greenhouse effect and also the possibility of peak oil.

However, there is increasing concern from environmental and other NGOs about the social and environmental impacts of the palm oil industry. Large areas of tropical forest are being cleared to make room for the plantations, thus destroying the habitat of a number of endangered species, in particular, the orangutan populations on the islands of Borneo and Sumatra.[1] In addition, clearing of tropical forests is one of the leading causes of climate change.

- **Palm oil nursery**

- **A related issue is the conversion of Indonesian peat bogs into plantations, a practise driven by the global demand for palm oil, hardwood, and paper pulp. Such practises are responsible for 2000 million tonnes of CO2 emitted annually in Indonesia: 600 million tonnes from the decomposition of dry peat, and 1400 million tonnes from fires resulting from the draining of the bogs.[2] Moreover, the plantations are often run by agribusiness companies, and local residents in places like West Papua and Kalimantan are losing out on jobs to migrant workers.

- Orangutan experts around the world have unified to recognise that continued development of the palm oil sector, if done unsustainably, is the single greatest threat to the future of orangutans in the wild. The best professional estimates state that if the industry is not regulated then within 12 years we may witness the disappearance of orangutans from the wild. Other species that are critically threatened by disappearance of the forests include the Sumatran tiger and rhinoceros.

Compiled from http://en.wikipedia.org/wiki/Palm_kernel_oil
Olive oil is a vegetable oil obtained from the olive (Olea europaea), a traditional tree crop of the Mediterranean Basin. It is used in cooking, cosmetics, soaps, and as a fuel for traditional oil lamps. Olive oil is regarded as a healthy dietary oil because of its high content of monounsaturated fat (mainly oleic acid) and polyphenols.

Over 750 million olive trees are cultivated worldwide, with about 95 percent in the Mediterranean region. About three-quarters of global olive oil production comes from European Union states; of the European production, 97 percent comes from Spain, Italy, and Greece; Spain alone accounts for more than 40 percent of world production. Much of the Spanish crop is exported to Italy, where it is both consumed and repackaged for sale abroad as olive oil "imported from Italy".[2]

The province of Jaen, Spain in general, and the city of Martos in particular claims to be the "World Capital of olive oil" as the largest producer of olive oil in the world.

In olive oil-producing countries, the local production is generally considered the finest. In North America, Italian olive oil is the best-known, but top-quality extra-virgin oils from Spain, Greece, and France (Provence) are sold at high prices, often in 'prestige' packaging.

Greece devotes 60 percent of its cultivated land to olive-growing. It is the world's top producer of black olives and boasts more varieties of olives than any other country. Greece holds third place in world olive production with more than 132 million trees, which produce approximately 350,000 tons of olive oil annually, of which 75 percent is extra-virgin (see below for an explanation of terms). This makes Greece the world's biggest producer of extra-virgin olive oil, topping Italy (where 40-45 percent of olive oil produced is extra virgin) or Spain (where 25-30 percent of olive oil produced is extra virgin). About half of the annual Greek olive oil production is exported, while only some 5 percent of this quantity reflects the origin of the bottled product. Greek exports primarily target European Union countries, the main recipient being Italy, which receives about three-quarters of total exports. Olives are grown for oil in mainland Greece as well as in Crete, the Aegean Islands and Ionian Islands, and the Peloponnese, the latter being the source of 65 percent of Greek production.[1]

The Italian government regulates the use of different protected designation of origin labels for olive oils in accordance with EU law. Olive oils grown in the following regions are given the Denominazione di Origine Protetta (Denomination of Protected Origin) status: Aprutino Pescarese, Brisighella, Bruzzo, Chianti, Colline di Brindisi, Colline Di Salernitane, Penisola Sorrentina, Riviera Ligure, and Sabina. Olive oil from the Chianti region has the special quality assurance label of Denominazione di Origine Controllata (Denomination of Controlled Origin; DOC) as well as the DOP.

Among the many different olive varieties used in Italy are Frantoio, Leccino Pendolino, and Moraiolo. Extra virgin olive oil is exported everywhere—and often mixed to produce pure. The oil, specifically from Bitonto, is held in highest regard. Demand for Italian olive oil has soared in the United States. In 1994, exports to the U.S. totaled 28.95 million gallons, a 215 percent increase from 1984. The United States is Italy's biggest customer, absorbing 22 percent of total Italian production of 131.6 million gallons in 1994. A 45 percent increase in 1995-1996 is blamed for a drop of 10 percent in sales in Italy, and a 10 percent decline in exports to the United States. Despite shrinkage in production, Italian exports of olive oil rose by 19.2 percent from 1994 to 1995. A large share of the exports went to the European Union, especially Spain.[1]
Greece has by far the heaviest per capita consumption of olive oil worldwide, over 26 liters per year; Spain and Italy, around 14 l; Tunisia, Portugal, and Syria, around 8 l. Northern Europe and North America consume far less, around 0.7 l, but the consumption of olive oil outside its home territory has been rising steadily.

Price in an important factor on olive oil consumption in the world commodity market. In 1997, global production rose by 47%, which replenished low stocks, lowered prices, and increased consumption by 27%. Overall, world consumption trends are up by 2.5%. Production trends are also up due to expanded plantings of olives in Europe, Latin America, USA, and Australia.

The main producing countries in 2003 were:

Traditionally, olive oil was produced by beating the trees with sticks to knock the olives off and crushing them in stone or wooden mortars or beam presses. Nowadays, olives are ground to tiny bits, obtaining a paste that is mixed with water and processed by a centrifuge, which extracts the oil from the paste, leaving behind pomace.

<table>
<thead>
<tr>
<th>Country</th>
<th>Production</th>
<th>Consumption</th>
<th>Annual Per Capita Consumption (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spain</td>
<td>44%</td>
<td>23%</td>
<td>13.92</td>
</tr>
<tr>
<td>Italy</td>
<td>20%</td>
<td>28%</td>
<td>12.35</td>
</tr>
<tr>
<td>Greece</td>
<td>13%</td>
<td>11%</td>
<td>23.7</td>
</tr>
<tr>
<td>Turkey</td>
<td>7%</td>
<td>2%</td>
<td>6</td>
</tr>
<tr>
<td>Syria</td>
<td>7%</td>
<td>4%</td>
<td>6</td>
</tr>
<tr>
<td>North Africa (mainly Tunisia and Morocco)</td>
<td>4%</td>
<td>4%</td>
<td>10.9</td>
</tr>
<tr>
<td>Portugal</td>
<td>1.6%</td>
<td>3%</td>
<td>7.1</td>
</tr>
<tr>
<td>United States</td>
<td>nil</td>
<td>8%</td>
<td>0.56</td>
</tr>
<tr>
<td>France</td>
<td>nil</td>
<td>4%</td>
<td>1.34</td>
</tr>
<tr>
<td>Other</td>
<td>5%</td>
<td>16%</td>
<td></td>
</tr>
</tbody>
</table>

Animal fats have been used for cooking and for fuel for centuries. The fat from animals had to be "cleaned" in order to be used. This cleaning process is called rendering, and involves separating the fat from the other tissues left over from the butchering on an animal. Rendering fat is an age old process that was carried out in every home in pioneer days and in agrarian cultures.

While lard isn't considered a food, it was vital to the cooking process for many years. Here is a brief description of this necessary pioneering activity.

**Rendering Lard**

A 225-pound hog will yield about 30 pounds of fat that can be rendered into fine shortening for pastries, biscuits, and frying. The sheet of fat just inside the ribs makes the best quality, snowy-white lard. This "leaf" fat renders most easily, too -- and is ninety percent fat. The "back" fat, a thick layer just under the skin, is almost as good, giving about eighty percent of its weight in lard.

A slow fire and a heavy pot that conducts heat evenly are most important in making lard. Put ¼" of water in the pot to keep the fat from scorching at first. Remove any fibers, lean meat, and bloody spots from the fat, and cut into very small pieces. It's not necessary to remove pieces of skin, but many people prefer to. Put a shallow layer of fat in the pot. When the first layer of fat has started to melt, add more. Do not fill the kettle to the top -- it can boil over too easily. Stir frequently and keep fire low.

The temperature of the lard will be 212F at first, but as the water evaporates, the temperature will rise. Be forewarned that this will take a long time at low heat and that you must stir the lard frequently to prevent scorching. As the lard renders, the cracklings will float to the surface. When the lard is almost done and the cracklings have lost the rest of their moisture, they will sink to the bottom. At this point turn off the heat and allow the lard to settle and cool slightly. Then carefully dip the liquid off the top into clean containers. Strain the cracklings and residual liquid through cheese cloth. Fill containers to the top -- the lard will contract quite a bit while cooling. Chill as quickly as possible for a fine-grained shortening.

Air, light, and moisture can make lard rancid and sour. So after it has been thoroughly cooled, cover the containers tightly and store them in a dark, cool area.

Compiled from http://www.easyfunschool.com/article1141.html
The chemistry of soap making is an acid-base reaction. But the acid is a fatty acid from a living organism, not a mineral acid, such as hydrochloric acid.

The irony about soap is that it is made from fats and oils, the very thing that soap helps to remove.

But the action of soap is more than just grease and oil cutting, it also bonds to dirt and other materials, and with the help of water, washes these materials away.

Chemically, soap is able to be polar and non-polar at the same time. Because of this dual property, it is such an effective cleansing agent.

Soap is actually a salt. It is an organic salt of the reaction of fatty acid with a strong base.

The following pages explain this chemistry and how soap is effective as a cleaner.
Perhaps the most useful way of understanding how acids and bases react is by considering one of several definitions for these types of reactions.

**The Arrhenius definition**

Svante Arrhenius provided the first modern definition of acids and bases in 1884. In water, a dissociation takes place:

\[ 2\text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+ + \text{OH}^- \]

A compound causing an increase in H\(_3\)O\(^+\) and a decrease in OH\(^-\) is an **acid** and one causing the reverse is a **base**.

An Arrhenius **acid**, when dissociated in water, typically yields a positively-**charged hydronium** ion and a complementary negative **ion**.

An Arrhenius **base**, when dissociated in water, typically yields a negatively-**charged hydroxide** ion and a complementary positive **ion**.

The positive ion from a base can form a salt with the negative ion from an acid. For example, two moles of the base **sodium hydroxide** (NaOH) can combine with one mole of sulphuric acid (H\(_2\)SO\(_4\)) to form two moles of **water** and one mole of sodium **sulphate**.

\[ 2\text{NaOH} + \text{H}_2\text{SO}_4 \rightarrow 2\text{H}_2\text{O} + \text{Na}_2\text{SO}_4 \]

In general, an acid plus a base react to make a salt and water.

\[ \text{acid} + \text{base} \rightarrow \text{salt} + \text{water} \]

This is true for so-called inorganic acids and bases. However, the acid used to make soap is an organic acid, or one originating from a living organism.

In organic chemistry, which soap making falls into, the acid-base reaction becomes:

\[ \text{Organic acid (triglyceride)} + \text{base} \rightarrow \text{organic salt (soap)} + \text{glycerine} \]

For handmade soaps using the cold process, the glycerine produced remains with the soap. In industrially produced soaps, the glycerine is removed for other uses. Glycerine is very good for the skin, so it is a good thing to have the glycerine remain in the soap.
To understand what is needed to achieve effective cleaning, it is helpful to have a basic knowledge of soap and detergent chemistry.

Water, the liquid commonly used for cleaning, has a property called surface tension. In the body of the water, each molecule is surrounded and attracted by other water molecules. However, at the surface, those molecules are surrounded by other water molecules only on the water side. A tension is created as the water molecules at the surface are pulled into the body of the water. This tension causes water to bead up on surfaces (glass, fabric), which slows wetting of the surface and inhibits the cleaning process. You can see surface tension at work by placing a drop of water onto a counter top. The drop will hold its shape and will not spread.

In the cleaning process, surface tension must be reduced so water can spread and wet surfaces. Chemicals that are able to do this effectively are called surface active agents, or surfactants. They are said to make water "wetter."

Surfactants perform other important functions in cleaning, such as loosening, emulsifying (dispersing in water) and holding soil in suspension until it can be rinsed away. Surfactants can also provide alkalinity, which is useful in removing acidic soils.

Surfactants are classified by their ionic (electrical charge) properties in water: anionic (negative charge), nonionic (no charge), cationic (positive charge) and amphoteric (either positive or negative charge).

Soap is an anionic surfactant. Other anionic as well as nonionic surfactants are the main ingredients in today's detergents. Now let's look closer at the chemistry of surfactants.

**SOAPS**

Soaps are water-soluble sodium or potassium salts of fatty acids. Soaps are made from fats and oils, or their fatty acids, by treating them chemically with a strong alkali, or base.

First let's examine the composition of fats, oils and alkalis; then we'll review the soapmaking process.
Fats and Oils

The fats and oils used in soapmaking come from animal or plant sources. Each fat or oil is made up of a distinctive mixture of several different triglycerides.

In a triglyceride molecule, three fatty acid molecules are attached to one molecule of glycerine. There are many types of triglycerides; each type consists of its own particular combination of fatty acids.

Fatty acids are the components of fats and oils that are used in making soap. They are weak acids composed of two parts:

A carboxylic acid group consisting of one hydrogen (H) atom, two oxygen (O) atoms, and one carbon (C) atom, plus a hydrocarbon chain attached to the carboxylic acid group. Generally, it is made up of a long straight chain of carbon (C) atoms each carrying two hydrogen (H) atoms.

Alkali

An alkali is a soluble salt of an alkali metal like sodium or potassium. Originally, the alkalis used in soapmaking were obtained from the ashes of plants, but they are now made commercially. Today, the term alkali describes a substance that chemically is a base (the opposite of an acid) and that reacts with and neutralizes an acid.

The common alkalis used in soapmaking are sodium hydroxide (NaOH), also called caustic soda; and potassium hydroxide (KOH), also called caustic potash.

How Soaps are Made

Saponification of fats and oils is the most widely used soapmaking process. This method involves heating fats and oils and reacting them with a liquid alkali to produce soap and water (neat soap) plus glycerine.
The other major soapmaking process is the neutralization of fatty acids with an alkali. Fats and oils are hydrolyzed (split) with a high-pressure steam to yield crude fatty acids and glycerine. The fatty acids are then purified by distillation and neutralized with an alkali to produce soap and water (neat soap).

When the alkali is sodium hydroxide, a sodium soap is formed. Sodium soaps are "hard" soaps. When the alkali is potassium hydroxide, a potassium soap is formed. Potassium soaps are softer and are found in some liquid hand soaps and shaving creams.

The carboxylate end of the soap molecule is attracted to water. It is called the hydrophilic (water-loving) end. The hydrocarbon chain is attracted to oil and grease and repelled by water. It is known as the hydrophobic (water-hating) end.

**How Water Hardness Affects Cleaning Action**

Although soap is a good cleaning agent, its effectiveness is reduced when used in hard water. Hardness in water is caused by the presence of mineral salts - mostly those of calcium (Ca) and magnesium (Mg), but sometimes also iron (Fe) and manganese (Mn). The mineral salts react with soap to form an insoluble precipitate known as soap film or scum.
Soap film does not rinse away easily. It tends to remain behind and produces visible deposits on clothing and makes fabrics feel stiff. It also attaches to the insides of bathtubs, sinks and washing machines.

Some soap is used up by reacting with hard water minerals to form the film. This reduces the amount of soap available for cleaning. Even when clothes are washed in soft water, some hardness minerals are introduced by the soil on clothes. Soap molecules are not very versatile and cannot be adapted to today's variety of fibers, washing temperatures and water conditions.

**HOW SOAPS AND DETERGENTS WORK**

Three types of energy are needed for good cleaning results:
- chemical energy, provided by the soap or detergent;
- thermal energy, provided by warm or hot water; and
- mechanical energy, provided by a machine or hands.

These types of energy interact and should be in proper balance. Let's look at how they work together.

Let's assume we have oily, greasy soil on clothing. Water alone will not remove this soil. One important reason is that oil and grease present in soil repel the water molecules.

Now let's add soap or detergent. The surfactant's water-hating end is repelled by water but attracted to the oil in the soil. At the same time, the water-loving end is attracted to the water molecules.

These opposing forces loosen the soil and suspend it in the water. Warm or hot water helps dissolve grease and oil in soil. Washing machine agitation or hand rubbing helps pull the soil free.

Compiled from http://www.cleaning101.com/cleaning/chemistry/index.cfm
1st Consideration: Topic 4-Soap Making

- The history of soap making goes back thousands of years. During the last century, multinational corporations have arisen from producing and selling soaps. In the last twenty years, small producers of handmade soap have made an industry on their own, competing with the large corporations.
- Modern soaps have largely been replaced with so-called detergents, which are some form of cleaning agent that may or may not have soap as a component.
- Handmade soaps are mostly true soaps, especially those made in a cold process.
- The following pages give a summary of soap and soap making. The details of how to carry out the cold process to make handmade soap is given in the 2nd Consideration.
Topic 4-Soap Making

- **Soap** is a surfactant used in conjunction with water for washing and cleaning. It usually comes in a moulded form, termed bars due to its historic and most typical shape. The use of thick liquid soap has also become widespread, especially from soap dispensers in public washrooms. Applied to a soiled surface, soapy water effectively holds particles in suspension so the whole of it can be rinsed off with clean water. In the developed world, synthetic detergents have superseded soap as a laundry aid.

- Many soaps are mixtures of sodium (soda) or potassium (potash) salts of fatty acids which can be derived from oils or fats by reacting them with an alkali (such as sodium or potassium hydroxide) at 80°–100 °C in a process known as saponification. The fats are hydrolyzed by the base, yielding glycerol and crude soap. Historically, the alkali used was potassium made from the deliberate burning of vegetation such as bracken, or from wood ashes.

- Soap is derived from either oils or fats. Sodium tallowate, a common ingredient in many soaps, is in fact derived from rendered beef fat. Soap can also be made of vegetable oils, such as olive oil. Soap made entirely from such oils, or nearly so, is called castile soap. The use of the word "soap" has become such a household name that even cleaning solutions for the body that don't have soap in the ingredients are referred to as soap.

- The common process of purifying soap involves removal of sodium chloride, sodium hydroxide, and glycerol. These components are removed by boiling the crude soap curds in water and re-precipitating the soap with salt.

- Most of the water is then removed from the soap. This was traditionally done on a chill roll which produced the soap flakes commonly used in the 1940s and 1950s. This process was superseded by spray dryers and then by vacuum dryers.

- The dry soap (approximately 6-12% moisture) is then compacted into small pellets. These pellets are now ready for soap finishing, the process of converting raw soap pellets into a salable product, usually bars.

- Soap pellets are combined with fragrances and other materials and blended to homogeneity in an amalgamator (mixer). The mass is then discharged from the mixer into a refiner which, by means of an auger, forces the soap through a fine wire screen. From the refiner the soap passes over a roller mill (French milling or hard milling) in a manner similar to calendering paper or plastic or to making chocolate liquor. The soap is then passed through one or more additional refiners to further plasticize the soap mass. Immediately before extrusion it passes through a vacuum chamber to remove any entrapped air. It is then extruded into a long log or blank, cut to convenient lengths, passed through a metal detector and then stamped into shape in refrigerated tools. The pressed bars are packaged in many ways.

- Sand or pumice may be added to produce a scouring soap. This process is most common in creating soaps used for human hygiene. The scouring agents serve to remove dead skin cells from the surface being cleaned. This process is called exfoliation. Many newer materials are used for exfoliating soaps which are effective but do not have the sharp edges and poor size distribution of pumice.

- Although the word 'soap' continues to be used informally in everyday speech and product labels, in practice nearly all kinds of "soap" in use today are actually synthetic detergents, which are less expensive and easier to manufacture. While effort has been made to reduce their negative effect upon the environment, the results have been mixed.
Soaps are useful for cleansing because soap molecules attach readily to both nonpolar molecules (such as grease or oil) and polar molecules (such as water). Although grease will normally adhere to skin or clothing, the soap molecules can attach to it as a "handle" and make it easier to rinse away. Allowing soap to sit on any surface (skin, clothes etc) over time can imbalance the moisture content on it and result in the dissolving of fabrics and dryness of skin.

The hydrocarbon ("fatty") portion dissolves dirt and oils, while the ionic end makes it soluble in water. Therefore, it allows water to remove normally-insoluble matter by emulsification.

Soap water can be used as a nature friendly way to get rid of an ant problem. Pouring soap water on an ant trail destroys the ant's sense of smell and the scent the ants were following to get to the food.

It used to be used as a punishment for cursing—"washing one's mouth out with soap."

The earliest known evidence of soap use are Babylonian clay cylinders dating from 2800 BC containing a soap-like substance. A formula for soap consisting of water, alkali and cassia oil was written on a Babylonian clay tablet around 2200 BC.

The Ebers papyrus (Egypt, 1550 BC) indicates that ancient Egyptians bathed regularly and combined animal and vegetable oils with alkaline salts to create a soap-like substance. Egyptian documents mention that a soap-like substance was used in the preparation of wool for weaving.

It is commonly reported that a soap factory with bars of scented soap was found in the ruins of Pompeii (79 AD). However, this has proved to be a misinterpretation of the survival of some soapy mineral substance, probably soapstone at the Fullonica where it was used for dressing recently cleansed textiles. Unfortunately this error has been repeated widely and can be found in otherwise reputable texts on soap history. The ancient Romans were generally ignorant of soap's detergent properties. The word "soap" appears first in a European language in Pliny the Elder's Historia Naturalis, which discusses the manufacture of soap from tallow and ashes, but the only use he mentions for it is as a pomade for hair; he mentions rather disapprovingly that among the Gauls and Germans men are likelier to use it than women.

The Arabs made the soap from vegetable oil such as olive oil or some aromatic oils such as thyme oil. Sodium Lye (Al-Soda Al-Kawia) NaOH was used for the first time and the formula hasn't changed from the current soap sold in the market. From the beginning of the 7th century soap was produced in Nablus (Palestine), Kufa (Iraq) and Basra (Iraq). Soaps, as we know them today, are descendents of historical Arabian Soaps. Arabian Soap was perfumed and coloured, some of the soaps were liquid and others were hard. They also had special soap for shaving. It was commercially sold for 3 Dirhams (0.3 Dinars) a piece in 981 AD. Al-Razi's manuscript contains recipes for soap. A recently discovered manuscript from the 13th century details more recipes for soap making; e.g. take some sesame oil, a sprinkle of potash, alkali and some lime, mix them all together and boil. When cooked, they are poured into moulds and left to set, leaving hard soap.

A story encountered in some places claims that soap takes its name from a supposed "Mount Sapo" where ancient Romans sacrificed animals. Rain would send a mix of animal tallow and wood ash down the mountain and into the clay soil on the banks of the Tiber. Eventually, women noticed that it was easier to clean clothes with this "soap". The location of Mount Sapo is unknown, as is the source of the "ancient Roman legend" to which this tale is typically credited. In fact, the Latin word sapon simply means "soap"; it was borrowed from a Celtic or Germanic language, and is cognate with Latin sebum, "tallow", which appears in Pliny the Elder's account. Roman animal sacrifices usually burned only the bones and inedible entrails of the sacrificed animals; edible meat and fat from the sacrifices were taken by the humans rather than the gods. Animal sacrifices in the ancient world would not have included enough fat to make much soap. The legend about Mount Sapo is probably apocryphal.
Topic 4-Soap Making

- Historically, soap was made by mixing animal fats with lye. Because of the caustic lye, this was a dangerous procedure (perhaps more dangerous than any present-day home activities) which could result in serious chemical burns or even blindness. Before commercially-produced lye was commonplace, it was produced at home for soap making from the ashes of a wood fire.

- Castile soap, made from olive oil, was produced in Europe as early as the 16th century.

- In modern times, the use of soap has become universal in industrialized nations due to a better understanding of the role of hygiene in reducing the population size of pathogenic microorganisms. Manufactured bar soaps first became available in the late nineteenth century, and advertising campaigns in Europe and the United States helped to increase popular awareness of the relationship between cleanliness and health. By the 1950s, soap had gained public acceptance as an instrument of personal hygiene.

- Some individuals continue to make soap in the home. The traditional name "soaper", for a soapmaker, is still used by those who make soap as a hobby. Those who make their own soaps are also known as soapcrafters.

- The most popular soapmaking processes today is the cold process method, where fats such as olive oil react with lye. Soapmakers sometimes use the melt and pour process, where a premade soap base is melted and poured in individual molds, but this is not really to be considered soap-making. Some soapers also practice other processes, such as the historical hot process, and make special soaps such as clear soap (aka glycerin soap).

- Handmade soap differs from industrial soap in that, usually, an excess of fat is used to consume the alkali (superfatting), and in that the glycerin is not removed. Superfatted soap, soap which contains excess fat, is more skin-friendly than industrial soap; though, if not properly formulated, it can leave users with a "greasy" feel to their skin. Often, emollients such as jojoba oil or shea butter are added 'at trace' (the point at which the saponification process is sufficiently advanced that the soap has begun to thicken), after most of the oils have saponified, so that they remain unreacted in the finished soap.

- Until the Industrial Revolution soap-making was done on a small scale and the product was rough. Andrew Pears started making a high-quality, transparent soap in 1789 in London. With his grandson, Francis Pears, they opened a factory in Isleworth in 1862. William Gossage produced low-price good-quality soap from the 1850s in Widnes, Robert Spear Hudson began manufacturing a soap powder in 1837, initially by grinding the soap with a mortar and pestle. William Hesketh Lever and his brother James bought a small soap works in Warrington in 1885 and founded what is still one of the largest soap businesses, now called Unilever. These soap businesses were among the first to employ large scale advertising campaigns to sell the output of their factories.

- These plants are supposed to contain saponins in sufficient quantities to produce lather (when mashed plant parts are beaten in water) and can be used in either soap or shampoos:
  - The soap plant group (amole root, soap plant root, soaproot bulb), guaiac leaves, papaya leaves, Quillaja bark, Red campion root and leaves, Atriplex root, Sapindus fruit, soap pod fruit, Mojave yucca root, Soapwort root, Our Lord's Candle root, wild gourd fruit.[1]

- Today, fat-based soaps have mostly been superseded by modern detergents. Washing agents do not contain soap for cleaning fabric, but for reducing foam.
The disadvantages of commercial soaps are:

- Most commercial soaps have had their glycerine removed for use in other industries, which deprives the skin of the natural, moisturising glycerine and generally leaves the skin feeling dry.
- Some antibacterial soaps have antiseptic chemicals that can kill "healthy" bacteria that live symbiotically on the skin's surface and contribute to skin health. There is a theoretical risk of antibacterial additives (specifically Triclosan) in soaps contributing to antibiotic resistant bacteria, however, controlled studies have not borne out that conclusion (Aiello AE et al. Antibacterial cleaning products and drug resistance. Emerg Infect Dis 2005 Oct; 11:1565-70). Some antibacterial soaps contain Triclosan which, when discharged into the environment and exposed to sunlight, breaks down into dioxins ("Occurrence and Environmental Behavior of the Bactericide Triclosan and Its Methyl Derivative in Surface Waters and in Wastewater" Anton Lindström, Ignaz J. Buerge, Thomas Poiger, Per-Anders Bergqvist, Markus D. Müller, and Hans-Rudolf Buser Environ. Sci. Technol.; 2002; 36(11) pp 2322 - 2329).
- Soap-based products often contain the additive sodium laureth sulfate, which research has found to be harsh on skin. This product is also present in many non-soap cleaners for personal hygiene (shampoos, bathfoams, toothpaste, etc.).
- Soap can have a mild base reaction with fabrics, resulting in damage over the long term. This is usually due to excess sodium hydroxide (NaOH, an alkali/base) left from manufacture, but can also be caused by the very slight presence of NaOH from the equilibrium reaction:
  \[ R\text{-} COO\text{-}Na + H2O \leftrightarrow R\text{-} COO\text{-} + Na^+ + H2O \leftrightarrow R\text{-} COOH + NaOH \]
  However, this equilibrium strongly favors the left-hand side so the fraction of NaOH formed is minuscule.
- A wide variety of emollient materials, such as shea or cocoa butters, are substantive to the skin.
- Poorly finished soaps contain alkali (NaOH) and react mildly basically with skin and fabric; commercial products are finished to neutrality or to a weak acid content to prevent this and be more compatible with the skin’s slightly acidic pH.
- Commercial products use chelating molecules (sequestrants), often EDTA derivatives to bind with any free Ca or Mg ions and prevent soap scum. These also help reduce fragrance loss, discolouration and rancidity.
- Castile soap has a very high alkalinity level, measured at about 9. pH of skin and hair has a slightly acidic pH level known to be about 5 to 6. Due to the high pH level, liquid castile soap is usually not recommended by soapmakers who market this high pH soap for washing hair because it is not pH-balanced and it may cause hair to become dry.
1st Consideration: Wrap Up

- Soap is an organic salt from reacting fatty acids with a strong base.
- The strong base now used most often is Sodium hydroxide.
- Oils and fats are composed of triglycerides, or three fatty acid chains attached to one glycerol.
- The most common oils used today for making soap are coconut oil, palm oil, palm kernel oil, and olive oil.
- Soap acts as a surfactant and emulsifier to make water “wetter,” and attach to fats, oils, and dirt to be washed away with water.
- Handmade soaps tend to be as natural as possible, using vegetable oils as base oils, essential oils and plant colours for aesthetic effects, i.e., these soaps are on the living end of the chemical spectrum of plant products.
- Industrially produced soaps tend to have their glycerine removed and be coloured and scented with synthesized coal tar derivatives, thus these soaps tend toward the “dead” end of the chemical spectrum of plant products.
2nd Consideration: Objectives

- See and experience the processes for making soap
- Learn the essential elements of soap making and how to bring these processes to youth
- Experience how to enhance soaps with natural scents and colours to increase the aesthetic quality and experience of cleaning
2nd Consideration: 
Topic 1-Materials

- Soap making requires some dedicated equipment because of the chemical nature of the substances being used. The lye has some hazardous qualities which are easy to be aware of, but the essential oils can also be harmful. Since soap making requires substantial amounts of concentrated essential oils, even the fumes can have effects. Having dedicated equipment ensures that no concentrated oils enter foods.

- Certain equipment is just necessary to make soap. Fairly precise weights and temperatures are necessary, so the right equipment is essential to make the reaction work. All the equipment is readily available, but it is necessary.

- The raw materials are also readily available, but may take a little searching to find sources that don't cost an arm and leg. Bulk oils can be bought in bulk at fairly reasonable prices, but essential oils are expensive. Sodium hydroxide is becoming harder to get because of its use in illegal drug manufacturing, but is still available if you know where to look.

- The following pages list the equipment and materials necessary to make soap.
- They also include current costs in Canadian dollars and a cost breakdown for individual bars of soap.
Equipment and Materials List for Soap Making

- Materials for soap making
- Equipment:
  - Stainless steel container or plastic bucket to make soap in
  - (a stainless steel soup pot works very well for melting the fats in as well as making the soap)
  - Glass (Pyrex) or stainless steel container for making lye water
  - A kitchen scale for measuring (needs to go down to at least 5 grams)
  - A kitchen thermometer (needs to be easily readable to 45º C)
  - Stirring sticks or paddles
  - Several spoons
  - Smaller plastic, glass, or stainless steel containers for measuring and mixing sodium hydroxide and enhancements
- Moulds (these can be plastic container, milk cartons, tetrapak boxes, etc., just no metal other than stainless steel or bare paper (milk cartons and tetrapaks have wax or plastic linings). A wooden box can work, but it is best lined with plastic wrap
- A heat source, such as a stovetop or burner, or a large sink with hot and cold water.
- A sink with hot and cold water as a warming and cooling bath
- A chart of SAP values
- A calculator is helpful
- Raw materials
  - Fats of your choice (animal fats must be rendered, so lard or tallow from the grocery store are fine)
  - Sodium hydroxide (hardware stores will carry sodium hydroxide in 3 kg containers for about $27.00—smaller containers are no longer available due to sodium hydroxide’s use in producing methamphetamine)
  - Sodium hydroxide can also be bought at some essential oil and soap making suppliers.
- Essential oils of your choice for scent
- Colour additives of your choice
Topic 1-Materials
Photos of raw materials

- The raw materials for making soap
- 1—base oils: coconut, olive, and palm kernel oils
- 2—sodium hydroxide, or lye crystals
- 3—essential oils
The raw materials for this workshop cost about $350. With two groups planned, we will use together about $220 to $240 worth of the materials to produce around 360 bars of soap, as long as no mistakes happen in measuring and no batches have to be remade.

Order Summary

- Item Subtotal: Can$287.89
- Shipping Cost: Can$0.00
- GRAND TOTAL: Can$287.89
- Includes Can$0.00 sales tax (if applicable)

Item Ref. | Price ea. | Qty. | Description
--- | --- | --- | ---
BLK008C/20kg | Can$75.00 | 1 | Coconut Oil 76, Hard 76º Coco nucifera, USA, CO-20kg/44.09lb
BLK015C/20kg | Can$94.44 | 1 | Palm Kernal Oil, Elasis spp, Malaysia, CO-20kg/44.09lbs
EO055C/16 | Can$14.86 | 1 | Clove Leaf Essential Oil, Eug enia caryophyllatta, Madagascar - 16oz/473.8ml
EO105C/16 | Can$26.86 | 1 | Lavandin Grosso Essential Oil, Lavandula hybrida grosso, France - 16oz/473.8ml
EO140C/34 | Can$17.41 | 1 | Orange Sweet Essential Oil, C itrus sinensis, Brazil - 34oz /1L
EO163C/16 | Can$59.32 | 1 | Rosemary Essential Oil, Rosma rinus officinalis, Morocco - 16oz/473.8ml

End of Order

I spent an additional $27 for sodium hydroxide at Home Hardware and $36 for olive oil at the Canadian Superstore.
## Topic 1-Materials
### Cost breakdown per bar of soap

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<th>bulk cost</th>
<th>total weight</th>
<th>used weight</th>
<th>number of bars</th>
<th>cost per bar</th>
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<td>1800</td>
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<td>$0.0487</td>
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</tbody>
</table>

### Cost per bar by soap
- Rosemary: $0.7145
- Orange: $0.6304
- Lavandin: $0.6634
2nd Consideration:
Topic 2-Safety

- Two main safety concerns exist in soap making—getting lye into eyes and ingesting lye.
- The early stages of making soap are harmless, so safety management for most of the preparation stages are easy.
- Once the container of sodium hydroxide is opened, then the safety issues become extremely important.
- Lye on the skin will cause a chemical burn, but one can usually feel a burning sensation before any real damage is done, and lye is easily washed away with water.
- The eyes are a different matter, however, and precautions must be taken to minimize the risk of getting any lye into eyes.
- Ingestion of sodium hydroxide is also extremely dangerous, but this is quite easily managed if proper boundaries around eating and drinking are established and proper cleanup is done.
- Much of the safety can be managed by thinking through the use of space before the soap making process begins.
- This leaves eye protection as the most important concern.
- Safety goggles or glasses are essential safety gear for students, although I have made many batches of soap with teenagers who would just not keep their safety glasses on their heads. Again, much of the risks can be minimized with proper space management and boundaries.
- Another consideration is the essential oils. Some essential oils can have radical effects on bodily functions. It is important to look over information on Material Safety Data Sheets. MSDS sheets can be obtained on the internet for most substances. MSDS data for the essential oils used in this workshop are in the appendix of this booklet.
A little more about the chemistry of strong alkalies

Strong alkalies dissolve proteins: fingernail cuttings put into lye will dissolve; cooked eggs will dissolve; and the proteins in skin and eyes will dissolve

Two main dangers exist with lye getting into eyes
- First, if solid NaOH gets into an eye, the water around the eye will dissolve it and that creates a lot of heat, so the eye can get heat burned
- Second, NaOH in the eye will begin to eat away the proteins in the eye and can cause fogging of the cornea and eventual rupture of the eye

The same can be true of the skin, especially if the skin is moist from sweat or water, but most of our skin tissue is much, much less sensitive than eye tissue, so we usually have more than five minutes of feeling burning before significant damage may be done, however, if anyone feels a burning sensation, it is always best to have the area flushed with plenty of water immediately.

The fumes from NaOH can be harmful, so it is best to make the solution in a well-ventilated place. Rain water or distilled water are the best to use for making the solution. Tap water usually contains some chlorine and/or fluorine from treatment by the local government. When the sodium hydroxide dissolves, hydrogen is released in the water, which often combines with chlorine and fluorine to become hydrochloric and hydrofluoric acids.

Once the lye is added to the oils, the mixture is still extremely alkaline for about three weeks. It is best to have an out of the way place to stir the soap mixture and a secure place to put the new soap while in its moulds and while curing to prevent skin burns, burnt eyes, and accidental ingestion from curious fingers.

Sodium Hydroxide should never be stored with: Acids, aluminum, organohalogen compounds, nitro and chloro-organic compounds, flammable liquids, nitro methane, whey solids and nitrous compounds
Moving the centres of activity as different processes begin is a good way to further the reduction of risk. A fairly large area is needed to cut, scoop and weigh the oils into the container for heating. This space needs to be the first centre of activity, and can remain as a continuing centre for further preparation of the moulds and enhancements once the activity has shifted to the heating, cooling, and mixing centres. Part of planning the space is to provide easy access to the areas where heating and cooling, are to take place. Having the sinks, for cooling and warming baths, as the second centre of activity is important for minimizing carrying and risk once the sodium hydroxide is put into play. The third centre needs to be near the heating and cooling area, but also close to the area where the enhancements and moulds have been prepared so that when the time comes, these are easily reachable. Now we come back to the first centre as the fourth, where the enhancements and moulds are being prepared as the soap mixture is being stirred.

Here are several key tips to practicing safety for soap making:

- Never work alone.
- Do not eat, drink or smoke in the soap making area.
- Wear the correct personal protective equipment (PPE) for the hazard, such as safety glasses, and protective aprons or clothing.
- Always use secondary containment if transporting the acids or bases and/or keep transport distances very short.
- Keep the soap making area clean at all times.
- Make sure bottles are tightly capped after measuring out what is needed.
- Be aware of the location of spill response equipment, such as buckets with water, rags, mops.
Once all the safety and space considerations have been figured out, it is time to actually make the soap.

The most important task in the soap making process is to use all the sodium in the chemical reaction, so the correct amounts of the raw ingredients need to be calculated.
We will be working with two documents here. One is a template for making a soap recipe, the second is a table of SAP values that tell how much lye is needed by weight for each type of oil or fat.

On the left, below, is an image of our recipe builder. We will determine the correct amounts of raw materials from this form. On the right is the table of SAP values. When we have chosen the base oils we will use, we will pull the SAP values for each oil from this table.

To make sure our soap is not caustic when it has cured, we use too much oil. The excess of oil ensures that all the lye is used up in making the soap, protecting against having a caustic soap. This is called super-fattening. Notice the space on the Recipe Builder for “SUPERFAT OIL.”
**Topic 3: The Recipe**

- Here we have a completed copy of the Recipe Builder for an Orange Soap.

### Soap Making Recipe

#### The Soap Base

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<tr>
<th>BASE OIL</th>
<th>SAP</th>
<th>OIL WEIGHT</th>
<th>LYE WEIGHT</th>
<th>WATER WEIGHT</th>
<th>SAP x OIL WEIGHT</th>
<th>0.38 x OIL WEIGHT</th>
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#### Enhancements

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<tr>
<td>Ground orange peel</td>
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<td>Amounts are very variable.</td>
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<table>
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<th>SCENT</th>
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<tr>
<td>Sweet orange oil</td>
<td>40 g</td>
<td>Generally, about 1.5% of total base oil weight. Mix ground orange peel into orange oil before adding to soap mixture at trace.</td>
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#### OTHER NOTES

**PROCESS:**

1. Weight out the oils.
2. Warm mixed oils to melt any fats and bring to 40 °C (104 °F).
3. Mix 288 grams of Sodium Hydroxide INTO 760 g of water. (Do not add the water into the sodium hydroxide. This can cause the water to vaporize violently, blowing sodium hydroxide all over the place, including you.)
4. Cool the lye solution to 40 °C (104 °F).
5. When both the oils and the lye solution are at the same temperature, add the lye solution to the oils while stirring. (The lye solution and the oils need to be within about 1 °C when they are combined.)
6. Continue stirring the saponifying mixture until it traces (raised lines of soap appear when the stirrer is run across the surface, and it is noticeably thicker). Enhancements can be added at the beginning of the tracing stage. Expect this to slow the tracing process a little bit.
7. Pour the tracing mixture into an appropriate mould.
Topic 3: Weighing the Oils

- Weigh out the oils on the scale. You must be careful to weigh as exactly as possible so that the chemistry is right.

- Once the oils have been weighed out, they can be heated to temperature on a burner or in a hot water bath.

- Most likely, the temperature will go over 40° C. You will have to put the oil container into a cool water bath to cool it to the right temperature and check it periodically.
Topic 3: Making the Lye Solution

- Weight out the water and set it aside. It needs to be cold water because the dissolving sodium hydroxide causes the water to heat up—a lot! It will change the water temperature by about 70° C.

- Weigh out the sodium hydroxide.

- Put the water (in a pyrex container) into a cold water bath so that it rests stably on the bottom.

- Add the sodium hydroxide while stirring. This is best done in a very well ventilated area because the fumes are quite noxious. Be careful not to splash any of the solution out of the container and especially not onto yourself. If you get some on you, rinse the area under cool, running water for 20 to 30 seconds.

- Leave the solution in the cold water bath to cool to 40° C. You must check the temperature periodically for this.
You will have to get the enhancements and moulds ready.

If you are making soap alone, you can do this now, while the oils and lye solution are cooling.

If you are in a group, some of the group can be preparing the enhancements and moulds while others are doing the weighing and cooling.

Knowing what enhancements you are going to use and how many moulds you need is part of the recipe building process. You should already know how much of each you need.
Once the oils and the lye solution are both very near 40°C, you can pour the lye solution into the oils, right into the stirring pot.

You will need to be fairly active with the stirring in the beginning. The idea is to create an emulsion (a mixing of oil and water). The strong alkali makes this easy, but physical stirring is still critical, otherwise, the oil and water begin to separate. If this happens, you will have to discard this batch of soap (you can save the mix and put it on the stove to heat up to a slow boil—this will save the soap, but it will need to be started fairly soon).

The next part is the monotonous part. You just keep stirring. After about an hour, you will notice that the mixture is starting to get slightly thicker, and you will see lines begin to show up on the surface when you stir through it. This is the first sign of tracing. After a little more time, the mixture will thicken some more and it will be time to add the enhancements (see Topic 4 for details on enhancements).
Topic 3: What To Do At Trace

- When the trace lines are quite pronounced, the mixture is setting and there is little danger of separation of the oil and water now.

- It is time to pour the mixture into moulds.

- You may want to guess the mould size, but have some extra containers around in case you have too much mixture. But you can also calculate the volumes of containers and know quite closely how much space you will need.

- Once you have poured the mixture into moulds, the process continues best if you can seal it (plastic stretch wrap makes a good cover), cover it with blankets and even keep it in a slightly warm place.

- After one to three days, it is ready to be removed from the moulds to cure.
Topic 3: And Now the Fun Part: Clean-up

- The principle here is to remove any possibility of sodium hydroxide being anywhere (especially where any food will be).

- Any stray oil will not be a bother, but any soap mixture is still highly caustic. It will still feel oily, but it will burn the skin and eyes quite badly if not rinsed away within a few minutes.

- Clean any horizontal surfaces with plenty of water.

- Clean the floor with plenty of water.

- Wash all the dishes and utensils you used. It is best not to use any of these for cooking or eating again, but the risk factor is quite small if you used stainless steel, glass, or plastic. Wooden utensils should absolutely never be used again for food.
2nd Consideration:  
Topic 4-Enhancing the Soap

- Once the soap mixture has started to trace, it is time to add the enhancements.

- Enhancements are the essential or scent oils added to give fragrance to the soap, and the materials used to give the soap a pleasing colour.

- The enhancements really provide an opportunity to explore aesthetics. And they supply some mystery to the process! Many plant materials simply turn brown from the lye because they are sensitive to pH. Some materials turn brown in the beginning and then change colours again as the soap cures and the pH drops below a certain value. A certain strain of rose hips turns the soap brown, only to transform into a beautiful burgundy colour as the soap cures. And then some materials give a vibrant colour that lasts throughout the life of the soap. Orange peel gives soap a bright orange colour and remains orange, dulling only slightly.

- I also include special effects in this section. It is possible to marble soap, make two layer soaps, and embed decorative objects into soaps as well as make special moulds that give bars a particular shape.

- Many of these elements can be left to the artistic sensibilities of the students.
Topic 4-Enhancing the Soap
Essential oils and Scent

- The addition of essential oils and scent oils at trace is the method for giving the soap its scent.

- Scent oils are artificial scents. These are produced chemically from “organic” chemicals. In this case, the term “organic” refers to the common name for the chemistry of hydrocarbons. Most of the components are obtained from petroleum distillates.

- Essential oils are obtained directly from plant by the methods stated earlier. Most essential oils are combinations of oils, ketones, esters, and aldehydes made in the living process of plants: nothing is artificial.

- The biggest problem with essential oils is the price. The smaller the quantity, the more you pay for each millilitre or ounce. But for some essential oils, buying a half a litre means spending over a hundred dollars. Prices vary dramatically.

- Most of the citrus oils are quite inexpensive and give very nice scents to soap. Floral scents tend to be more expensive. Rose oil must be extracted by dissolving the oil from the petals in a carrier oil or solvent, and then separating the two. This translates to over $1,300 for half a litre!

- The process here is quite simple. From the recipe, the amount by weight of essential oil is measured out and is then poured into the soap mixture at trace, while stirring, of course.

- Any ground colour materials can be soaked in the essential oil to “wet” them before adding to the soap mixture.
Colour enhancement is made from either earth materials or from dried, ground up plant material.

The choice of plant material comes from experience. Many plant materials may have beautiful colour, but once it is put into the alkaline environment of the soap mixture, it just turns brown. There is really nothing wrong with brown soap, but to expect green soap only to find out it has become dark brown is shocking and disappointing.

One good method to take with students is to divide a soap mixture into many small quantities and try out as many different materials, keeping each one labelled. This is a good way to introduce the scientific method and a good way to catalogue good colour agents for making soap.

For most plant materials, a coffee grinder is essential for getting a properly ground colouring agent. After grinding the material, sift it through a mesh screen to remove the larger, rougher bits. The rougher bits are okay to leave if you want an abrasive soap, otherwise, the finely ground powder is best for colouring.

Before adding the powder to the soap mixture, mix it with the essential oils or take out a half cup or so of soap mixtures and “wet” the dry ingredients so that they will mix well into the soap.

Right, top, is dried orange peel, ground up and ready to be “wetted.” Right, bottom, is dried blackberries, whole and ground.
A timeline of the whole process

Weeks 1, 2, and 3 can be condensed if materials and workspace are readily available and easily set up. Weeks 4 through 7 are necessary to make the soap ready for use.
2nd Consideration: A Soap Making Timeline—On the Day

A day of soap making

- Prepare moulds, sort enhancements, Prepare soapmaking containers
- Weigh out water and lye
- Add lye to water, Cool in water bath
- Cool Oils To temp In Water bath
- Combine Lye With oils
- Stir until trace A little more than 1 hour
- Pour Into moulds
- Cleanup

Hour 1
Hour 2
Hour 3
Hour 4
2nd Consideration: Wrap Up

- Some dedicated equipment is important.
- The raw materials are fairly easily obtained.
- Safety is important and needs to be thought out before starting.
- Basic soap is easy to make.
- Soap can be used as an artistic medium and promotes an aesthetic consideration for the senses of smell and sight.
3rd Consideration: Objectives

- Learn how to finish soap for aesthetic quality
- Discuss ways and methods to enhance the beauty and artistic quality of the soap product
- Review the Waldorf curriculum applications for soap making
3rd Consideration:
Topic 1-Demoulding the Soap

- After the soap has set in the mould for 2 to 3 days, it is time to remove it. Several things can help in the demoulding. By using plastic wrap in the mould, it can be easily removed. Any lines or creases can be shaved off at the end of cure.
- At this time the soap will be quite soft. It will be fairly easy to cut, and sometimes it is easier to remove from the mould if it is cut.
- If you are using cutaway moulds, such as tetrapak containers, this will minimize any gouging in the soap when it is removed.
- Since the soap is still quite soft, it is easily massaged into the shapes and sizes you want.
- Once the soap is removed and cut into bars, set it up somewhere dry and warm to cure.
- If you try washing with the soap after 2 to 3 days, it will lather up quite well. But be cautious—it is still very caustic.
3rd Consideration: Topic 3- Curing the Soap

- The soap is still caustic as it is removed from the moulds. Caution needs to be taken with it for several weeks.
- As the soap cures, you will see changes starting to happen. The colours will change slightly. Its shine will disappear, being replaced with a duller, matte surface. It will become harder.
- After three weeks, it can be used. But letting it cure for several months is much better.
- The longer the soap cures, up to about a year, the harder it will be and the longer it will last.
- If you set the bars on end or on side, it leaves more surface area for moisture to leave and speeds up the curing.
3rd Consideration:
Topic 2-Finishing the Soap

- After the cure time (a minimum of three weeks), the soap is ready to use or to be finished and packaged.
- Often, a light coloured layer will appear on the surface of the soap. This is sodium carbonate. It is a base itself, and is caustic, but not nearly as much as sodium hydroxide.
- The shape, the surface texture, and the sodium carbonate layer can be altered by shaving. A block plane used for carpentry is a good tool for this, however, the plane needs to be set up more as a scraper than a shaver.
- Once the surfaces of the soap are prepared and finished, it is ready to be packaged. Little boxes can be quite nice, but cellophane bags tied with a ribbon, and including some flower petals, is an attractive package. The students can take this up themselves.
3rd Consideration: Topic 4-Obtaining Essential Oils


- [http://www.wellnaturally.ca/](http://www.wellnaturally.ca/)--a Vancouver, BC company. She has mixed pricing. Some products more expensive and some less than the two sources above. She is small, so you may have to wait for re-stocking of items, as I did.

- [http://www.aromablast.com/](http://www.aromablast.com/)--a Canadian company. Prices are more expensive than above, at retail level. This company will do wholesale, but you contact them for pricing. Office in Belleville, ON.

3rd Consideration:  
Topic 5-Curriculum Application Summary

- Steiner’s statements about the teaching of chemistry in grades 7, 8, 9, and 10 combine to build a picture that moves the curriculum from the world of the mineral, to the plant world, to taken from driving living material all the way into the mineral, to essences from the plant world, then to how these chemical “processes” combine in the human being.

- The beauty of the practical arts is that it can be developed over several years in the curriculum, built up to a culmination over several grades.

- From the natural history of fire and burning, the process of soap making begins. The product of burning wood, ash, yields the first element of the soap making process-lye. The burning process can come with the production of charcoal, which then goes into the iron age forge for working with metal.

- A further study of the unburned plant leads to sugars and starches, then oils and alcohols.

- Then comes the meeting of the two, the balance, and along with it, the way to cut the oil and wash it away, with soap.

- A further foray into the plant kingdom leads to more rarefied oils and pigments that give the possibility of returning life to the soap and making it beautiful and pleasing. The gardening which takes place from grades 6 through 10 can incorporate much of the production of plants for oils and dried botanicals for this.

- Whether soap making happens in grade 8 as a culmination of working with gardening leading into the industrial processes of chemistry, or whether it is taken in grade 10 when acids, bases, and salts are studied, the practical work of making soap leads the students into details connected with everyday experiences of our world.
Although I have concentrated on the process of making soap, which is most applicable to Grade 10 chemistry, a number of chemical processes underlie it that easily work into the intentions Steiner had for Grades 7, 8, and 9.

For Grade 7, Steiner says, “You make your start with a process such as burning and from such an ordinary process you try to achieve a transition to simple chemical concepts.”

The traditional, and early industrial, production of lye was done by soaking ashes and pouring off the water. So we begin by burning. It is possible to burn hardwood to white ash, then set up a potash still to extract the potassium salts from the wood ash. If this still is set up, it is easy to try another burning, the burning of seaweed to ash and then extract the sodium salts from this ash. It is then possible to do a number of experiments to distinguish the two. These two experiments easily lead to a discussion of what happens with burning and the ash that is leftover. If you can really show the distinction between the two salt groups (potassium and sodium) it is possible to lead the students into a conceptual picture of these salts being arrested processes in two different plants in different growing conditions.

If the idea is to make charcoal, then the chemistry dialogue can expand considerably. The esters, aldehydes, resins, oils, and coal tars that are ejected from the wood that is burned without oxygen in making charcoal gives a variety of substances that can be brought into discussion about chemistry and the use of these chemical substances. The ash from the fire underneath can then be used to produce potash. In that way, a broad look at chemistry can be made quite efficiently. Of course, the charcoal is then used in a forge where students are heating steel and hammering it into usable shapes. In the end, everything in the curriculum is connected>

“Try for instance to link what ahs been done in music and singing lessons to handicraft lessons…Such an approach has an extraordinarily beneficial effect on children. All manual work was based on musical rhythm. Today this is hardly noticeable any longer. However, if you went into the country and listened to people thrashing, you would realise how the flail was handled rhythmically. I think we could recapture such a way of working. What I really mean is, we must try to bring spirit back into our activities.” –Rudolf Steiner
Topic 5-Curriculum Application: Grade 8

- For Grade 8, Steiner says, “You extend the simple chemical concepts so that the child learns to understand how industrial processes are connected with chemistry. Using chemical concepts you try to develop a link with substances which build up the human organism, such as starch, sugar, albumen, and fat.”

- For this part of the chemistry curriculum, it is easy to make the link from the burnt mineral remains of plants to sugars and starches, and the increasing carbon chain production of woody substance in plants. Building on the place in the plant from where different chemical substances appear (see plant diagram in 1st Consideration, The Plant and its derivatives), we can move into the fruit and look at the transformation sugars into other chemical substances. We can easily move into the acids from fruits. We have a polarity in the acid of fruits and the alkali extracted from the burning of plant material. It is important to take these two substances and begin to show their effects on the more animal substances-proteins and fats. Of course, all of this takes a bit of effort and set up, but it is the essence of the curriculum.

- If we take an egg and look at its liquid white, we can “coagulate” this egg white with heat. We can then take the alkali and dissolve it again. If we burn the egg white, we get a distinct odor, that of sulfur. If we apply the acid from lemons to skim milk, we begin to coagulate the milk. In fact, this is a way to make a quick, soft cheese. The alkali will dissolve this as well. If we take fingernail clippings, the alkali will dissolve them as well. Here, we have introduced protein as a chemical process in animals. From a practical view, making cheese is an excellent process to bring much of this into an interesting, and tasty, group of lessons.

- With fat, we have the possibility of looking at acid from another perspective. Of course, reacting the fat with some of the potash gives soap. But if we have brought things into the proper perspective by reacting some potash with some lemon juice, we can lead students into considering the fat (or oil) as an acid. If the soda ash is obtained from burnt seaweed, on can make a very crude sodium chloride salt with the lemon juice.
Topic 5-Curriculum Application: Grade 8

- Chemically, of course, fats and oils are combinations of three fatty acids to make what are called triglycerides. To make soap with students in class 8 would be a good culmination to a chemistry block, leading them into considering alcohols and ethers in class 9.

- The gardening curriculum can be easily included in the chemistry lessons, especially for soap making. Although the gardening starts in class 6, by class 8 the students need to be working at a level of planning for harvest and looking at what products come from the garden. Oils and dried plant materials can be some of these harvestable materials.

- The use of soap in felting is common. I have been told by felters and weavers that the best soap for this is a castille soap made solely from olive oil. Even if the chemistry is beyond a class in soap making, the production of some soap to be passed down to the handwork teacher and kindergarten teachers for felting is good. If a school has a commitment to carry this on, a culture is being built whereby a class takes a traditional responsibility to supply another group with a common item used each year.
Topic 5-Curriculum Application: Grade 9

- For grade 9, Steiner gave the following:
  "What we have put down for class 8, viz the elementary chemistry taking place in our organism, should be extended in class 9 to include the understanding of substances such as alcohols and ether."

- Even though the grade 8 curriculum emphasizes a view into the substances which make up the human organism, all of the grade 7, 8, 9, and 10 chemistry curricula can be based around the picture of the plant and the substances which come from them. The picture can act as a framework on which to develop a coherent understanding of chemistry.

- In grade 9, students can produce alcohol from various sugar-containing plants. By letting the natural yeasts in the air provide the fermentation enzymes, then distilling a little bit of the alcohol from the mash, the teacher can go into the chemistry behind this. It is a good time to begin introducing some of the “invisible” products into the lessons by collecting some of the carbon dioxide coming off the ferment. It is also a good time to start introducing solubilities by looking at how sugars dissolve in some substances and not in others.

- With some careful demonstrations, the teacher can move into ethers, ketones, and aldehydes. It is instructive to produce some artificial scents and flavours at this stage, relating them to the natural flavours in plants, again referring to the plant picture showing how artificial substances can be produced from the tarry substances that come off a burning plant, contrasting these with the natural products produced in the upper parts of the plant.

- As a relation to soap making, it is possible to use these derived substances as scents in the soap.
Steiner suggests that a good understanding of salt, acid, and base (alkaline) is the goal of the grade 10 chemistry lessons. He suggests contrasting the behaviours of food-sap and bee blood, since one is acid and the other base, but these are mostly unknown to people today. He does not say that the contrasting substances have to be these two, but to try to show the contrast between acid and base, with a resulting salt when the two react, within an organism. This may be more difficult to do with the human being, particularly with finding an alkaline substance. However, I think I would rather look for something in the human being rather than trying to extract food-sap and bee blood from an angry hive of bees!

Of course, soap is an organic salt produced from a strong alkaline and fatty acids. Both of these are fairly straightforward to obtain from plants. In the human being some relation can be made to the bile salts in this regard. **Bile** (or gall) is a bitter, yellow or green alkaline fluid secreted by hepatocytes from the liver of most vertebrates. In many species, it is stored in the gallbladder between meals and upon eating is discharged into the duodenum where it excretes waste and aids the process of digestion. Bile salts and bile acids are terms that are often used interchangeably. While some components of bile are technically acids, the bile solution in the body is actually alkaline. Bile acts as an emulsifier for fats, just like soap. It acts as a detergent in the digestive system. All of this can be brought out in relation to the acid/alkaline/salt relationships through soap making. This also meshes well with the physiology curriculum in Class 10, looking at the organ systems of the human body (from a statement found in the Nature Study section of Stockmeyer).

But producing soap really provides a culmination of the picture of the plant, as well as providing an artistic and everyday product. Soap making relates to industry, economics, resource use, gardening, botany, physiology, and a lot of chemistry.
Summary

- Soap making is a good way to bring practical and artistic elements into Waldorf Grades 7, 8, 9, and 10 chemistry
- The study of oils and ashes is a practical and imaginative approach to chemical concepts and processes
- More information is available from the Hiram Trust booklet, the handouts, and the list of URLs
The Soap Base

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Enhancements

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<th>ENHANCEMENT WEIGHT</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Amounts are very variable.</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>SCENT</th>
<th>SCENT WEIGHT</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Generally, about 1.5% of total base oil weight.</td>
</tr>
</tbody>
</table>

OTHER NOTES

PROCESS:

1. Weight out the oils.

2. Warm mixed oils to melt any fats and to bring to 40°C (104°F).

3. Mix _____________ of Sodium Hydroxide _____________ of water. (Do not add the water into the sodium hydroxide. This can cause the water to vaporize violently, blowing sodium hydroxide all over the place, including you.)

4. Cool the lye solution to 40°C (104°F).

5. When both the oils and the lye solution are at the same temperature, add the lye solution to the oils while stirring. (The lye solution and the oils need to be within about 1°C when they are combined.)

6. Continue stirring the saponifying mixture until it traces (raised lines of soap appear when the stirrer is run across the surface, and it is noticeably thicker). Enhancements can be added at the beginning of the tracing stage. Expect this to slow the tracing process a little bit.

7. Pour the tracing mixture into an appropriate mould.
Saponification values for different fats and oils

<table>
<thead>
<tr>
<th>Oil</th>
<th>$\text{NaOH}$</th>
<th>$\text{KOH}$</th>
<th>Oil</th>
<th>$\text{NaOH}$</th>
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<td>Neat’s foot</td>
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<td>Babassu, Brazil nut</td>
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<td>.2450</td>
<td>Neem</td>
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<td>Beef Hoof</td>
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<td>Niger-seed</td>
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<td>.0966</td>
<td>Nutmeg Butter</td>
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<td>Brazil Nut</td>
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<td>.2450</td>
<td>Olive Olivate</td>
<td>.1340</td>
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<td>Butterfat, Cow</td>
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<td>Shortening (veg.)</td>
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</table>
MSDS for Rosemary Oil

- MATERIAL SAFETY DATA SHEET
- Disclaimer
- The information contained on the Material Data Sheet has been compiled from data considered accurate. This data is believed to be reliable, however, it must be pointed out that values for certain properties are known to vary from source to source. The Good Scents Company USA expressly disclaims any warranty expressed or implied as well as any liability for any injury or loss arising from the use of this information or the materials described. This data is not to be construed as absolutely complete since additional data may be desirable when particular; conditions or circumstances exist. It is the responsibility of the user to determine the best precautions necessary for the safe handling and use of this product for your application. This data relates only to the specific material designated and not to be used in combination with any other material. Many federal and state regulations pertain directly or indirectly to the product's end use and disposal of containers and unused material. It is the purchaser's responsibility to familiarize themselves with all applicable regulations.

1. Identification of the substance / preparation and company
- Product Code / Trade Name : ES101892 / rosemary oil (Rosmarinus officinalis) morocco
- Supplier Details : The Good Scents Company
- Information : 414-764-2659
- Version Date : 04/23/2006

2. Composition / information on ingredients
- Chemical characterization :
- Hazardous ingredient(s) :
  - rosemary oil 100.00 %
- Hazard symbols : Xi R
- Phrases : 10 36/37/38
- CAS : 8000-25-7
- Rtecs number : VL044500
- Toxnet epa-srs

3. Hazard identification
- Most important hazards :
  - Irritant
  - Flammable.
  - Irritating to eyes, respiratory system, and skin.
  - Keep away from sources of ignition - No Smoking.
  - In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
  - Wear suitable clothing, gloves and eye/face protection.
  - Keep out of the reach of children.

4. First-aid measures
- Remove contaminated soaked clothing and wash before reuse.
- After eye contact :
  - In case of contact with eyes, rinse immediately with plenty of water for at least 15 minutes.
- After skin contact :
  - After contact with skin, wash immediately affected area with soap and plenty of water.
- After inhalation :
  - If inhaled, remove person to fresh air. If not breathing give artificial respiration. If breathing is difficult, give oxygen.
- After ingestion :
  - If swallowed, rinse mouth with water (only if the person is conscious). Obtain medical advice.

5. Fire-fighting measures
- Extinguishing media :
  - Water spray, carbon dioxide, dry chemical powder or appropriate foam. For safety reasons do not use full water jet.
- Special firefighting procedures :
  - Wear self-contained breathing apparatus and protective clothing to prevent contact with skin and eyes.
  - Unusual fire and explosion hazards :
    - Emits toxic fumes under fire conditions.

6. Accidental release measures
- Wear respirator, chemical safety goggles, rubber boots and heavy rubber gloves. Keep people away, evacuate area.
- To avoid possible contamination of the environment, Do not discharge into any drains, surface waters or groundwaters.
- Cover with an inert, inorganic, non-combustible absorbent material (e.g. dry-lime, sand, soda ash). Place in covered containers using non-sparking tools and transport outdoors.
- Avoid open flames or sources of ignition (e.g. pilot lights on gas hot water heater). Ventilate area and wash spill site after material pickup is complete. Dispose of in accordance with current laws and regulations.

7. Handling and storage
- Measures should be taken to prevent materials from being splashed into the eyes or on the skin. Wear eyeshields and protective clothing. Smoking should not be permitted in work areas.
- Provide suitable air extraction ventilation in the work areas. Vapors may form explosive mixtures with air. Keep material away from sources of ignition (e.g. hot surfaces, sparks, flame and static discharges.
- To be stored in tightly sealed and preferably full containers in cool, dry and ventilated area. Protect from heat/overheating and light sources.
- Keep in glass, suitable plastic, aluminum or lacquer-lined containers.

8. Exposure controls / personal protection
MSDS for Rosemary Oil

- Occupational exposure limits:
  - OSHA TWA: Not determined
  - ACGIH TWA: Not determined
  - NIOSH TWA: Not determined
  - OSHA PEL: Not determined
  - ACGIH STEL: Not determined
  - NIOSH STEL: Not determined

- Respiratory protection:
  - Do not breathe vapors. Mechanical exhaust required. In confined or poorly ventilated areas, the use of an appropriate respiratory protection may be required.

- Hand protection:
  - Compatible chemical-resistant gloves are recommended. Wash contaminated gloves before reuse.

- Eye protection:
  - Chemical safety goggles are recommended. Wash contaminated goggles before reuse.

- Body protection:
  - Light protective clothing recommended. Wash contaminated clothing before reuse.

- Hygiene measures:
  - Avoid inhalation and contact with skin and eyes. Good personal hygiene practices should be used. Wash after any contact, before breaks and meals, and at the end of the work period. Safety shower and eye bath recommended.

9: Physical and chemical properties

- Appearance / odor:
  - Colorless to pale yellow liquid / fresh strong camphor woody balsam herbal minty

- Melting point: Not determined

- Boiling point: Not determined

- Flash point: 104.00 °F. TCC (40.00 °C.)

- Flammability: Not determined

- Autoflammability: Not determined

- Explosive properties: Not determined

- Oxidizing properties: Not determined

- Vapor pressure: Not determined

- Vapor density: Not determined

- Solubility in water: Insoluble

10: Stability and reactivity

- Stability: Stable

- Conditions to avoid: Heat, excessive heat, open flames and other sources of ignition.

- Incompatibility: Strong oxidizing agents, strong reducing agents.

- Hazardous decomposition products: Hazardous combustion or decomposition products: carbon monoxide, carbon dioxide. Hazardous polymerization will not occur.

11: Toxicological information

- Rtecs No.: VL0445000

- Acute effects: Irritant

- Toxicity data:
  - LD 50 ORL-RAT 5.00 ML/KG FCTXAV 12,977,1974
  - LD 50 SKN-RBT > 10.00 ML/KG FCTXAV 12,977,1974
  - Irritation data:
    - SKN-RBT 500.00 MG/24H MOD FCTXAV 12,977,1974

12: Ecological information

- Biodegradability:
  - Readily biodegradable: Not determined
  - Inherently biodegradable: Not determined

- Ecotoxicity:
  - Fish: Not determined
  - Algae: Not determined
  - Daphnia: Not determined
  - Bacteria: Not determined

- Further information:
  - Prevent contamination of soil, ground and surface waters. Do not discharge product unmonitored into the environment.

13: Disposal considerations

- Dispose of in accordance with all federal, state and local environmental regulations.
MSDS for Rosemary Oil

- 14 : Transport information
- US DOT Hazard Class : N/A KEEP AWAY FROM CHILDREN
- UN Number : Not found
- UN Pkg. Group : Not determined
- UN Item : Not determined
- ERG Number : Not determined
- Land transport (ADR/RID)
  - Class : Not determined
  - Transport factor : Not determined
- Marine transport (IMDG)
  - IMDG-class : Not determined
- Air transport (IATA)
  - IATA-class : Not determined
  - Passenger : Not determined
  - Cargo : Not determined
- 15 : Regulatory information
  - European information :
  - Xi - Irritant
    - R 10 - Flammable.
    - R 36/37/38 - Irritating to eyes, respiratory system, and skin.
    - S 16 - Keep away from sources of ignition - No Smoking.
    - S 26 - In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
    - S 36/37/39 - Wear suitable clothing, gloves and eye/face protection.
    - S 02 - Keep out of the reach of children.
  - Reviews, standards, and regulations :
    - None found
- 16 : Other information
  - FEMA No. : 2992
  - Hazardous materials identification system :
    - Fire : 3
      - Health : 2
      - Reactivity : 0
      - Personal protection : B
MSDS for Lavandin Oil

- MATERIAL SAFETY DATA SHEET
- Disclaimer

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- For Manufacturing, Processing, or Repacking Only.
- 1 : Identification of the substance / preparation and company

Product Code / Trade Name :-ES101304 / lavandin oil (lavandula hydrida abrialis)
Supplier Details :-The Good Scents Company
Information :-414-764-2659
Version Date :-01/24/2007

- 2 : Composition / information on ingredients

Chemical characterization :
Hazardous ingredient(s) :
lavandin oil 100.00 %
Hazard symbols : Xn R phrases : 65 36/37/38 43
CAS : 8022-15-9

- 3 : Hazard identification

Most important hazards :
Harmful. Irritating to eyes, respiratory system, and skin.
Harmful: may cause lung damage if swallowed.
May cause sensitisation by skin contact.
In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
Wear suitable protective clothing.
If swallowed, do not induce vomiting: seek medical advice immediately and show this container or label.
Keep out of the reach of children.

- 4 : First-aid measures

Remove contaminated soaked clothing and wash before reuse.
After eye contact :
In case of contact with eyes, rinse immediately with plenty of water for at least 15 minutes.
After skin contact :
After contact with skin, wash immediately affected area with soap and plenty of water.
After inhalation :
If inhaled, remove person to fresh air. If not breathing give artificial respiration. If breathing is difficult, give oxygen.
After ingestion :
If swallowed, rinse mouth with water (only if the person is conscious). Obtain medical advice.

- 5 : Fire-fighting measures

Extinguishing media :
Water spray, carbon dioxide, dry chemical powder or appropriate foam. For safety reasons do not use full water jet.
Special firefighting procedures :
Wear self-contained breathing apparatus and protective clothing to prevent contact with skin and eyes.
Unusual fire and explosion hazards :
Emits toxic fumes under fire conditions.

- 6 : Accidental release measures

Wear respirator, chemical safety goggles, rubber boots and heavy rubber gloves. Keep people away, evacuate area.
To avoid possible contamination of the environment, Do not discharge into any drains, surface waters or groundwaters.
Cover with an inert, inorganic, non-combustible absorbent material (e.g. dry-lime, sand, soda ash). Place in covered containers using non-sparking tools and transport outdoors.
Avoid open flames or sources of ignition (e.g. pilot lights on gas hot water heater). Ventilate area and wash spill site after material pickup is complete. Dispose of in accordance with current laws and regulations.
MSDS for Lavandin Oil

7 : Handling and storage

- Measures should be taken to prevent materials from being splashed into the eyes or on the skin. Wear eyeshields and protective clothing. Smoking should not be permitted in work areas.
- Provide suitable air extraction ventilation in the work areas. Vapors may form explosive mixtures with air. Keep material away from sources of ignition (e.g. hot surfaces, sparks, flame and static discharges).
- To be stored in tightly sealed and preferably full containers in cool, dry and ventilated area. Protect from heat/overheating and light sources.
- Keep in glass, suitable plastic, aluminum or laquer-lined containers.

8 : Exposure controls / personal protection

- Occupational exposure limits :
  - OSHA TWA : Not determined
  - ACGIH TWA : Not determined
  - NIOSH TWA : Not determined
  - OSHA PEL : Not determined
  - ACGIH STEL : Not determined
  - NIOSH STEL : Not determined
- Respiratory protection :
  - Do not breath vapors. Mechanical exhaust required. In confined or poorly ventilated areas, the use of an appropriate respiratory protection may be required.
- Hand protection :
  - Compatible chemical-resistant gloves are recommended. Wash contaminated gloves before reuse.
- Eye protection :
  - Chemical safety goggles are recommended. Wash contaminated goggles before reuse.
- Body protection :
  - Light protective clothing recommended. Wash contaminated clothing before reuse.
- Hygiene measures :
  - Avoid inhalation and contact with skin and eyes. Good personal hygiene practices should be used. Wash after any contact, before breaks and meals, and at the end of the work period. Safety shower and eye bath recommended.

9 : Physical and chemical properties

- Appearance / odor :
  - pale yellow clear liquid / floral herbal lavender camphor
- Melting point :
  - Not determined
- Boiling point :
  - 211.00 °C. @ 760.00 mmHg
- Flash point ( Deg. F. ) :
  - 151.00 °F. TCC ( 66.11 °C. )
- Flammability :
  - Not determined
- Autoflammability :
  - Not determined
- Explosive properties :
  - Not determined
- Oxidizing properties :
  - Not determined
- Vapor pressure :
  - Not determined
- Vapor density :
  - Not determined
- Volatile by volume :
  - 100.00 %
- Evaporation rate :
  - Not determined
- Specific gravity :
  - 0.88900 - 0.91000 @ 25 °C.
- PH of Product :
  - Not determined
- Solubility in water :
  - Insoluble

10 : Stability and reactivity

- Stability :
  - Stable
- Conditions to avoid :
  - Heat, excessive heat, open flames and other sources of ignition.
- Incompatibility :
  - Strong oxidizing agents, strong reducing agents.
- Hazardous decomposition products :
  - Hazardous combustion or decomposition products: carbon monoxide, carbon dioxide. Hazardous polymerization will not occur.

11 : Toxicological information

- Acute effects :
  - Harmful.
  - Irritating to eyes, respiratory system, and skin.
  - Harmful: may cause lung damage if swallowed.
  - May cause sensitisation by skin contact.
- Toxicity data :
  - LD 50 ORL-RAT > 5.00 GM/KG FCTXAV 14,447,1976
  - LD 50 SKN-RBT > 5.00 GM/KG FCTXAV 14,447,1976
  - Irritation data :
    - SKN-RBT 500.00 MG/24H MLD FCTXAV 14,447,1976
    - Not determined
Inhalation data : - Not determined
Mutagenicity data : - Not determined
Phototoxicity data : - Not determined
Human experience : - Not determined
Carcinogenicity : - Per OSHA, IARC, NTP, ACGIH, OEHHA-Prop 65, RTECS : No
Reproductive toxin : - Per OSHA, IARC, NTP, ACGIH, OEHHA-Prop 65, RTECS : No
On the TSCA Inventory? : - Yes
12 : Ecological information
Biodegradability :
Readily biodegradable : - Not determined
Inherently biodegradable : - Not determined
Ecotoxicity
Fish : - Not determined
Algae : - Not determined
Daphnia : - Not determined
Bacteria : - Not determined
Further information : - Prevent contamination of soil, ground and surface waters. Do not discharge product unmonitored into the environment.
Mixture reportable to : - None found
13 : Disposal considerations
Dispose of in accordance with all federal, state and local environmental regulations.
14 : Transport information
US DOT Hazard Class : - TERPENE HYDROCARBONS, N.O.S. (TERPENES)
UN Number : - Not found
UN Pkg. Group : - Not determined
UN item : - Not determined
ERG Number : - Not determined
Land transport (ADR/RID)
Class : - Not determined
Transportfactor : - Not determined
Marine transport (IMDG)
IMDG-class : - Not determined
Page No. : - Not determined
MFAG : - Not determined
EmS-No. : - Not determined
Air transport (IATA)
IATA-class : - Not determined
Passenger : - Not determined
Cargo : - Not determined
15 : Regulatory information
European information :
Xn - Harmful.
R 36/37/38 - Irritating to eyes, respiratory system, and skin.
R 65 - Harmful: may cause lung damage if swallowed.
R 43 - May cause sensitisation by skin contact.
S 26 - In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
S 36 - Wear suitable protective clothing.
S 62 - If swallowed, do not induce vomiting: seek medical advice immediately and show this container or label.
S 02 - Keep out of the reach of children.
Reviews, standards, and regulations :
None found
16 : Other information
Fema No. : - 2618
Hazardous materials identification system :
Fire : 2-Health : 3-Reactivity : 0-Personal protection : C
Material Safety Data Sheet

Orange oil, Sweet MSDS

Section 1: Chemical Product and Company Identification
Product Name: Orange oil, Sweet
Catalog Codes: SLO1006
CAS#: 8028-48-6 or 8008-57-9
RTECS: RI8600000
TSCA: TSCA 8(b) inventory: Orange oil, Sweet
CI#: Not available.
Synonym: Oil of Sweet Orange
Chemical Name: Orange Oil
Chemical Formula: Not available.
Contact Information:
Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396
US Sales: 1-800-901-7247
International Sales: 1-281-441-4400
Order Online: ScienceLab.com
CHEMTREC (24HR Emergency Telephone), call:
1-800-424-9300
International CHEMTREC, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients
Composition:
Name CAS # % by Weight
Orange oil, Sweet 8028-48-6 or 100
8008-57-9

Toxicological Data on Ingredients: Orange oil, Sweet: ORAL (LD50): Acute: &gt;5000 mg/kg [Rat]. DERMAL (LD50): Acute: &gt;5000 mg/kg [Rabbit].

Section 3: Hazards Identification
Potential Acute Health Effects:
Hazardous in case of skin contact (irritant), of eye contact (irritant). Slightly hazardous in case of skin contact (permeator), of ingestion, of inhalation.

Potential Chronic Health Effects:
CARCINOGENIC EFFECTS: Not available.
MUTAGENIC EFFECTS: Not available.
TERATOGENIC EFFECTS: Not available.
DEVELOPMENTAL TOXICITY: Not available.
Repeated or prolonged exposure is not known to aggravate medical condition.

Section 4: First Aid Measures
Eye Contact:
Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical attention.

Skin Contact:
In case of contact, immediately flush skin with plenty of water. Cover the irritated skin with an emollient. Remove contaminated clothing and shoes. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention.

Serious Skin Contact:
Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek medical attention.

Inhalation:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

Serious Inhalation:
Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek medical attention.

Ingestion:
Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention if symptoms appear.

Serious Ingestion: Not available.

Section 5: Fire and Explosion Data
Flammability of the Product: Flammable.
Auto-Ignition Temperature: Not available.
Flash Points: CLOSED CUP: 46.111°C (115°F).
Flammable Limits: Not available.
Products of Combustion: Not available.
Fire Hazards in Presence of Various Substances:
Flammable in presence of open flames and sparks, of heat.
Non-flammable in presence of shocks.
Explosion Hazards in Presence of Various Substances:
- Risks of explosion of the product in presence of mechanical impact: Not available.
- Risks of explosion of the product in presence of static discharge: Not available.

Fire Fighting Media and Instructions:
- Flammable liquid, insoluble in water.
  - SMALL FIRE: Use DRY chemical powder.
  - LARGE FIRE: Use water spray or fog. Cool containing vessels with water jet in order to prevent pressure build-up, autoignition or explosion.

Special Remarks on Fire Hazards: Not available.

Special Remarks on Explosion Hazards: Not available.

Section 6: Accidental Release Measures
Small Spill: Absorb with an inert material and put the spilled material in an appropriate waste disposal.

Large Spill:
- Flammable liquid, insoluble in water.
- Keep away from heat. Keep away from sources of ignition. Stop leak if without risk. Absorb with DRY earth, sand or other non-combustible material. Do not get water inside container. Do not touch spilled material. Prevent entry into sewers, basements or confined areas; dike if needed. Call for assistance on disposal.

Section 7: Handling and Storage
Precautions:
- Keep away from heat. Keep away from sources of ignition. Ground all equipment containing material. Do not ingest. Do not breathe gas/fumes/vapor/spray. Wear suitable protective clothing. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as oxidizing agents.

Storage:
- Store in a segregated and approved area. Keep container in a cool, well-ventilated area. Keep container tightly closed and sealed until ready for use. Avoid all possible sources of ignition (spark or flame). Sensitive to light.
- Store in light-resistant containers.

Section 8: Exposure Controls/Personal Protection
Engineering Controls:
- Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapors below their respective threshold limit value. Ensure that eyewash stations and safety showers are proximal to the work-station location.

Personal Protection:
- Splash goggles. Lab coat. Vapor respirator. Be sure to use an approved/certified respirator or equivalent.
- Gloves.

Personal Protection in Case of a Large Spill:
- Splash goggles. Full suit. Vapor respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits: Not available.

Section 9: Physical and Chemical Properties
Physical state and appearance: Liquid.
- Odor: Characteristic. (Strong.)
- Taste: Characteristic.
- Molecular Weight: Not available.
- Color: Yellow. Orange. Deep Orange
- pH (1% soln/water): Not applicable.
- Boiling Point: Not available.
- Melting Point: Not available.
- p. 3
- Critical Temperature: Not available.
- Specific Gravity: 0.844 (Water = 1)
- Vapor Pressure: 0.1 kPa (@ 20°C)
- Vapor Density: Not available.
- Volatility: Not available.
- Odor Threshold: Not available.
- Water/Oil Dist. Coeff.: Not available.
- Ionicity (in Water): Not available.

Dispersion Properties: Not available.
Solubility: Insoluble in cold water.

Section 10: Stability and Reactivity Data
Stability: The product is stable.
- Instability Temperature: Not available.
- Conditions of Instability: Heat, ignition sources, light, incompatible materials
- Incompatibility with various substances: Reactive with oxidizing agents.
- Corrosivity: Non-corrosive in presence of glass.

Special Remarks on Reactivity: Sensitive to light.

Special Remarks on Corrosivity: Not available.
Polymerization: Will not occur.

Section 11: Toxicological Information
Routes of Entry: Absorbed through skin. Eye contact.
Toxicity to Animals:
- Acute oral toxicity (LD50): >5000 mg/kg [Rat].
- Acute dermal toxicity (LD50): >5000 mg/kg [Rabbit].

Chronic Effects on Humans: Not available.

Other Toxic Effects on Humans:
- Hazardous in case of skin contact (irritant).
- Slightly hazardous in case of skin contact (permeator), of ingestion, of inhalation.

Special Remarks on Toxicity to Animals: Not available.

Special Remarks on Chronic Effects on Humans: Not available.

Special Remarks on other Toxic Effects on Humans:
- Acute Potential Health Effects:
  - Liquid is irritating to eyes and skin. It may also be irritating to the respiratory tract and digestive tract.

Section 12: Ecological Information
- Ecotoxicity: Not available.
- BOD5 and COD: Not available.

Products of Biodegradation:
- Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: Not available.

Section 13: Disposal Considerations
- Waste Disposal:
  - Waste must be disposed of in accordance with federal, state and local environmental control regulations.

Section 14: Transport Information
- DOT Classification: CLASS 3: Flammable liquid.
- Identification: Extracts, Flavoring, Liquid (Orange Oil) UNNA: 1197 PG: III
- Special Provisions for Transport: Not available.

Section 15: Other Regulatory Information
- Federal and State Regulations: TSCA 8(b) inventory: Orange oil, Sweet
- EINECS: This product is on the European Inventory of Existing Commercial Chemical Substances.
- Other Classifications:
  - WHMIS (Canada):
    - CLASS B-3: Combustible liquid with a flash point between 37.8°C (100°F) and 93.3°C (200°F).
  - DSCL (EEC):
    - R10- Flammable.
    - R36/38- Irritating to eyes and skin.
    - S16- Keep away from sources of ignition - No smoking.
    - S24/25- Avoid contact with skin and eyes.
    - S36/37/39- Wear suitable protective clothing, gloves and eye/face protection.
  - HMIS (U.S.A.):
    - Health Hazard: 2
    - Fire Hazard: 2
    - Reactivity: 0
- Personal Protection: h
- National Fire Protection Association (U.S.A.):
  - Health: 2
  - Flammability: 2
  - Reactivity: 0
  - Specific hazard:
- Protective Equipment:
  - Gloves.
  - Lab coat.
  - Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate.
  - Splash goggles.

Section 16: Other Information
- References: Not available.
- Other Special Considerations: Not available.
Evaluation

- For each question circle the scale number, 1 being lowest, 5 being highest.

1. I found this workshop to be interesting.
   
   1   2   3   4   5

2. I learned a lot from this workshop.
   
   1   2   3   4   5

3. I was given enough hands-on experience of how to make soap to be able to do it on my own now.
   
   1   2   3   4   5

4. I feel I am now ready to make soap with a youth group.
   
   1   2   3   4   5

5. I believe I understand where making soap works in the Waldorf curriculum.
   
   1   2   3   4   5

6. I found Gary clear and understandable.
   
   1   2   3   4   5

7. Gary was organised and knowledgeable about the content of the workshop.
   
   1   2   3   4   5

Comments: