The oldest manufactured products soap biology essay

Science, Biology

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\n[/toc]\n \nKnown as one of the oldest manufactured products, soap results from the chemical reaction of an insoluble fatty material with a metal radical or an organic base and was first produced over two thousand years ago by the reaction of animal fats with ashes from plants (Burke, 2006; Zhu et al., 2006; Willcox, 2000). As informed by the Roman Historian, the art of manufacturing soap is the invention of the Gauls (Ott, 2004). The manufacture of soap has prospered in Spain and Italy during the eighth century and around five hundred years later it was introduced in France. The first record of soap in England appeared in the fourteenth century in 1524. Thereafter the manufacture of soap progressed very slowly till the beginning of the nineteenth century (Simmons et al., 2007). The development of a low cost process for the production of soda ash was by Leblanc led to a reduction in the cost of soap production (Simmons et al., 2007; Willcox, 2000; Zhu et al., 2006). The basic chemistry of soap making was better understood throughout the nineteenth century with the discovery of different fatty acids present in fats and oil (Willcox, 2000; Zhu et al., 2006). The French devised a method of manufacturing soap from olive oil rather than animal fat producing castile soap. They also learned to make perfumed soap through the floral infusion of fat (McDaniel et al., 2010). At present, soap is used for cleaning and hygienic purposes and it is produced in bar form. However, liquid and gel form soap are also becoming popular in some part of the world (Zhu et al., 2006). Chemical additives are added to commercial soaps to make them lather properly. Water pollution resulting from the production of commercial soaps represent a typical case of problems that results from the rapid evolution of the industry. The tremendous increase in consumption of surfactants led to a type of pollution having a great impact as toxic foam is produced in rivers, lakes and treatment plants (Wang, 2005) as well as on the quality and sustainability of rivers (Tekade et al., 2011). Soap manufacturing effluents require different kinds of treatment which have high implementing and maintenance costs (Fa et al., 1987). Today the soap industry is thriving in much of the world especially in developing countries. The formulation of soap bars has become more complicated over the years due to an ever-increasing number of soap bases that contain an increasing number of additives. The " green" and " natural" market segments have led to soap production from new materials (Spitz, 2009). Organic soap is made up with organic ingredients which mean that its manufacture avoids the utilization of inorganic chemicals for making soap. We help in preserving the environment and the ecological balance by adopting the use of organic soap. Use of non-organic materials will pollute the land, harm plants and humans whereas use of organic materials will be a healthy practice. Organic soap protects the skin from synthetic fertilizers, pesticides, insecticides, fungicides and preservatives since the skin absorbs 60 % of what is put on it. According to a statistics in March 2004 by the Soap Making Business, there has been a growth in the market for people who use natural personal care products since there is a variety of natural bath products designed to perform an array of functions such as cleanse, relax, soothe, stimulate, deodorize and even treat skin problem. When compared with petrochemical raw materials, renewable sources have shown to have more advantages ensuring a high degree of product safety for the consumers and the environment. Thus the raw materials used for the production of organic soap can be regarded as ideal (Hill., 2000). Among the three basic processes that exist for soap making, cold process and hot process are the two ways of manufacturing soap which make use of the saponification reaction (Gallant, 2012). Cold process soap making is used more frequently by people making their own soap at home or having a small soap business. Cold process is referred to the fact that no external heat source is required for the saponification process. Hot process soap making required heat to completely saponify the soap. Hot process soap making is also used at home where the soap is ready in about 6 hours compared to the cold process soap which take four to six weeks to cure (Sievers, 2011). Soap manufacturing industries deal with cooking soaps and producing a large batch of soap daily (Ott, 2004). In this thesis, both the cold process and hot process soap making will be considered. For saponification reactions to occur, fats or oil are heated with caustic lye (Ott, 2004). Different oils have different beneficial properties that they provide to the soap depending on which types of fatty acid predominate in their position. The fatty acids present in the oils are lauric, linoleic, myristic, oleic, palmitic, ricinoleic, stearic (Goyal et al., 2007). These acids provide beneficial properties to the soap. Some common vegetable oil used for organic soap making is olive oil, coconut oil and palm oil. Coconut oil is one of the primary oils that are used by soapmakers due to its low price and it gives tremendous lather of about 35 to 54% to the soap (Miller, 2003; Sanchez, 2011). Coconut oil also produces hard and white bar soap. Soapmakers use olive oil in most recipes as the soaps produced from olive oil are very moisturizing, hard and white bars and exceptionally mild (Sanchez, 2011). Olive oil is very rich in oleic acid which acts as good conditioning (Miller, 2003). However since the cost of olive oil is very high in the Mauritian market, this study will focus mostly on the use of coconut oil for the saponification reaction to reduce the cost of producing organic soap. Mauritius is an island with an almost unexploited supply of marine seaweeds with a high diversity of marine macroalgae, with 127 species (Schwartz, 2005). The health benefits of polyunsaturated fatty acids (PUFAs) have led to a keen interest in commercial production (Ramamurthy et al., 2006). Algae are good sources of PUFAs for the neutraceutical market since they can be relatively easily cultivated at different conditions. The seaweed by the name Gracilaria Salicornia will be used for this thesis which is actually being cultivated by the Mauritius Research Council. The gracilaria contain protein which helps in fighting premature aging of the skin by restructuring collagen and generating elasticity, skin suppleness which in turn reduces and softens wrinkles (Estacio, 2011). Another green plant which will be considered will be the aloe vera plant which is readily available in Mauritius and can also be cultivated on large scale. Aloe vera has multiple benefits to the body and is also known as a medicinal plant (Titus, 2012). The aim of this study is to investigate the processes involved in organic soap making. The specific objectives are: To carry out a literature review onThe cold and hot process of soap makingAvailability of Oil in MauritiusLiquid Soap makingTo characterize the oil used for soap making. To decrease the concentration of lye in the soap and more precisely to determine an optimum NaOH concentration for soap making. Addition of a surfactant to produce more lather in the soap. Addition of green additives to the soap such as seaweed, aloe vera and vetiver. Using seaweed extract for soap making. To analyze the pH, the foaming capacity and the degree of cleanliness of the soap. To design a pilot scale plant for organic soap making and compare the cost of implementation and production of organic soap between the hot and cold process. To investigate the potential of producing liquid soap. Chapter 1 introduces the topic, the research, the aims and objectives and the layout of the project. Chapter 2 consists of past reviews and critics about the project and identifying the knowledge that we have. Chapter 3 outlines the aims of the research, data collection and methods of analysis. Chapter 4 consists of the results and discussion based on experiments done and the conditions affecting the experiments were discussed. Chapter 5 deals with the investigation of implementation of the project on a pilot scale basis. Chapter 6 summarize the aims and the key findings of this project both theoretically and practically, acknowledge the limitations and include some recommendation for future works. This section provides an overview of the word organic and the types of soap such as hard soap, soft soap and liquid soap. It includes the chemistry behind soap making, soap cleaning, the necessary ingredients for organic soap making and the chemistry of oil.

Studies on vegetable oil used for organic soap making is also presented in this section. It also focuses on the manufacture of organic soap with the addition of green plants that can be cultivated in Mauritius such as seaweeds and aloe vera. For the last couple decades, people are moving more towards the natural lifestyle. The two concerns united in the organic philosophy is the responsibility and caring attitude for the environment. Organics is seen as a positive counter force to the excessive use of chemicals in all aspects of our lives (Farrer-Hall, 2004). The traditional philosophy emphasizes the importance of environmental sustainability for its contributions to reducing the use of harmful chemicals (Clark, 2007). The aim of the organic philosophy is to create integrated, humane, environmentally and economically sustainable agricultural production systems, which in turn increases the reliance on renewable sources and the management of ecological and biological processes and interactions (Clark, 2007). In many countries most people make their own homemade soap and start small soap business. Homemade soap retains the glycerin which is very soothing for the skin and people love it for the fact that it is not homogenized, pasteurized, deodorized and sanitized unlike manufactured soaps (Bramson, 1975). The unique properties of soaps are determined by the type of fatty acid and the length of the carbon chain. The longer the chains, the more insoluble will be the fatty acid. For example, coconut oil is a source of lauric acid with 12 carbons which can be made into sodium laurate and produces a soluble soap (Ophardt, 2003). Fatty acids that contain lower amount of carbons such as 10 are not used for Soapmaking as they will irritate the skin and give rise to odors. Soaps are of two kinds; soft and hard. Soft soaps are produced using soft oils which are generally liquid at room temperature with the exception of olive oil. A hard bar of soap can be produced by hard oils which are solid at room temperature. Soap consistency also depends on the alkali used. Potash soaps are always liquid and soft as potash has a strong attraction for water. All hard soaps contain soda ash (Dick, 1872). Soap is produced by the chemical combination called " saponification" of one of the caustic hydrates in the presence of water and forming soap and glycerine (Thomssen, 1922). The fatty acid portion is turned into a salt due to the presence of a basic solution like NaOH (Ophardt, 2003). In chemistry the saponification process can be defined as the hydrolysis of an ester under basic conditions to form alcohol and the salt of a carboxylic acid. Oils are the fatty esters in the form of triglycerides. The ester bond is broken by the alkali releasing fatty acid and glycerol (Al-Zahrani, 2012). The ability of soap to remove dirt will depend on its efficiency as a surfactant and an emulsifying agent. Surfactants contain a molecular structure that is able to form a link between the dirt particles to be removed and water. As a surfactant, soap reduces the water's surface tension enabling it to spread evenly and wet the object. The soap molecule then works as an emulsifying agent after accelerating the wetting process (Al-Zahrani, 2012). Soap is soluble in water since it has a polar head – the sodium/carboxyl portion and the other head is the hydrocarbon chain which is non-polar. The soap molecule forms a unimolecular film on the water surface with the carboxyl groups being dissolved in the water (Thorpe et al., 2009). The non-polar tail attaches to the grease particles and create a " micelle", a bubble of soap molecules surrounding the grease. The micelles carry away the grease and dirt in the rinse water (Toedt et al., 2005; Al-Zahrani, 2012; Dunn, 2009). The raw materials required for some making are basically fats and oils, sodium hydroxide, water, perfumes, filling agents and colour (Donkor, 1986). One of the basic ingredients needed to make soap is sodium hydroxide (Grosso, 2007). Only pure sodium hydroxide is used for soap making. There are safety precautions to be taken while dealing with sodium hydroxide since it is highly reactive even in its dry form and can be very fatal to the human health (Cavitch, 1997). They should always be handled using gloves and always pour the pellets into the water so as to avoid volcanic reactions. Sodium hydroxide is basically used to make solid soap whereas potassium hydroxide is mainly used to make liquid soap (Grosso, 2007). Its disposal is an important issue to be considered. However, organic soap making has the advantage of creating reusable waste as soap scraps can be recycled and the lye left after one batch of soap can be used next time (Cavitch, 1997). Another necessary ingredient in soapmaking is oil. The fat comes from both animal and plant (Watson, 2007). The nature and the properties of the oils and fats used in the manufacture of soap will determine the properties of the soap and also the cost of production (Trew et al., 2010; Moulay et al., 2011). The physical, chemical and Soapmaking properties of the oils should be fully understood when producing soap. The art of Soapmaking will lie in choosing the appropriate oils to produce the qualities needed for the soap since different oil has different properties (Donkor 1986). It is important to make sure that all animal and vegetable oils and fats to be used for soap-making should be from unsaponifiable matter and they should have good colour and appearance and be in a fresh condition (Simmons et al., 2007). Both the physical and chemical characteristics of oils and fats are greatly influenced by the kind and proportion of the fatty acids on the triacylglicerol (Zambiazi et al., 2007; Senanayake et al., 2002). Fats and oil are primarily triglycerides which are broken down during the saponification process into glycerol and fatty acids with the latter combining with the sodium in the alkali to form soap (Gonzales, 1983). The fatty acids present in the oil are the most important basic oleochemical as they are used as starting material in soap making (Shahidi, 2005). Several parameters related to both saponifiable and nonsaponifiable fractions have been considered for the evaluation of the quality of unrefined oils. Unrefined oils contain about 98 – 99 % saponifiable compounds with the rest being unsaponifiable compounds. Saponifiable compounds are triglycerides and fatty acids whereas nonsaponifiable compounds are phenol, hydrocarbons and other organic compounds. Parameters considered for the evaluation of the quality of oil are the acid value, peroxide value, saponification value and iodine value which are related to determining the saponifiable fraction and the total phenol will determine the unsaponifiable fraction (Seneviratne et al., 2005). Fats and oil can be classified into three types namely: Fixed oil which is the main raw material for Soapmaking as it decomposes to fatty acids and glycerol. These are further classified into nut oils, hard fats and soft oils (Donkor, 1986). Nut OilsTree nuts are rich in monounsaturated fatty acids, predominantly in oleic acid. They contain lesser amounts of polyunsaturated fatty acids, mainly linoleic acid and comparatively little amount of saturated lipids. Tree nut oils are also used as ingredients of some skin moisturizers and cosmetic products (Shahidi et al., 2005). Some examples of this type of oil are coconut oil, almond oil and palm kernel oil and which are also the most common oil used to make soap (Donkor, 1986; Shahidi et al., 2005; Ward, 2007). They also saponify easily with strong alkaline solution and they are more suitable for the cold process Soapmaking (Donkor, 1986; Warra et al., 2010). Hard FatsThey contain appreciable quantities of palmitic and stearic acids. Although these types' oils or fats produce slow-lathering soaps, the lather produced is more stable over a longer period of time when compared to nut oils (Donkor, 1986). Soap-making industries commonly manufacture household soaps with a mixture of 75-85 % of hard fats and the rest being lauric fats such as coconut oil and palm kernel oil to be able to meet the soap detergency criteria such as firm texture and foaming (Moulay et al., 2011). Examples of hard fats are palm oil and animal tallow (Donkor, 1986). Soft OilsThey have substantial amounts of unsaturated acids, namely oleic, linoleic and linoleneic acids. Depending on their fatty acids composition, the physical and chemical properties, the soapmaking properties of these oils will vary (Donkor, 1986). Very fine oils consist of less than 1 per cent acidity. Commercial oils are graded according to their free acidity, for example, under 5 per cent or under 10 per cent. The desired price of the resultant soap will determine the grade to be used for the soap (Simmons et al., 2007). Examples of soft oils are olive oil and castor oil (Donkor, 1986; Simmons et al., 2007; Ward, 2007; Warra et al., 2010). These oils have very good lather properties and lather freely (Donkor, 1986).

Mineral Oils

They are from non-vegetable sources and are composed mainly of alkanes and cyclic paraffins. They are a common ingredient in baby oil, ointments and lotions but not for soap making (Darma, 2008).

Essential Oils

Essential oil is mainly used to add scents to the soap (Dunn, 2011). Each essential oil is unique and has distinct properties. However, essential oils' scents may generally be categorized as top, middle, or base notes. Top notes tend to be more fleeting than middle or base notes. Base notes generally tend to have more staying power. Therefore, an essential oil blend of top, middle, and base notes will have the best combination of appealing aroma with the most staying potential. Example of top notes is citrus and base note is patchouli (Mixon, 2004). In soap-making, it is preferable to use soft water. Chemical treatments are to be undertaken if the water supply is hard. Softening agents such as lime and soda ash together, or soda ash, or caustic soda are often used (Simmons et al., 2007). The total permissible amount of water in soap is around 17 percent (Toedt et al., 2005). Soaps have become a beauty product in many countries and today soaps with shapes, colour and fragrance are produced. Most scents in soaps come from oils. These are essential oils extracted directly from plants, or fragrance oils that are synthesized artificially from coal tar chemicals (Ward, 2007). Since perfumes are very volatile at high temperatures, they are added to the soaps at low temperatures. Some synthetic perfumes and essential oils may cause soap to darken rapidly on keeping, for example clove oil, and vanillin and other oils may decompose the soap. Therefore due consideration must be given as to what the action of a particular perfume will have on the soap. Suitable oils for soapmaking are lavender oil, lemon grass oil and citronella oil (Donkor, 1986).

Chemical Ingredients

Some chemical additives used in the industrial soap making process are Coco Diethanol Amide (CDEA) which boosts the production of foam, Benzalkonium Chloride which is used to fight bacteria or fungi, Sodium Silicate used to bind ingredients more effectively in liquid soap and sodium (Dr. Almanzor, 2007) and Sodium Laureth Sulphate (SLES) which reduces the need for glycerol in soapmaking (Dunn, 2012).

Natural Ingredients

Natural additives for soapmaking can be oatmeal, dried seaweeds, green plants like aloe vera and vetiver, dried herbs and extra oils to help soaps to nourish and soften and be used for their gentle scrubbing properties. However too much additive may soften the soap too much or may be scratchy to use (Browning, 2002).

Color

Color is an important ingredient to soap’s allure. Spices or dried herbs are used for a natural colour whereas cosmetic grade colorants are used for bright colors (Browning, 2002). In soapmaking, all fats and oils used consist of a mixture of compounds of glycerol with fatty acid occurring in nature in the form of triglycerides (Donkor, 1986). In 1000 fatty acids known, only 20 or less are present in significant amount in most important oils and fats (Shahidi, 2005). Saturated fatty acids are of more interest to soapmakers since they have good cleaning properties and lather whereas unsaturated fatty acids are liquids which have poor lather properties (Oghome et al., 2012). Generally the acids used for soap making lie between the ranges from C12 to C18. Below this range, the high water solubility leads to poor surface activity and above this range the water solubility is too low for use (Reinish, 1952). Some examples of fatty acids are lauric and myristic acids which are present in coconut oil and palm kernel oils, palmitic and stearic acids are present in palm oil (Dunn, 2010). Most soap bars are formed from reactions of palmitic, lauric, myristic, stearic or oleic acids with a base (Ward, 2007; Oghome et al., 2012). The main conditioning fatty acids are oleic, linoleic and linolenic. As they increase in size from lauric to stearic, the melting point of the oil increases. The longer the fatty acid chain, the harder will be the soap (Oghome et al., 2012). Lauric acid is a saturated fatty acid whose single bond helps in soap hardening and has good cleansing and foaming properties. Stearic acid, C18, has three members namely the oleic acid C18: 1, the linoleic acid C18: 2 and the linolenic acid C18: 3. The stearic acid is a saturated fatty acid while the other three are unsaturated fatty acids. Stearic acid provides hardness to the soap bar with a creamy lather. Oleic and linoleic provides good conditioning. Myristic acid has good cleansing properties and provides conditioning and good lather. Palmitic provides hardness and a creamy lather to the soap bar. Ricinoleic acid provides good conditioning and produces a bubbly and creamy lather (Oghome et al., 2012). Low iodine value will make a harder soap bar (Panda, 2003). These oils are normally complex mixtures of dozens of chemical compounds. Some compounds present in a given essential oil will react with alkali and there will be others that will not. To be able predict which of the essential oils will undergo a reaction with the alkali, the list of components is examined and it is noted which of them are reactive (See Appendix A). Such compounds consist of esters, phenols, and acids (Tisserand et al., 2011). Soap making industries make great use of the coconut oil as it contain an important chemical derivative; methyl esters which are obtained by treating the oil with methyl alcohol. The methyl esters are significant raw material for the chemical industries as they are more stable and are easily separated by fractional distillation (Gopala et al., 2010). Coconut oil contains more than 90 % of saturated fatty acids which accounts for its low iodine value (Canapi et al., 2005). It also consists of about 8% of unsaturated oleic and linoleic acids as triglycerides. Coconut oil has less than 0. 5 percent of unsaponifiable matter (Gopala et al., 2010). It also used in producing liquid soap due to its chemical and physical properties, especially if a rich lathering soap is desired (Nirr, 2009). Due to the high share of fatty acids with a short or medium chain length present in coconut and palm kernel oil, special attention must be given to these oils. The soap industry is also the largest consumer of palm oil. They contain about 5-10 % fatty acid depending on the extraction method. The oil is usually obtained from the fruit of a palm tree. Palm kernel oil obtained from the kernels of palm fruits has almost the same characteristic as coconut oil and thus it is being largely used as an alternative as there is greater availability of palm oil compared to coconut oil (Hill., 2000; Thiagarajan., 2003). There are various technologies used nowadays to produce soap industrially (Niir, 2009). These are: The Full Boiling ProcessThe Semi Boiling ProcessCold Made Soap ProcessesContinuous Saponification of FatsContinuous Splitting of Fats and NeutralizationWhen compared to industrially produced soap bars, organic soap making is more beneficial. In Organic soap making processes, all the glycerin remains in the soaps whereas there is an additional process for glycerin removal in soap industries (Thorpe et al., 2009). There are different ways of making organic soap on small scale basis namely: The Melt and Pour ProcessCold Process Soap MakingHot Process Soap MakingLiquid Soap MakingThis process requires a commercially available base; a glycerin base (Cusick et al., 2003; Palmer, 2007). The soap is melted completely and then let to cool before any additives or colorants is added to it (Cusick et al., 2003) after which it is poured in soap moulds . It is the easiest and safest method of soap making but requires a soap base. Cold process is the simplest type of saponification batch operation (Baldwin, 1987). This type of soap making requires the lye bought from the store and also eliminates the need for cooking the soap for a long period of time (Stein, 2008). The alkali and fat are mixed together forming an emulsion at a relatively low temperature (Niir, 2002). The cold process soap making is very time consuming since the soap requires 24 hours for the saponification reaction to take place and about four weeks or more curing time before use (Hamblen, 2003). In this process, the fat and the alkali are missed together and then instead of pouring into the soap moulds for the cold process, the mixture is heated and cooked until the soap has been neutralized completely. Cooking time will depend on the soap recipes and it can be up to 2 to 3 hours. Curing time may be up to one week only so as to allow evaporation of excess moisture and allow the soap bar to harden (Miller, 2013). Liquid Soap was developed by William Shepphard in 1865 (Bellis, 2013). Compared to hot and cold soap making processes, liquid soap requires potassium hydroxide as a base as opposed to sodium hydroxide in the other processes. Since the molecules of potassium hydroxide are greater than that of sodium hydroxide, the soap can maintain its liquid state. Liquid soap is an easy product to use and it is safer than the ones with harsh chemicals available on the market (Jones, 2011). Liquid soaps are now commonly used due to its popularity and its hygienic qualities and has a great advantage of being easily used in pump dispenser bottler (Farrer-Halls, 2004). Liquid soaps may be classified as liquid toilet soap, liquid washing soap and shampoos (Panda, 2003). Among the studies on soap making processes, it can be seen that organic soap making processes is a technology which can improve the environment and use environment friendly technology. The cost of production will be less since there is no addition of harmful ingredients in organic soap compared to synthetic soaps. Green soap is an environmentally friendly soap which is made mostly from vegetable oil. Most commercial soaps recover the glycerin produced during the saponification reaction whereas organic soaps have this emollient ingredient. This chapter describes all the experimental procedures that were carried out in the Sugar Tech Laboratory at the University of Mauritius during this study. The study was done during a period of three months whereby two different types of oil were used; coconut oil and olive oil for the cold and hot saponification processes. The aim was to determine the optimum concentration of lye that can be used to produce organic soap.

Investigation of producing organic soap with the addition of dried seaweeds and seaweed extract was done. A chemical additive used by detergent manufacturing industries was also added to the soap for comparison with the organic soap. The soap was also tested for pH, its foam capacity, its degree of cleanliness and for its total alkali content. A trial investigation on the production of liquid soap was also done. During storage, oils are subjected to many chemical reactions. Some of the reactions are desirable while others are undesirable, thus the reactions and the effects of these reactions need to be minimized. Thus characterization with respect to composition, structure, saponification number and reactivity are carried out. The specific gravity of the oil was determined using the density bottle where the latter with a known volume was weighed empty and weighed containing water first and then the oil. Using a viscometer with spindle number 1 available in the laboratory, the viscosity of the oil was determined. SAP number is defined as the amount of alkali needed to saponify a given quantity of fat or oil, expressed as mg potassium hydroxide to saponify 1 g of sample (Jinadasa B. K. K. K, 2009; Nielsen S. S, 2010). The SAP value was determined using the following steps: The oil samples were melted and filtered to remove any impurities. 5 g of fat was weighed in a 250 ml conical flask which will connect to a condenser. The mass of the sample was recorded and a sample in duplicate was prepared. 50 ml of 0. 7 N alcoholic KOH was measured accurately (prepared by dissolving 20 g of KOH pellets in 500 ml of distilled ethanol while keeping the temperature below 15. 5 ºC and obtaining a clear solution) and then added to the flask. Blank samples were prepared using only 50 ml of alcoholic KOH. Several boiling beads were added to the flasks and were connected to a condenser. The sample was boiled gently on a hot plate until a clear and homogenous solution was obtained indicating complete saponification (about 45 minutes). The sample was allowed to cool a little and the flask was then disconnected from the condenser. The sample was then allowed to cool to room temperature. 1 ml of phenolphthalein indicator was added to the samples and titrated against 0. 5 N HCL until the pink colour disappears. The volume of titrant used was then recorded for calculation. The blank samples were refluxed for the same amount of time as the oil samples and the other steps were repeated. The calculations are annexed in Appendix C. The saponification is then determined using the equation below: Where; SAP value = mg KOH per g of sampleB = Volume of titrant for blank (ml)S = volume of titrant for sample (ml)56. 1 = molecular weight of KOH (mg/mmol)W = Sample mass (g)The molecular weight of Sodium hydroxide is only 40/56. 1 of potassium hydroxide's weight. In order to incorporate the same amount of hydroxide ions into the soap making recipe, the Saponification value that reflects potassium hydroxide as the base is multiplied it by 40/56. 1 to get the sodium hydroxide Saponification value. After determining the saponification value of the oil, the amount of sodium hydroxide solution needed is calculated as follows: The saponification of the cold process soap making was carried out by the following steps and using a concentration 10. 7 mol/dm3 NaOH as calculated. The amount of water, oil and sodium hydroxide pellets required for the process were measured accurately in heat resistant beakers. The measured NaOH pellets are then added slowly and steadily to the water while mixing with a stirrer to dissolved the pellets in the water. Maximum care should be taken as this reaction is an extremely exothermic one. The mixture is then allowed to cool. Any solid fat is then melted. The temperature of the lye solution and the oil is then measured using a thermometer. When both are at temperatures around 45°C, the lye solution is poured slowly and carefully into the oil and mixed using a spatula. A stick blender is then used to reach tracing time faster (about 2 – 5 minutes). The trace stage has been reached when the soap mix has changes from a totally liquid state to a cream like consistency. To know if the soap mix has reached trace, the stick blender must leave a visible trail behind when lifted from the mix. Trace time depends on the oil used, stirring speed and tool type. Any additives such as essential oil, herbs can now be added since the soap mix is not as reactive once the trace stage is reached. The soap is then poured into the moulds lined with wax paper. For the saponification reaction to take place, the soap molds must be well insulated to stop heat from escaping early. The moulds are left undisturbed for a period of 24 hours. The soap will pass through the " gel phase" if the moulds are well insulated. The gel phase will give a hint that the saponification reaction is taking place and there is production natural heat which helps in converting lye and oil into soap. After 24 hours the soap are then unmolded and can then be cut into appropriate sizes. The soap is then stored for the compulsory " curing time" for about 4 weeks in a cool, dry, and airy room. During curing time, the excess water present in the soap is rid off and the soap is turned into a milder, harder and longer lasting bar. The soap will also obtain its final color and texture during the curing time. A longer curing time will yield a harder and richer soap. In order to assess the effect of the concentration of NaOH in the saponification reaction; the concentration of NaOH solution was decreased keeping the amount of water used constant but reducing the amount of chemical used. The saponification reactions for the different concentrations were carried out using the cold process soap making. In order to investigate how more lather can be produced in the soap, a chemical reagent SLES which is used by soap manufacturing industries was added to the soap. According to some studies SLES in some products ranging from 1 % to 15 %; with toothpaste containing the lowest amount and shampoo containing the highest. The amount of NaOH present as a chemical in the 10. 7 mol/dm3 soap was calculated and from this, 15 % of the total mass of the NaOH present is the mass of SLES to be incorporated in the soap and the rest will be NaOH. About 2. 5 ml (50 drops) of sandalwood essential oil was added to the soap mix for scent. Olive oil which is a vegetable oil and having powerful antioxidant effect was incorporated in the soap mix to determine its effect on the saponification process compared with the coconut oil saponification process. 50 grams of olive oil was added to 150 grams of coconut oil. The amount of NaOH needed for complete saponification was calculated using the SAP value of the coconut and olive oil. For the hot process, saponification was carried out using NaOH concentration of 10. 0 mol/dm3 and 9. 0 mol/dm3. The oil, NaOH pellets and water were measured accurately. After preparing the lye solution, it was poured in the oil and brought to trace with a stick blender. The soap mix was then poured in a beaker and covered with a plate at the top and then placed on a heating plate for cooking the soap. After 10 minutes or more, the mix was uncovered and mixed. The soap is cooking and has become thick. The soap was left to continue cooking and stirred every ten minutes and eventually reaches the gel phase. There is transition from the gel phase to an applesauce stage and finally when the soap will look like mashed potatoes. To verify if the soap has neutralized completely, a small was taken and a drop of phenolphthalein indicator was added to the sample. If the sample stayed clear, it meant that the soap has been neutralized else if the sample turned a pink colour, more cooking is required. At this stage any additives is added and colour if desired. Essential oil is added when the soap has cooled down a bit since the oil will be vaporized if it was added above its flash point. Thus essential oil is added below its flash point. The soap is then poured in the mould lined with wax paper and the latter is banged on the counter to remove any air bubbles formed when the soap was being poured. The mould is then covered and allowed to sit for 6 – 8 hours after which the soap can be removed and cut into bars. The seaweed Gracilaria Salicornia used for the soap making was collected by the Mauritius Research Council. The seaweed extract was prepared as follows from fresh seaweed in order to mix the extract in the soap instead of using water. A beaker filled with water was brought to boiling point and set aside. A portion of seaweed with size of an ice cube was placed in a zipper bag. For each piece of seaweed, two tablespoon of hot water was added to the bag. Excess air was squeezed out and the bag was sealed tightly and kept under the hot water in the beaker. After a period of one hour or after the water in the zipper bag has changed colour, the bags was removed. A strainer lined with a layer of cheesecloth was placed over a beaker to transfer the extract. The bag was carefully emptied and as much extract as possible was squeezed out. The extract was transferred in a container; sealed and refrigerated until use. The seaweed used for the extract was then dried. The wet seaweed was washed once with water and then placed for drying in the sun for about 3 days. The dried seaweeds were then crushed in a grinder. Three types of soap were produced with the seaweed extract and seaweed powder from Mauritius and seaweed powder from Rodrigues. The saponification process was carried out with decreasing NaOH concentrations starting from 10. 7 mol/dm3. The pH of the prepared soaps was determined using a pH meter available in the laboratory. 10 g of soap shavings were weighed and dissolved in 100 ml of distilled water contained in a volumetric flask. This was made up to prepare 10 % soap solution (Dalen et al., 2009). The pH readings of the solutions were recorded. To determine if the soap can produce foam, the following procedure was undertaken (Warra et al., 2010): About two grams of soap shavings were transferred to a measuring cylinder containing 100 ml of distilled water. The mixture was then shaken vigorously for about 2 minutes to generate foam. The cylinder was allowed to stand for 10 minutes and the height of foam formed was measured and recorded. The steps were repeated for soaps produced from different oil concentration, different oils and different additives (Issah, 2006). To determine the cleaning property of the soaps produced (Warra et al., 2010); A drop of oil was placed on four separate filter papers. The filter papers were then immersed in separate test tubes containing soap solution. The soap solution was prepared using 2 grams of soap in 100 ml of distilled water. Each test tube was shaken vigorously for 1 minute. The filter papers were removed and rinsed with distilled water and the degree of cleanliness in each filter paper was observed. The total alkali content in soap is amount of alkaline elements combined as soaps with fatty acids and free caustic alkali (Hautfenne, 1982). The test was carried out as follows: 10 g of soap was weighed to the nearest 0. 01 g into an incineration dish and the soap was incinerated until a black ash was obtained. It was then transferred to a 100 ml volumetric flask with warm distilled water and allowed to cool. The flask was make up to 100 ml and shaken to mix. The solution was then filtered using a filter paper. 50 ml of the filtrate was transferred to a conical flask and titrated with sulphuric acid with methyl orange as indicator. The total alkali content is expressed as a percentage (m/m): Where, V = volume of sulphuric acid solution used (ml). T = exact normality of sulphuric acid solution used. m = mass of the test portion (g). This section presents and describes the results obtained during this study and also provides supporting explanation for the observed results. The main parameters studied were decreasing NaOH concentration with the cold saponification process; comparison between the hot and cold saponification processes and integration of value added products to the soap. Calculations leading to the results are enclosed in Appendix C. The specific gravity of the coconut oil was found to be 0. 932 g/cm3. The density of oil varies with each type and temperature. The range is from 0. 91 to 0. 93 g/cm3 between the temperatures of 15ºC and 25ºC (Jinadasa, 2009). The viscosity of coconut oil as found to be 69 cP at 31ºC. The viscosity of coconut oil has been reported to be 28 cP at 37. 8 º C (Noureddini et al., 1992). At 37. 8 ºC the viscosity of the coconut oil for soap making would be around 23 cP. This difference in values may be due to the type of coconut oil whether it is pure or refined and the countries where the coconut were produced and the method of oil extraction and liquid viscosities are temperature sensitive. The

SAP value was determined for coconut and olive oil to calculate the amount of NaOH needed for saponification. The saponification value for coconut oil was found to be 255 which reflect potassium hydroxide as a base. The saponification value of coconut oil ranges between 250 – 264 (Donkor, 1986; Jinadasa, 2009) which means that the results obtained above lie between the required range. SAP value of the oil which reflects NaOH as a base was calculated to be 181. The saponification value for olive oil was found to be 187 which reflect KOH as a base. The saponification value of olive oil may be between 184 -196 (Dunn, 2010). The SAP value determined for the olive oil falls between the range of values. The SAP value of olive oil which reflects NaOH as a base is calculated to be 134. Higher saponification value for a triglyceride indicates a higher medium chain of fatty acids composition (Seneviratne et al., 2005). The first saponification process was conducted with 800 g of pure coconut oil, 145 g of lye and 338 g of distilled water; with a required NaOH concentration of 10. 7 mol/dm3. 1100 g of soap was produced. The soap may be classified as made with organic products not counting water as specified by The National Organic program (January 2003) since the NaOH present in the soap amounts to 15. 3 %. With decreasing NaOH concentration from 10. 7 mol/dm3 to 2. 0 mol/dm3, it was observed that saponification process takes place with 10. 7 mol/dm3 till 7. 0 mol/dm3 and no saponification takes place with 2. 0 mol/dm3 NaOH. The saponification process takes two weeks to set for the 6. 0 and 4. 0 mol/dm3 NaOH. Thus for the cold process soap making 8. 0 mol/dm3 NaOH is the optimum pH with pure coconut oil. With addition of sodium laureth sulfate (SLES), it was found that the optimum NaOH concentration required for saponification was 9. 1 mol/dm3. It was also found that with addition of SLES in the soap, more lather is formed when used. The soap can be classified as made with organic ingredients since it contain up to 15 % of chemical. The soap is classified as made with organic contents as water does not count in any way into organic levels. The soap is not classified as organic as it must contain up to 95 % of organic material which is way impossible to achieve because of the chemistry involved in the soap making. The maximum reachable organic content in a bar soap is 90 % as stated by the United States Department of Agriculture.