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Utilization of Waste Cooking Oil and Tallow for Production of Toilet “Bath” Soap.

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Abstract

A green prospective based on the reuse of waste materials such as beef tallow and waste cooking vegetable oils to manufacture soap is presented. Beef tallow and waste cooking oils that is discarded as waste from households and restaurants after frying is reviewed for the production of toilet (bath) soap. The discarded oil is purified with a brine solution and bleached with Hydrogen Peroxide (H_2O_2). Purified waste cooking oils and beef tallow is mixed with coconut oil commonly used oil in toilet soap manufacturing. The oils are normally mixed at different ratios for the preparation of toilet soap. The triglycerides in the vegetable oils and beef tallow are saponified with Sodium Hydroxide (NaOH) by hydrolysis. Cold process soap shows significant improvements in physical properties at different triglycerides ratios and storage time at room temperature. It could be recommended that discarded waste cooking vegetable oils can be used after purification and bleaching together with beef tallow that may be regarded as waste to produce toilet (bath) soaps.

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Keywords: Saponification; sodium hydroxide; triglycerides

1. Introduction

Giving back to the community can take many forms, depending on one's skills, and the unique nature of the community, hence sharing expertise can improve the general lifestyle of others. Citizens in remote locations have limited access to utilities (especially electricity) and they are far from infrastructure. These people are known for their low standards of living because they cannot afford to meet most of their needs. Due to the abundance of cow tallow produced by Botswana Meat Commission (BMC) as waste material, there is a need to produce soap from this cow tallow in order to empower citizens living in villages. Generally, waste cooking oil which also has the same composition as the cow tallow, save for the fact that it is liquid in form and is not properly disposed either in homes,

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restaurants and catering outlets. This waste disposal issue has resulted in blockage of sewage drains and aquatic life destruction. From this waste cooking oil, soap can also be produced that will serve the dual purpose of taking care of the waste management problem as well as employment creation for the local village folk.

The creation of soap, like so many other wonderful discoveries, was most likely accidental. The prevailing story holds that back in the days, on Mount Sapo in Rome, animals were burnt as offerings to the gods. After the ceremonies, the fire pits were full of ashes and animal fats. When it rained, water ran through the ashes and fats thereby washing them down to the river. As the roman women took their washing to the river, they found clumps of a pale waxy substance floating on the water. The women soaked their clothes and washed by pounding them on rocks. When the waxy substance was beaten with the clothes, it made a lather and the clothing got cleaner. Eventually, this was puzzled out and the process of making soap from animal fat began [1]. Soap making became a routine task after sodium hydroxide (then a strong alkaline solution leached from wood ashes that turn fats into soap) became available commercially.

Soap is made from an acid (animal fat in our case) and base (sodium hydroxide solution) reaction that produces salt (soap), water and glycerin. The process is called saponification. Virtually any kind of fat or oil can be converted into soap by reacting it with an aqueous base [2]. In its simplest form, the soap-making process is economically sustainable and environmentally friendly as there are no waste products formed. The soap itself is biodegradable and the saponification process requires minimal energy input. Vegetable oils and animal fats are both comprised of triglycerides which are molecules of glycerol that are esterified to three long chain carboxylic acids (fatty acids). When triglycerides are combined with an aqueous base such as sodium hydroxide or potassium hydroxide, hydrolysis of the triglyceride esters occurs. The product of this reaction is soap, which contains the salts of the fatty acids and free glycerol. The salts of the fatty acids are what give soap its characteristic properties. In making the toilet soap, materials used are oils such as olive, canola, marula, coconut and tallow and other ingredients such as avocado, titanium dioxide, paw paw, milk. The major ingredient (tallow) is sourced locally from the meat processing industry. The toilet soap is a community based project coordinated by the Department of Chemical, Materials and Metallurgical Engineering (Botswana International University of Science and Technology). The mandate of this project is to assist in the socio-economic needs of the less privileged members of our immediate community. Both the technology and the products of this project are not for sale but rather are meant to be transferred to the communities in need.

2. Cold Process Soap Making “Review”

2.1 Tallow Rendering

Suet and cow body fats which are harvested from the animal after slaughtering are rendered to tallow and the process consist of cleaning the fats to remove impurities. This can be carried out in stainless pot with distilled water and boiling the mixture together until the fat is melted [3]. The mixture is allowed to cool down at ambient temperature and the solidified tallow that is free from impurities float at the top and the impurities being denser remain with the water underneath.

2.2 Purification and Bleaching of vegetable oil

Hydrogen Peroxide (H_2O_2) solution is usually used in vegetable oil bleaching to improve the colour after purification of the oils with brine solution. Girgis et al [7] studied purification of discarded palm oil from potato chip factory. Hot brine solution (5% NaCl, w/v) was used to wash the vegetable oil at $\sim 90^\circ\text{C}$ by stirring at 60rpm for hr, after cooling the two phase (brine solution with impurities and washed oil) were separated by siphoning. Washing with brine solution revealed some improvements in impurity levels from the waste cooking oil and improvement in colour. H_2O_2 further improved the colour of the vegetable oil, the reduction in colour may be due to the action of hydrogen peroxide on some pigments by releasing free oxygen. Felix et al also studied cooking oil treatment using brine solution, the process involved three phases namely filtration to remove particulate matter, washing with brine solution at 90°C brine solution (10% NaCl, w/v) to remove impurities and deodorizing with almond shells powder for the removal of molecules that give the odour, however, it was discussed that the oil still presented a frying odour.

2.3 Saponification reaction

Saponification reaction (Figure 1), also known as alkaline hydrolysis of triglycerides is the cold process for soap making. Triglycerides are the major constituents of animal fats and edible vegetable oils, these molecules react with strong base like sodium hydroxide (NaOH) in aqueous phase to produce sodium salts of hydrolyzed fatty acids (soap molecules) and glycerin molecules [2].

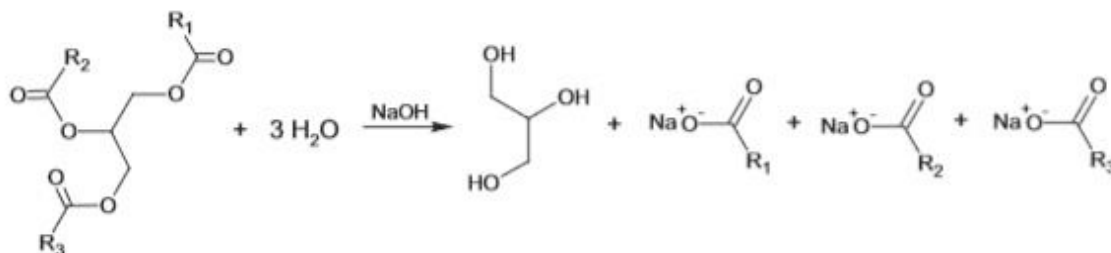


Figure 1: Saponification reaction [2]

Historically, soap production by cold process used to be process to recycle animal fats. Nowadays, most people use industrial/commercial soap however, there are families and communities which still produce their own bar soap. Felix et al [2] states that there is a growing movement to enhance artisanal production of good quality green soap since it is considered better for the skin and for health in general. The production of good quality soap may be supported by the fact that fat/oil sources have become almost vegetable and include a larger number of different oils/fats which in association with additives such as Titanium Dioxide (TiO₂), lavender essential oil etc, produce soaps with different characteristics.

3. Interaction of soap with skin barrier

Surfactants (surface active agents) are the essential cleaning substances and they determine the cleaning and lathering characteristics of the soap, as well as, its skin compatibility and other features [1]. Surfactants are compounds that have both the hydrophobic and hydrophilic ends, the hydrophobic tail group which attach to the greasy soil (dirt) and hydrophilic polar head group which associate with water helps disperse and rinse away dirt. Soap was discovered many years ago and it have been used for cleansing skin for millennia. The progression of skin cleansing over time is shown in Figure 2.

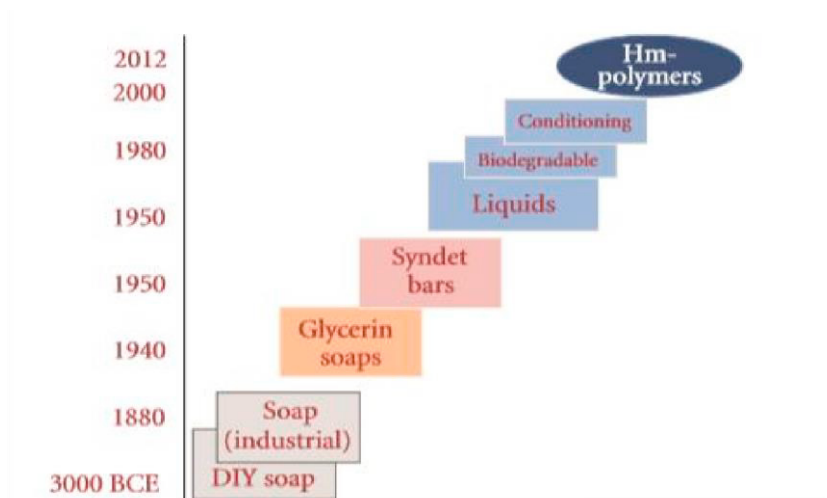


Figure 2: Progress in human skin cleansing [4]

The skin is the largest organ of the human body making up to 16% of the human total body weight, its vital role is to prevent water loss and other components, it also protects the body from harmful substances and microbes from the environment. It also has immune and sensory functions, which help to regulate body temperature and vitamin D synthesis [5]. The general purpose for skin cleansing is to reduce sebum and exogenous contaminants and to control odours and the skin microbes. Repeated washing of the skin with soaps and surfactants, however, can negatively impact multiple functions of the epidermal barrier. Figure 3 depicts how surfactant within a cleanser can remove stratum corneum (SC) material and also remain in the SC.

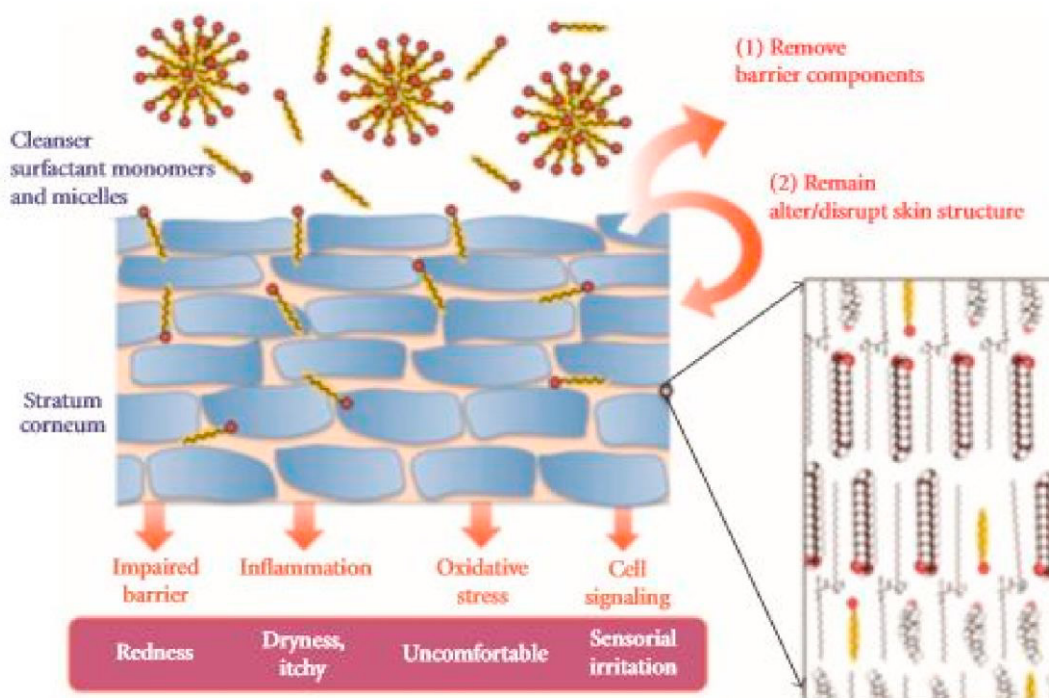


Figure 3: Interaction of surfactant with skin barrier [6]

From the Figure 3, the molecular-level on the right illustrate ordered SC lipids (ceramides, cholesterol and fatty acids) and surfactant from cleanser medium inserting into the skin barrier lipids. Walters et al [6] states that in order to maintain the skin barrier during cleansing it is best to maintain the original lipids and the native skin structure, it is further stated that polymeric species which interact with surfactant creates less aggressive cleansers.

4. Conclusion

Waste vegetable cooking oil after its purification and in optimized ratios with tallow and other additives may be used for manufacturing of toilet “bath” soap. This may eventually lessen the environmental pollution and impact economy through sustainable production of toilet soap.

Acknowledgement

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