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**WOLKITE UNIVERSITY**

**COLLEGE OF ENGINEERING AND TECHNOLOGY**

**DEPARTMENT OF CHEMICAL ENGINEERING**

**Title: Extraction of Oil from Avocado Fruit for Shampoo Production**

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**DECLARATION**

*We declare that this thesis is our own original work carried out under the supervisions of Mr Lamesgen. It is being submitted to the Department of Chemical Engineering for the Degree Bachelor of Science. It has not been submitted before for any degree or evaluation to other University. Permission is here with granted to Wolkite Institute of Technology to circulate and to have copied for noncommercial purpose while the author reserves other publication rights.*

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## **AKNOLOGMENT**

*First of all we would thank our almighty God to give us wisdom and strength to finish this project. Following to this, we would like to express our deep gratitude and admire that we have to Mr. Lamesgen for his end ever, and great effort to assist, and guided us throughout our project activities. It would be grateful to thank Chemical Engineering department head Dr. Gebre Egenet for his Cooperation in writing letters for other departments in order to get materials that we lack. We also like to say thanks for. We would also like to thank chemical engineering Lab technicians Mr. Metages, and Mr. Amsalu, for their great cooperation and, always assisting us in the time of the whole experimental work. Finally we like to express last year graduate students friends admire and love to share thier work experience in order to carry out the mission we did.*

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## **LIST OF ACRONYM**

CTFA	Cosmetic toiletry and Fragrance Association
UV	Ultraviolet
INCI	International Nomenclature of Cosmetic Ingredient
SLS	Sodium lauryl sulphate
DEA	Diethanol Amine
NaOH	Sodium hydroxide
DOE	Design on Experiment

**ABSTRACT**

The main aim of this study is to determine the optimum extraction of oil from avocado fruit. For this, particle size of 0.5mm and 1mm, solvent type (hexane) and extraction time of 4hrs and 6hrs were considered for optimization. When the particle size range decreased from 1mm to 0.5mm the oil yield increased for solvent type and with a certain extraction time. As extraction time was increased from 4hr to 6hr the oil yield increased from 15.73% to 20.68% for particle size 1mm and 0.5mm respectively.

Different physico-chemical properties of the produced oil were characterized, and its values were recorded, such as acid value, specific gravity, pH value and, free fatty acid values are 0.214%, 0.9126, 6.8, and 0.107% respectively. From 160gm sample powder avocado 69.91ml of oil was found.

The produced shampoo was characterized and its physical property values are calculated such as foam ability and stability, visual inspection, detergence ability and surface tension. From the result the characteristics were good foaming capacity, moderate dirt dispersion, yellowish color, fine and smooth texture and nature of hair after wash was soft and manageable. From the techno economic feasibility analysis, the rate of return (ROI), 21% and payback period 2.8 years were found.

## CHAPTER ONE

### 1. INTRODUCTION

#### 1.1 Background

Washing the hair and scalp has become a near-universal practice. The method of doing so varies depending on both geographic and economic factors. Shampoos assumed importance as a product category with the advent of synthetic detergents. These were developed in the 1930s, became widely used in laundry markets by the mid-1940s and appeared in a shampoo format during the 1950s. Shampoos are probably the most widely used hair products today; based on synthetic detergents they are relatively insensitive to water hardness, thus allowing for efficient rinsing since there are no scum residues. (Knowlton, 1993.)

Shampoos are cleaning formulations used for a wide range of applications, including personal care, pet use, and carpets. Most are manufactured in roughly the same manner. They are composed primarily of chemicals called surfactants that have the special ability to surround oily materials on surfaces and allow them to be rinsed away by water. Most commonly, shampoos are used for personal care, especially for washing the hair. New shampoos are initially created by cosmetic chemists in the laboratory. These scientists begin by determining what characteristics the shampoo formula will have. They must decide on aesthetic features such as how thick it should be, what color it will be, and what it will smell like. They also consider performance attributes, such as how well it cleans, what the foam looks like, and how irritating it will be. Consumer testing often helps determine what these characteristics should be. Once the features of the shampoo are identified, a formula is created in the laboratory. These initial batches are made in small beakers using various ingredients. In the personal care industry, nearly all of the ingredients that can be used are classified by the Cosmetic, Toiletry, and Fragrance Association (CTFA) in the governmentally approved collection known as the International Nomenclature of Cosmetic Ingredients (INCI). The more important ingredients in shampoo formulations are water, detergents, foam boosters, thickeners, conditioning agents, preservatives, modifiers, and special additives. (Knowlton, 1993.)

The primary ingredient in all shampoos is water, typically making up about 50-60% of the entire formula. Deionized water, which is specially treated to remove various particles and ions, is used in shampoos. The source of the water can be underground wells, lakes, or rivers. The next most abundant ingredients in shampoos are the primary detergents. These materials, also known as surfactants, are the cleansing ingredients in shampoos. Surfactants are surface active ingredients, meaning they can interact with a surface. The chemical nature of a surfactant allows it to surround and trap oily materials from surfaces. One portion of the molecule is oil compatible (soluble) while the other is water soluble. When a shampoo is applied to hair or textiles, the oil soluble portion aligns with the oily materials while the water soluble portion aligns in the water layer. When a number of surfactant molecules line up like this, they form a structure known as a micelle. This micelle has oil trapped in the middle and can be washed away with water, thus giving the shampoo its cleansing power. Surfactants are derived from compounds known as fatty acids. Fatty acids are naturally occurring materials which are found in various plant and animal sources. The materials used most often to make the surfactants used in shampoos are extracted from coconut oil, palm kernel oil, and soy bean oil. Some common primary detergents used in shampoos are ammonium lauryl sulfate, sodium lauryl sulfate, and sodium lauryl ether sulfate. (Kentish, October 1995).

## **1.2 Statement of the problem**

Now days there are many types of shampoos which are available in the market, even if they possess some qualities, they couldn't afford adequate qualities which customer anticipate. The marketed shampoo was completely based on chemicals. Besides this the chemicals within the shampoo may affect children's during handling. Due to this avocado shampoo produced from avocado oil is preferable. In Ethiopia, there is high demand of shampoo, and hence imported from abroad, because there is no value added ingredients of shampoo like avocado oil which is extracted in Ethiopia.

Shampoo which has avocado oil as its ingredients, can overcome those problem, because of the following special ability; Avocado shampoos have the ability to penetrate the skin and deliver adequate amount of minerals in to the skin, Avocado shampoos have the ability to filter out and protect skin from UV when they exposed to high sun light, A shampoo which has avocado oil has the highest concentration of vitamin E. Not only does it help repair damaged hair, but it also helps keep the scalp healthy and flake-free. In addition to vitamin E, the oil also contains different types of abundant minerals, which can contribute value added to shampoo.

## **1.3 Objective of the study**

### **1.3.1 General objective**

The general objective of this project is extraction of oil from avocado fruit for shampoo production.

### **1.3.2 Specific objectives were**

- ❖ To study the effect of particle size on oil yield.
- ❖ To study the effect of extraction time on oil yield.
- ❖ To characterize the produced oil.
- ❖ To characterize the produced shampoo.

### **1.4 Significance of the project**

With the raise in the standard of living & health consciousness of people the demand for cosmetics is growing very fast. Demand is still growing very fast as smaller sizes (sachet type) are vigorously promoted by the leading manufacturers and selling it even in the smaller roadside pan shops. Because of high demand in Ethiopia it helps to reduce import, to satisfy customers and to share market business.

There are many types of shampoos which are available in the market, some contains synthetic minerals others may or may not. Even though they contains some minerals that helps for hair to gain little amount of food and moisture, those things are not adequate. Because of this, customers are not satisfied in terms of quality. Shampoos which have avocado oil as its ingredient, it enjoys a great advantage over other competitive shampoo types.

## CHAPTER TWO

### 2. LITRATURE REVIEW

#### 2.1 General Overview of avocado oil

Avocado (*Persea Americana Miller*) which is native to the high lands of Mexico and center America is cultivated in tropical and sub-tropical regions from 40°N and 40°S (Samson, 1986). It is one the most nutritive fruits known. It contains eleven vitamins, fourteen minerals and high percentage of oil (up to 30%) with no cholesterol l(Currier,1991). Avocado is by itself a complete food containing nine essential amino acids even though not in balanced proportion (Bergh, 1991). Avocado is also processed into oil for human consumption and used as ingredient in various cosmetics and health products ((Gaillard etal, 1995).

Avocado oil is the major avocado product but here in Ethiopia there may be few peoples that even know oil can be produced from avocado. Only a few countries are actually involved in the production of oil namely Mexico (34%), USA (8%), Israel (4%), South Africa (<2%) and New Zealand (<1%) and these are also the countries involved in growing and trading of the fruit.

Avocado oil was predominantly processed by the traditional producing countries and sold to the cosmetics and pharmaceutical industry to be used in cosmetic and healthcare products and as a lubricant. The methods of extraction used resulted in oil that was not suitable for consumption until now. A new method has recently been developed in New Zealand which produces avocado oil that is comparable in quality to olive oil the industry's finest or premium cooking oil. The fatty acid make up of avocado oil which is of great health importance, coupled with the presence of many essential nutrients and phytochemicals make it a very valuable product. The emerging market for it should be acknowledged and taken advantage of as it presents many opportunities for using surplus fruits and producing a value added product (, Eyre *set al*, 2006).

## **2.2. Factors Influencing the Oil Content of Avocado**

Avocado fruits with high oil content must be used in the production of oil. Various factors however are known to affect the oil content of fruits and they are:

### **1. Cultivar**

Different cultivars vary in oil content upon maturity and only those with high oil content should be considered. Because the oil is contained in the pulp or flesh, cultivars with high proportion of flesh and minimum seed and peel should also be selected. Many studies have confirmed the Hass cultivar to be superior in quality with all the favorable attributes.

### **2. Maturity stage**

The time at which the fruits of any given cultivar are harvested was noted by Arpaia in 2006 to have the greatest impact on the oil content of the fruits. Maturity is when the fruit is most suitable for human consumption and not for processing. Some cultivars mature early while others mature much later and understanding this becomes very important for choosing when to harvest. However it is understood that when avocado fruits mature their moisture content lower while their oil increases and leaving the fruits on the trees much longer after maturity tend to increase oil content (Arpaia, Avocado Post harvest Quality, 2006.).

### **3. Location and growth conditions**

The same study of avocado postharvest quality by Arpaia *et al.* (2006) also noted differences in oil content for the same cultivar due to different locations and growth conditions such as soil fertility. Sun exposed fruits were also found by Woolf *et al.* (1999) to yield higher levels of oil than those fruits in the shade.

## **2.3 Biochemical Composition & Physio-chemical Properties of Oil**

Understanding the biochemical composition and physio-chemical properties of the oil help to explain its functional properties and uses. Most of the beneficial attributes associated with eating avocados are mostly preserved in the oil and for this reason is very valuable. The composition and in particular properties of the oil varies according to how it is produced whether it be crude, virgin or refined according to the method and number of successive operations involved in its

production (Simmental&Escalona, 2004). Various analyses have been done on the composition of avocado oil and Table1 lists typical results according to Eyreset *al.* (2006). A major difference in color or chlorophyll content of the oil is noted when it is refined, bleached and deodorized (RBD) compared to virgin oil.

The Vitamin E, Beta-sistosterol and alpha tocopherol levels however are higher in avocado oil, the micro-nutrients with significant proof of health benefits. The flash or smoke point of avocado oil is another noticeable feature. The acidity value and peroxide values indicate stability in terms of minimal hydrolysis and lipase activities. The oil is also free of cholesterol and carbohydrate.

Table 2.1 Typical analysis results of Avocado oil Composition

Parameter	Avocado oil
Acidity Value (as oleic) (%)	2.0 – 0.08
Peroxide value (meq/kg fat)	3.3-0.1
Iodine value (from GLC)	87-75
Colour (chlorophyll )(ppm)	40-70 virgin
Specific Gravity (250C)	0.912- 0.916
Beta-sistosterol (%)	0.45 -1.0
Total Vitamin E (mg/kg)	112 -200
Alpha-tocopherol (mg/kg)	130
Beta/Gamma-tocopherol	15
Delta-tocopherol	5
Flash Point	150 – 255°C
Unsaponifiables	1.0 – 12%
Cholesterol	0
Sodium	0
Carbohydrate	0

*Source (Eyreset al., 2006)*

### **2.3.1 Fatty Acid Composition**

As seen in Table 2.1 the iodine value is high indicating a high degree of unsaturation. Typical avocado oil is comprised mostly of monounsaturated fatty acids (74%), 11% polyunsaturated fatty acids and about 13% saturated (Arpaia *et al.*, 2006). These percentages vary slightly with cultivars and other influential factors but the oil is very similar to olive oil. It is this high level of monounsaturated fat which gives the desirable effect of being “anti-cholesterol” as it prevents the formation of clots the major cause of coronary heart disease.

### **2.3.2 Phytochemicals**

The naturally occurring phenolic compounds found in vegetables and fruits have been proven to have equal or greater cholesterol lowering properties than unsaturated fatty acids (Nicolosi & Orthoefer, 2004). Beta-sitosterol (a phytosterol) is one of the healthy plant compounds found to be most abundant in avocado. It is widely proven to be responsible for the non-absorption of the bad cholesterol (LDL) and maintaining the good HDL cholesterol in the intestine which then lowers total plasma cholesterol (Arpaia *et al.*, 2006). This compound was also reported by the British Medical Journal the Lancet to be very effective in offering relief to men above 50 years who suffered from benign prostatic hyperplasia resulting in significant improvements in urinary difficulties.

The phytosterol content has the same skin penetrating abilities of lanolin and for this reason avocado oil is highly valuable in the cosmetic industry. Lutein or carotenoid is also highly abundant in avocado oil. This phytochemical is effective in providing protection against prostate cancer, eye diseases and macular degeneration. Lozano *et al.* (1993) noted that the unsaponifiable fraction from immature fruits contained a much higher level for both total sterol (1.1 – 6.2%) and tocopherol (20.1-45.6 mg/100 g of oil) compared to matured fruits (sterol 0.8-2.0% & tocopherols 5.7-10.3 mg/100 g oil). This is very significant for the extraction of enriched amounts of these compounds as they are of high health significance.

### **2.3.3 Antioxidants**

Phytochemicals in plants is reported to have greater antioxidant effects than minerals and vitamins. Lutein for example is one very effective antioxidant. Vitamin E represents a mixture of chemicals known as tocopherols and tocotrienols and is another well-known vitamin with antioxidant effects.  $\alpha$  – tocopherol is one powerful antioxidant which neutralizes the free radicals

produced under the normal metabolism of lipid compounds (Arpaia *et al.*, 2006). As noted in table 2.1 this is also abundant in avocado oil. All these antioxidants found in high levels in avocado oil neutralize the free radicals which would otherwise result in the following:

- eye deterioration;
- inflammation of the joints;
- damage to nerve cells in the brain;
- accelerating the ageing process and certain cancers;

### **2.3.4 Chlorophyll & Carotenoids**

Crude and virgin oils have high chlorophyll and amounts of other soluble pigments (carotenoids) which give it their distinctive brown – green or emerald green color. The virgin oil with high chlorophyll content is highly desired by consumers due to the health benefits associated with the presence of these micronutrients. The high chlorophyll content makes the oil highly prone to oxidative effects upon exposure to light and for this reason must be packed in dark bottles. Other carotenoids like lutein are also present in high amounts while others like neoxanthin, violaxanthin, antheraxanthin are present in very minute amounts (Arpaia *et al.* 2006). Further processing and refining removes the chlorophyll and other pigments giving oil that is pale yellow in color and also more stable (Botha, 2004; Eyre *et al.* 2006).

### **2.3.5 Unsaponifiable Fraction**

The healthy plant micronutrients which have anti-oxidant, anti-inflammatory, and cholesterol lowering properties are mostly contained in this portion of the oil. This part of avocado oil is highly valued in the pharmaceutical and cosmetic industries for the high skin penetration coefficient and the specific biological actions of its sterols (Botha, 2004). Human (1987) also reported this fraction to contain an unknown factor known as the H-factor which has healing properties. Eyre *et al.* (2006) reports that the healing properties may be linked with lipoxygenase which initiates cross linking in collagen and inhibits enzyme activity. This would be very important for the treatment of wounds and burns.

The unsaponifiable fraction is also high in nutrients which are another reason why it is highly sought after by the cosmetic industry. The French pharmaceutical industry filed two separate

patents No 17/245 and No 102888 for the extraction of this fraction indicating its high value (Human, 1987). Lozano *et al.* (1993) reported that the unsaponifiable matter in oil from immature fruits (15-40%) was always higher than the matured fruits (4-9%). This fraction of the oil is where most of the healthy plant sterols are concentrated. This is interesting as it presents another valuable option for farmers in using immature fruits for extracting this highly valuable unsaponifiable matter from oil.

## **2.4 Oil Utilization**

### **A. Cosmetic Industry**

Avocado oil is well known for its anti-bacterial, anti-wrinkle and healing properties. The multiple properties of avocado oil namely stability, emolliency, skin penetration, softening and moisturizing results in its wide applicability for cosmetic products. The high penetration ability of the oil in particular makes it very successful in its use as a natural and effective beauty aid. It is used in a wide variety of creams and oils for skin application as it acts as an effective carrier of other supplements incapable of permeating the skin (Human, 1987). The high content of lecithin and phytosterols facilitates its spread-ability. It is easy to emulsify as its low surface tension makes smoother creams and soaps. Vitamin A helps prevent dry skin while Vitamins E and D are effective against skin wrinkling and slow the process of ageing. A few New Zealand and US companies now manufacture various skin care products using avocado oil, like body moisturizer, replenishing facial creme, skin repair creme and natural oil for everyday use. The oil is an ingredient for up-market skin care cosmetics, shampoos and baby products. The oil is highly priced to those with skin problems and is used as a base for ointments used for treating dermatitis, acne, lacerations and other skin conditions. It is also used as a post-operative dressing to prevent adhesions to wounds and skin burns while accelerating the healing process. It also has strong UV absorption properties making it a very good effective sunscreen.

## **2.5 Processing of Avocado Oil**

To produce a quality product requires high quality raw materials. For this reason it is imperative that the fruits used are of high grade in particular must contain high proportion of pulp, have high oil content, free of diseases and must not be physically damaged as evident in pulp discoloration and/or off-flavors. The fruits have to be carefully matured and ripened to allow for maximum oil development before they are used. Various methods have been used in the extraction of oil from

avocado fruits. The methods vary in their degree of effectiveness for oil extraction and also subsequent effect on the resultant oil quality. Heating and chemical extraction have been the traditional methods used and now a new method has been developed in New Zealand which allows oil to be expressed from the fruits with very minimal processing.

Various methods are used in the past for the extraction of avocado oil involving steam pressure, hydraulic pressing, solvent extraction, centrifugation, freeze drying, rendering process and the use of a tube press plant. However the specific application of the oil should determine the process and method chosen. Only the most practical and suitable methods are discussed below.

### **2.5.1 Pre-Process Treatment**

Avocado fruits destined for oil production must be firstly inspected for physical damage and other abnormalities. They are then washed before being processed to remove the skin and seed. The means used for washing, de-stoning and de-skinning of the fruits vary but all processes involve this first critical step.

#### **1. Rendering process**

This method involves heating of the avocado pulp in avocado oil. The moisture evaporates off leaving the oil and the dry matter behind. The oil can then be decanted off while the remaining slurry is subjected to hydraulic pressure to press out more or the remaining oil. It is reported that laboratory experiments resulted in 94% recovery of the oil using this method.

#### **2. Tube Press Plant**

This consists of either one or two tubes. The tubes are filled with avocado pulp and then subjected to hydraulic pressure to press out the oil through perforations within the inner tubes. This method was developed by Messrs. Alfa Laval and aims at extracting out most of the oil with minimal damage to the oil quality.

#### **3. Cold Press**

This relatively new method of extracting oil makes use of the modern Alfa Laval centrifugal extraction method so is a variation of the above method. The fruit flesh is firstly macerated by high speed grinders before the mixture is mixed in malaxers. When this process is complete, a three phase decanter then separates the mixture into oil, water and solids before polishing takes place with a multi-cone centrifuge. Extra virgin oil is produced after the first press. The

extraction efficiency is dependent on such things like pH, centrifugation rate, salt, mixing temperature (<50°C) and duration of pressing (Eyreset *et al.*, 2006; Sionek, 1997). At no time along the whole process is the oil subjected to light or oxygen as this has a deteriorating effect on the quality of the oil. The extraction rates vary from 10-22% of the whole fruit and also tend to vary during the season. The production of cold pressed oil requires little investment and the process itself is simple. However the process has inefficiencies in that around 6-15% of the oil remains in the pressed residue (Uzytku&Higieny, 1997).

#### 4. Centrifugation

After the pre-processing treatment, the fruits are fed into a mill where it takes the form of a guacamole. The malaxation takes up to several hours until the release of the fine emulsion of oil. The paste is then fed to a centrifugal decanter where the oil is separated from the guacamole. Werman&Neeman (1986) and Bizimana *et al.* (1992) reported that extraction of oil was most efficient using centrifugal force 12,300kg, a 5:1 water to avocado ratio, temperature 75°C, with a pH 5.5 and a 5% concentration of either NaCl, CaCO<sub>3</sub> or CaSO<sub>4</sub>.

#### 5. Supercritical CO<sub>2</sub>

Botha (2004) reported extraction results for avocado oil extracted using supercritical carbon dioxide under four different extraction conditions. At higher temperatures and pressures, chlorophyll can be co-extracted along with the oil. Xiao *et al.* (2006) reported that the power of solubilisation for supercritical CO<sub>2</sub> can be achieved with higher densities which are achieved at higher pressures. This allows large amounts of organic compounds to be dissolved which can later be separated from the fluid by means of reducing the temperatures or pressures. Thus the extraction of the phytochemicals was only possible at higher pressures and temperatures only due to the solubilisation of the organic compounds.

Lower temperatures and pressures will extract only the oil without chlorophyll. This method is very important as it basically proves that more stable oil without chlorophyll can be extracted this way which eliminates the need to refine the oil of its color pigments. The oil however does not contain the healthy plant compounds which are highly attributed for its health benefits. Before analyzing the free fatty acid of the oil the CO<sub>2</sub> must be totally removed as it increases the acidity level. This can be done by subjecting the oil to vacuum evaporation (Botha, 2004). The degree of oxidation of the oil in the dried material used for extraction is also important as volatile

acids are also co-extracted by this method. The free fatty acid content however of the oil extracted by this method was not different to the FFA of the oil extracted by hexane indicating no effect of pressure, temperature or supercritical CO<sub>2</sub> on the hydrolysis of the parent glycerides. An important outcome of extracting with supercritical fluid as reported by Botha (2004) was that the unsaponifiable fraction of the oil was found to be higher for the first fractional extraction (20 minute intervals) and tend to decrease with subsequent extractions.

Thus the unsaponifiable fraction of the oil can be enriched by extracting at time intervals. The use of supercritical fluid is proven to be a cost-effective technique for laboratory scale while large scale units still require experimentation for accurate economic valuations. This method has advantages such as low operating temperatures, shorter extraction periods, high selectivity in the extraction of compounds and no undesirable solvent residue (Xiao *et al.*, 2006). It also uses a safe, readily available gas.

#### 6. Extraction Solvent

This is one of the traditional methods commonly used. Various solvents could be used and organic solvents have mostly been utilized. Botha (2004) reported experimental solvent extractions using n-hexane and a Soxhlet extractor on a 10g dried sample for 6 hours. Subsequent removal of the solvent followed by vacuum evaporation and drying until constant mass. The resultant oil has a high chlorophyll content meaning the chlorophyll is co extracted along with the oil. Chlorophyll levels as high as 192.9 ppm was reported by Werman&Neeman (1986) to have been extracted in the laboratory by ethanol extraction reported this method to have the highest yield but industrial equipment is very expensive to install plus the highly flammable solvents used are very dangerous.

N-hexane is faster than that of ethanol hence giving 1 and 2 hours for n-hexane's high and low parameter and 4 and 8 hours for ethanol. The oil extracted using n-hexane showed to be better at an extraction time of 2 hours. This may be due to the rapid solubility of the oil present on the facade of the powdered sample and higher mass transfer driving force since the concentration of the oil present in the fresh solvent is minimal. In contrast, due to ethanol's properties, it renders the solvent to longer extraction time but allows it to extract higher oil yield compared to Hexane. Also it was shown on the study made by Saxena, et al., (2011) that longer extraction times decrease the amount of oil yield for hexane and leaves the sample with wastes while for Ethanol

longer extraction times allows it to extract higher oil yield. The conventional technology used for oil extraction from oilseeds is by solvent extraction. In solvent extraction, n-hexane is used as a solvent for its attributes such as simple recovery, non-polar nature, low latent heat of Vaporization (330KJ/Kg) and high selectivity to solvents.

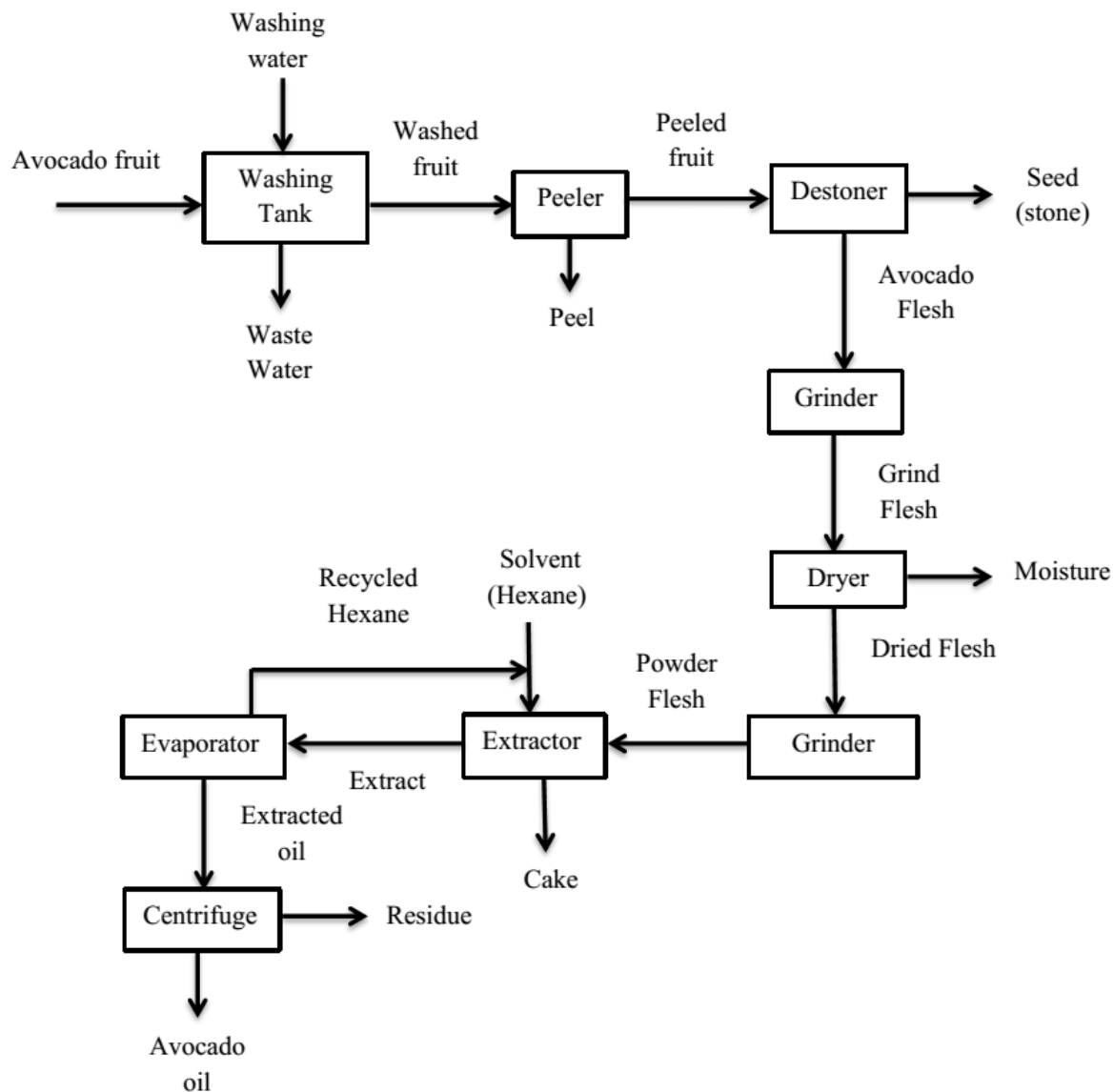


Figure 2.1 Block flow diagram of oil extraction process

## **2.6. Purifying avocado oil**

### **A. Refining of Avocado Oil**

Virgin and crude oil can be further processed when it does not meet the virgin oil quality standards. The crude oil with high chlorophyll content is dark green transparent oil with brown or yellow tints. This highly unstable oil could be refined using the following steps.

### **B. Bleaching**

Bleaching removes color pigments like chlorophyll and lutein using acidified activated earth at an elevated temperature. This is followed by filtration and a spectrophotometer may be used to monitor the bleaching process by measuring the optical density of the oil. Losses as high as 5% may be encountered here.

### **C. Deodorizing**

Deodorizing is required to remove objectionable flavors/odors which may develop during bleaching by using steam distillation. This is done under vacuum at elevated temperatures. Again losses as high as 7% may be incurred here.

### **D. Winterizing**

The presence of high melting components in the oil makes it cloudy at low temperatures. These components tend to crystallize at low temperatures and must be removed. Winterizing aid like oxystearin is used to help the formation of larger crystals which could then be removed via decanting and filtration.

### **E. Alkali Refining**

The refining process involves the use of a strong alkali (e.g. NaOH) to remove free fatty acids and peroxides. Both compounds tend to reduce the shelf life of the oil and also give it a rancid smell. This tedious process may result in losses as high as 7% - 8% (Human, 1987; Eyreset *al.*, 2006). Nicolisi&Orthoefer (2004) reported that a patent (6, 197, 357) was awarded for the replacement of NaOH with Na<sub>2</sub>CO<sub>3</sub> or NaHCO<sub>3</sub> which resulted in a refining process that retained more than 85% of the phenolic compounds. These healthy compounds are usually lost with the unsaponifiable fraction of the oil during the refining process when NaOH is used.

Another method for refining is by heating the oil under vacuum at elevated temperatures, and sparged with live steam causing the free fatty acids to be distilled off refined oil is pale yellow, bland, and highly stable. It is highly suitable for general purpose cooking because of its high smoke point and has a healthy fatty acid composition. It is most suited for barbeques as most common vegetable oil polymerize and oxidize readily on hot surfaces.

### **2.7. Effect of Processing on the Quality of Oil**

The phenol compounds which are well publicized for their health benefits are lost or destroyed by most processing methods. Extra virgin oil loses its highly beneficial micronutrients during the refining process and the cholesterol lowering and anti-oxidant properties are significantly reduced as a result (Nicolisi&Orthofer, 2004).

The color or chlorophyll content of the oil is noticeably lower than that of virgin oil due to the removal of these plant compounds (Eyreset *al.*, 2006). Xiao *et al.* (2006) noted that the usual methods of hydro-distillation and organic solvent extractions present problems like toxic solvent residues, degradation of the unsaturated compounds and vitamins, and giving objectionable off-flavors due to heat. The change from NaOH to Na<sub>2</sub>CO<sub>3</sub> or NaHCO<sub>3</sub> when refining is reported to achieve the same results when refining with the extra benefit of retaining the phenolic compounds. Thus a more stable and healthy oil can still be achieved after refining if Na<sub>2</sub>CO<sub>3</sub> or NaHCO<sub>3</sub> is used. The cold pressing and supercritical fluid methods appear to be the most suitable and beneficial methods to extract the avocado oil. Both utilize low temperature which help retain the healthful composition of the oil, involves minimal processing and requires less capital investment. (Nicolisi&Orthofer, 2004).

### **2.8 Shampoo**

Shampoo is defined as a preparation of a surfactant (surface active material) in suitable form liquid, solid or power which when used under the conditions specified will remove surface grease, dirt and skin debris from the hair shaft and scalp without affecting adversely the hair, scalp or health of the user. Shampoos are of various types and forms on the basis of physical appearances, constituents and properties (Martin M. Rieger, 1985).

### **2.8.1 Raw Materials**

New shampoos are initially created by cosmetic chemists in the laboratory. These scientists begin by determining what characteristics the shampoo formula will have. They must decide on Aesthetic features such as how thick it should be, what color it will be, and what it will smell like. They also consider performance attributes, such as how well it cleans, what the foam looks like, and how irritating it will be. Consumer testing often helps determine what these characteristics should be. Once the features of the shampoo are identified, a formula is created in the laboratory.

These initial batches are made in small beakers using various ingredients. In the personal care industry, nearly all of the ingredients that can be used are classified by the Cosmetic, Toiletry, and Fragrance Association (CTFA) in the governmentally approved collection known as the International Nomenclature of Cosmetic Ingredients (INCI). The more important ingredients in shampoo formulations are water, detergents, foam boosters, thickeners, conditioning agents, preservatives, modifiers, and special additives.

1. Water: - The primary ingredient in all shampoos is water, typically making up about 70-80% of the entire formula. Deionized water, which is specially treated to remove various particles and ions, is used in shampoos. It helps dilute the detergents, makes the formula easier to spread and reduces irritation. It also keeps the formula inexpensive. (Natural Cosmetic Formulating Element by, Perry Romanowski, 2015).

2. Detergents: - The next most abundant ingredients in shampoos are the primary detergents. These materials, also known as surfactants, are the cleansing ingredients in shampoos. Surfactants are surface active ingredients, meaning they can interact with a surface. The chemical nature of a surfactant allows it to surround and trap oily materials from surfaces. One portion of the molecule is oil compatible (soluble) while the other is water soluble. When a shampoo is applied to hair or textiles, the oil soluble portion aligns with the oily materials while the water soluble portion aligns in the water layer. When a number of surfactant molecules line up like this, they form a structure known as a micelle. This micelle has oil trapped in the middle and can be washed away with water, thus giving the shampoo its cleansing power.

3. Surfactants: - are derived from compounds known as fatty acids. Fatty acids are naturally occurring materials which are found in various plant and animal sources. The materials used most often to make the surfactants used in shampoos are extracted from coconut oil, palm kernel oil, and soy bean oil. Some common primary detergents used in shampoos are ammonium lauryl sulfate, sodium lauryl sulfate, and sodium lauryl ether sulfate. (Natural Cosmetic Formulating Element by, Perry Romanowski, 2015).

4. Foam boosters: - In addition to cleansing surfactants, other types of surfactants are added to shampoos to improve the foaming characteristics of the formulation. These materials, called alkanolamides, help increase the amount of foam and the size of the bubbles. Like primary detergents, they are also derived from fatty acids and have both water soluble and oil soluble characteristics. Typical materials include lauramide DEA or cocamide DEA.( Natural Cosmetic Formulating Element by, Perry Romanowski,2015)

5. Thickeners: - To some extent, the alkanolamides that make shampoos foam also make the formulations thicker. However, other materials are also used to increase the viscosity. For example, methylcellulose, derived from plant cellulose, is included in shampoos to make them thicker. Sodium chloride (salt) also can be used to increase shampoo thickness. (Natural Cosmetic Formulating Element by, Perry Romanowski,2015)

6. Conditioning agents: - Some materials are also added to shampoos to offset the sometimes harsh effect of surfactants on hair and fabrics. Typical conditioning agents include polymers, silicones, and quaternary agents. Each of these compounds deposit on the surface of the hair and improve its feel, softness, and comb ability, while reducing static charge. Shampoos that specifically feature conditioning as a benefit are called 2-in-1 shampoos because they clean and condition hair in the same step. Examples of conditioning agents include guar hydroxyl propyltrimonium chloride which is a polymer, avocado oil also serve as conditioning agent. (Natural Cosmetic Formulating Elements by, Perry Romanowski)

7. Preservatives: - Since shampoos are made from water and organic compounds, contamination from bacteria and other microbes is possible. Preservatives are added to prevent such growth. Two of the most common preservatives used in shampoos are Formaldehyde and methyl.( Natural Cosmetic Formulating Elements by, Perry Romanowski, 2015)

8. Modifiers: - Other ingredients are added to shampoo formulas to modify specific characteristics. Opacifiers are added to make the formula opaque and give it a pearly look. Materials known as sequestering agents are added to offset the dulling effects of hard water. Acids or bases such as citric acid added to adjust the pH of a shampoo so the detergents will provide optimal cleaning. (Natural Cosmetic Formulating Element by, Perry Romanowski, 2015)

Special additives: - One of the primary factors that influence the purchase of a shampoo is its color and odor. To modify these characteristics, manufacturers add fragrance oils and governmentally approved and certified FDC & dyes. Other special additives can also have a similar effect. Natural materials such as botanical extracts, natural oils, proteins, and vitamins all impart special qualities and help sell shampoos. Additives such as zinc pyrithione are included to address the problem of dandruff. Other additives are dyes which can color the hair. (Natural Cosmetic Formulating Element by, Perry Romanowski, 2015).

### **2.8.2 Production of shampoo**

Active Ingredients (AIs) and other raw materials are dispensed for processing. Initially, active ingredients and other raw materials have taken into a vessel known as 'Mixing Vessel'. In this vessel the raw materials was mixed with hot water. For preparing liquid shampoo, sodium hydroxide, and stearic acid are heated to about 65°C Water & preservatives are also heated to 65°C. The water used for this process should be De-mineralized and free from any kind of impurities.

Avocado oil is mixed with the solution; the mixing process is carried out at a specific temperature (about 75 to 80°C). Subsequent, after that the solution should cool to at room temperature. The solution is taken to another vessel (known as 'Side Vessel') and other ingredients like Fragrances, Pigments, etc. are added. The mixture is agitated for about 20-30 minutes to form a homogenous solution. Eventually Citric Acid or Sodium Hydroxide is used to adjust pH between 6-8. Finally, the solution is will back to room- temperature and is ready for packing. (Sharma, 1998).

### **2.8.3 Types of shampoos**

#### 1. Basic shampoos

A. Normal Hair shampoos:- They achieve good cleansing with minimum conditioning.

B. Oily hair shampoos: - They give excellent cleansing and very minimal conditioning.

C. Dry hair shampoos: - They cause mild cleansing and good conditioning. They reduce static electricity and make the hair more manageable.

D. Damaged hair shampoos: - Meant for hair which have been chemically treated with hair color, bleaching agents or hair straightening agents. They have mild detergents and more conditioner in order to temporarily repair the hair surface defects.

2. Baby shampoos: - These are formulated with amphoteric surfactants which cause little or no irritation. They are mild and can also be used by adults who wish to wash their hair every day.

#### 3. Medicated shampoos

Anti- Dandruff shampoos: - In addition to the regular ingredients, also contains additives such as anti-fungal, anti-bacterial, selenium sulphide and tar derivatives. They remove sebum, oil, scalp scales and the anti- fungal acts on fungus pityrosporum ovale which is usually the cause of dandruff.

4. Conditioning shampoos: - They are a combination of shampoos and conditioner. These products may be self-defeating since the shampoos removes sebum, the body's natural conditioner and replace it with an artificial conditioner.

### **2.8.4 Requirements of a Shampoo**

The ingredients that should be avoided in good hair care products can cause dry or oily looking hair. A good shampoo and conditioner will balance the scalp's environment while cleansing the hair, leaving the hair to appear clean and healthy instead of dry and oily. Shampoo should clean away the oil and dirt, rinses out easily, and leaves your hair shiny, manageable and flexible. The following are some requirements of shampoo.

- It should effectively and completely remove dust or soil, excessive sebum or other fatty substances and loose corneal cells from hair.
- It should produce good amount of foam to satisfy the psychological requirement of the user.
- It should be easily removed on rinsing with water.
- It should have the hair non-dry; soft, lustrous with good manageability and minimum fly away.
- It should not cause any side effect or irritation to skin or eye.
- It should not make the hand rough and chapped.

## **CHAPTER THREE**

### **3. MATERIALS AND METHODS**

The experimental work has been done in the laboratory of Department of Chemical Engineering, Wolkite University.

#### **3.1. Equipment's used in laboratory**

- Plastic bag- was used to collect the avocado fruit.
- Knife -was used to pile and cut the avocado fruit.
- Drying oven-was used to remove the moisture of the cut avocado fruit.
- Miller - was used to crush the dried avocado flash.
- Sieve- was used to separate the Avocado flash powder in to different size.
- Digital balance- was used to measure the sample and chemicals.
- Filter paper- was used to put sample during extraction Process.
- Round bottom flask- was used to put hexane during Soxhlet extraction and crude oil has been collected at the round bottom flask and also used during simple distillation to put the crude oil.
- Soxhlet extractor- was used to extract the oil and separate the cake from the oil.
- Heat mantel- was used to heat during Soxhlet extraction and simple distillation.
- Beaker- was used to put the avocado oil.
- Measuring cylinder- was used to measure the volume of liquid chemicals and distil water.
- PH meter- was used to measure the PH of avocado oil and shampoo.
- Droplet- was used to add the perfume in to the shampoo.

### 3.2. Raw materials and chemicals used in laboratory

- Ethanol
- Toluene
- Phenolphthalein indicator
- Deionized Water
- Surfactants (Sodium hydroxide)
- Conditioners (Avocado oil)
- Hexane
- Viscosity modifier (sodium chloride)
- Citric acid
- Preservative (Formaldehyde or methyl)
- Fragrance (perfume)

### 3.3 Methods

#### 3.3.1 Determination of moisture content of the flesh of avocado

Three cleaned and sliced samples were weighed and dried in an oven at 105°C for 12hr. using petry and then the weight was measured. The percentage moisture in the avocado flash was calculated using the following:

$$\%mx(wb) = \left[ \frac{(m_2 - m_1) - (m_3 - m_1)}{(m_2 - m_1)} \right]$$

Where:

$m_1$  = the empty container weight

$m_2$  = Empty container + sample weight before drying

$m_3$  = Empty container + sample sample weight drying

### **3.4. Laboratory Procedures for oil extraction from avocado Fruit**

4kg Avocado was obtained from the city market in Wolkite, Gubre. Initially washed and then parts to be removed like peel stone (seed) and other unwanted materials were removed by hand and finally weighted with electronic balance.



Figure 3.1 Avocado fruit

Then the flesh was grinded with knife and dried using sunlight and oven at low temperature. Then the dried avocado is grinded with break miller.



Figure 3.2 Dried avocado and grinder

The powder avocado was then inserted to plastic bag here the required measurements were taken before going to the next step.



Figure 3.4 Powder avocado flesh was inserted to the plastic bag

Then after the powder avocado was measured and inserted into the Soxhlet apparatus. Here the heating mantel was adjusted at the boiling point of the solvent and the distillation column was attached to the water tank at the top and to the Soxhlet apparatus at the bottom. The round bottom flask that contains the solvent is also attached to the bottom of the Soxhlet apparatus.



Figure 3.5 Soxhlet apparatus

After inserted into soxhlet apparatus the extraction time for 4hrs and 6 hours and particle size for 0.5mm and 1mm was recorded the produced oil. The solvent was recovered and the extracted oil was gained.

Table 3.1 Particle size and time factor in extraction of oil

Experiment run	Particle size (mm)	Time (hrs.)
1	0.5	4
2	0.5	6
3	1	4
4	1	6



Figure 3.6 Evaporator

Then the extracted oil and the recovered solvent were measured for further analysis. Then the oil was separated from residue by using centrifuge and measurement was taken after decanting.



Figure 3.7 Centrifuge

### 3.5 Avocado oil analysis

#### A. Determination of the yield

160 g ( $W_1$ ) of the sample was placed in the thimble and about 720ml of n-hexane was poured into the round bottom flask. The apparatus was heated at  $69^\circ\text{C}$  and allowed for 4hrs and 6hrs for extraction process. At the end, the cake was weighed and dried in the oven at  $105^\circ\text{C}$  until the constant weight ( $W_2$ ) is attained and the percentage of oil extracted was determined as:

$$\% \text{Yield} = \frac{W_1 - W_2}{W_2} * 100$$

$W_1$  = weight of sample before extraction

$W_2$  = weight of sample after extraction (Saxena, et al., 2011)

#### B. Determination of Specific Gravity

The density of the oil was determined by using the following given formula. The expression for specific gravity (Sp.gr) is:

$$\text{Specific gravity} = \frac{\text{Density of oil}}{\text{Density of water}}$$

#### C. Determination of pH Value

2g of the sample was poured into a clean dry 25ml beaker and 13ml of hot distilled water was added to the sample in the beaker and stirred slowly. It was then cooled. The pH electrode was standardized with buffer solution and the electrode immersed into the sample and the pH value was read and recorded.

#### D. Determination of Acid Value

25ml of Toluene and 25ml of ethanol was mixed in a 250ml beaker. The resulting mixture was added to 2g of oil in a 250ml conical flask and few drops of phenolphthalein were added to the mixture. The mixture was titrated with 0.1M NaOH to the end point with consistent shaking for which a dark pink color was observed and the volume of 0.1M NaOH ( $V_0$ ) was noted.

The Acid value was calculated as: (Kardash tetal, 2005)

$$\text{Acid value} = \frac{[V \cdot C \cdot 40]}{M}$$

### **3.6 Laboratory procedure to formulate Liquid Shampoo**

110 ml pure water was prepared in beaker. Then after 0.1 molar of 60ml solution sodium hydroxide was added to a 20ml of extracted avocado oil. The prepared avocado oil and sodium hydroxide together are kept in de-mineralized water and heated at 65°C for 20 minutes, then immediately mix using stirrer in order to form a uniform solution. Then after the solution was cooled down at room temperature. After cooling it at a room temperature, 3gm of fine sodium chloride was added to the prepared solution, and stir using stirrer this makes the formulations thicker and enhance the viscosity increases. Finally 1ml and 1.4ml formaldehyde and perfume were added in to the prepared solution, and stirred continuously for 30 minutes in order to get uniform product of shampoo. The PH of the mixture was adjusted by using 3ml of citric acid (Ernest W. Flick, 1992).

Using this purified avocado oil in shampoo formulation as ingredient, three trials were run to make appropriate formulation of shampoo using these three formulations (**F1**), **F2** and **F3**. Their chemical compositions were:

**Formulation (F1)** = 110ml of water, 50ml of NaOH, 20ml of avocado oil, 3gm of NaCl, 1ml of perfume and 0.6ml of formaldehyde.

**Formulation (F2)** = 110ml of water, 55ml of NaOH, 20ml of avocado oil, 3gm of NaCl, 1ml of perfume and 0.4ml of formaldehyde.

**Formulation (F3)** = 110ml of water, 60ml of NaOH, 20ml of avocado oil, 3gm of NaCl, 1.4ml of perfume and 1ml of formaldehyde. The pH might be different since there is a difference in composition for the three trials. Using these trials we measured the pH of each formulation by varying the concentration of sodium hydroxide.

### **3.7 Evaluation of liquid Shampoos**

To evaluate the prepared formulations, quality control tests including visual assessment and physicochemical controls such as pH, density and viscosity were performed. Also, to assure the quality of products, specific tests for shampoo formulations including the determination of dry residue and moisture content, total surfactant activity, salt content, surface tension, thermal and mechanical stability and detergency tests are carried out. The results were compared with marketed formulations.

#### **1. Physical appearance/visual inspection**

The formulations prepared were evaluated in terms of their clarity, foam producing ability and fluidity.

#### **2. Determination of pH**

The pH of 10% shampoo solution in distilled water is determined at room temperature 25°C. The pH is measured by using a digital pH Meter.

### **3. Dirt dispersion**

Two drops of shampoo is added in a large test tube contain 10 ml of distilled water. 1 drop of India ink is added; the test tube is stoppered and shakes it ten times. The amount of ink in the foam is estimated as None, Light, Moderate, or Heavy.

### **4. Cleaning action**

5 grams soiled human hair is placed at 35°C in 200ml of water containing 10 ml of shampoo in a flask. The flask is shaken for 4 minutes at the rate of 50 times a minute. Then washed once again with sufficient amount of water, then after filter the hair dried and weighed. The amount of soil removed is calculated using the following formula.

$$DP = 100(1-T/C)$$

Which, DP is the percentage of detergency power;

C is the weight of hair before washing in the control sample,

T is the weight of hair after washed in the test sample,

### **5. Surface tension measurement**

Measurements are carried out with a 1ml of shampoo dilution in distilled water at room temperature. Thoroughly clean the stalagmometer using chronic acid and purified water, because surface tension is highly affected with grease or other lubricants. The data calculated by following equation given bellow:

$$R2 = \frac{(W3-W1) N1}{(W2-W1) N2} \times R1$$

Where:-

W1 is weight of empty beaker.

W2 is weight of beaker with distilled water.

W3 is Weight of beaker with shampoo solution.

N1 is no. of drops of distilled water.

N2 is no. of drops of shampoo solution.

R1 is surface tension of distilled water at room ( $71.9 \text{ dynes/cm}^2$ ) temperature.

R2 is surface tension of shampoo solution.

## CHAPTER FOUR

### 4. RESULT AND DISCUSSION

#### 4.1. Laboratory Result for avocado oil extraction

During extraction of avocado oil from its avocado flesh, there were a lot of different types of trial have been conducted and the following result recorded.

##### 1. Moisture content

Table 4.1 Moisture content measurement trial data.

Trial	$m_1$	$m_2$	$m_3$
1	9.13	665	103
2	10.3	615.3	150
3	13.2	572	125

$$\%mx(wb) = \frac{[(m_2 - m_1) - (m_3 - m_1)]}{(m_2 - m_1)} * 100$$

Trial 1

$$\%mx(wb) = \frac{[(665 - 9.13) - (103 - 9.13)]}{(665 - 9.13)} * 100 = 85.7\%$$

Trial 2

$$\%mx(wb) = \frac{[(615.3 - 10.3) - (150 - 10.3)]}{(615.3 - 10.3)} * 100 = 73.5\%$$

Trial 3

$$\%mx(wb) = \left[ \frac{(572 - 13.2) - (125 - 13.2)}{(572 - 13.2)} \right] * 100 = 75.3\%$$

$$mxi = \left[ \frac{mx1+mx2+mx3}{3} \right] \% = mxi = \left[ \frac{85.7+73.5+75.3}{3} \right] \% = 78.2\%$$

Table 4.2: The effects of time and particle size on the yield of extracted oil

Experim ent no	Particle size (mm)	Time(hr.)	Extracted oil (ml)
1	1	4	14.75
2	1	6	15.73
3	0.5	4	18.75
4	0.5	6	20.68

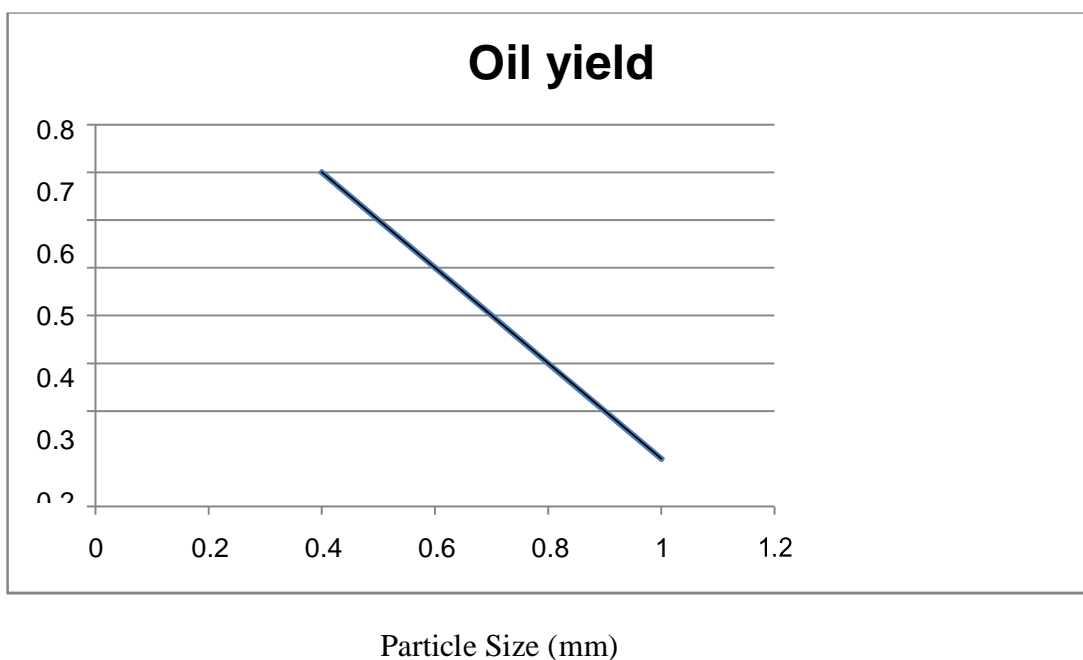


Figure 4.1 Particle sizes vs. yield of oil

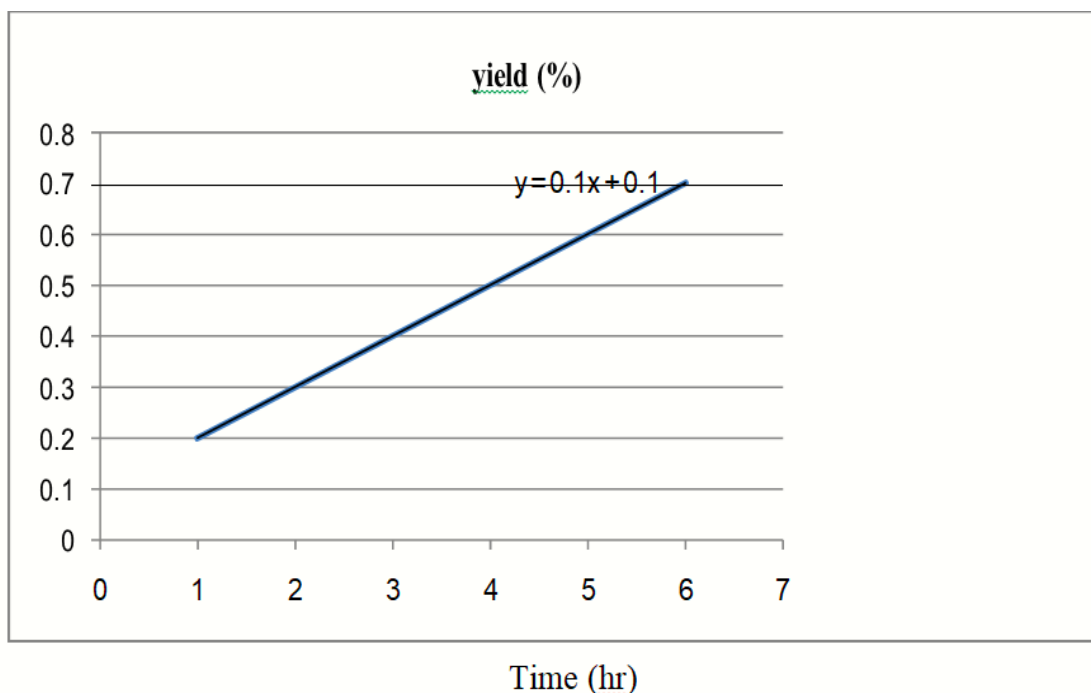


Figure: 4.2 Time vs oil yield

The sample that has extracted for 6hrs has the higher amount of oil as compared to the sample that has extracted for 4 hrs. As the extraction time increases, the yield of oil also increases. And also the sample that has 0.5mm in size extracts higher amount of oil as compared to the sample that has 1mm particle size. The reason behind this is the surface area contact of solvent has increased in case of 0.5mm and whereas in case of 1mm contact surface are between powder avocado and solvent is minimum. The maximum amount of oil percentage obtained by increasing the extraction time and by reducing the particle size of the sample because; the surface contact area of solvent with powder avocado was increased.

## 2. Percent yield

$$\%yield = \frac{w_1 - w_2}{w_1} * 100$$

Percent yield for the oil extracted using hexane

$W_1$  = weight of sample before extraction = 40g

$W_2$  = weight of sample after extraction (residue) = 19.325g

$$\%yield = \frac{40-19.325}{40} * 100 = 51.7\%$$

Note:-Amount of oil extracted from 40g in ml was found 51.70%\*40g= 20.68ml

For one batch extraction 40g dried and grinded avocado oil was used. Since we have run 4 trials the total avocado used and oil extracted was 160g and 69.91ml respectively.

### 3. Specific gravity

$$\text{specific gravity} = \frac{[w_1 - w_0]}{[w_2 - w_0]}$$

$$W_1 = M_{oil} + M_b$$

$$W_0 = M_b$$

$$W_2 = M_{water} + M_b$$

$$\begin{aligned} \text{specific gravity} &= \frac{[112.91 - 94.23]}{[114.70 - 94.23]} \\ &= 0.2196 \end{aligned}$$

### 4. PH value

Using the PH meter the PH of the oil was determined as 6.8 which indicate the neutrality of the oil.

### 5. Acid value

$$\text{Acid value} = \left[ \frac{V * C * 40}{M} \right] * 100$$

V= volume of added NaOH for titration= 107ml=0.107liter

C= concentration of NaOH=0.1 mol/liter

M=mass of sample= 2g

Molecular weight of NaOH=40g/mole

$$AV = \text{Acid value} = \left[ \frac{0.107 * 0.1 * 40}{2} \right] * 100 = 0.214\%$$

6. Free fatty acid value

$$\text{Free fatty acid value (FFAV)} = \left[ \frac{AV}{2} \right]$$

$$= 0.214\% / 2$$

$$= 0.107\%$$

#### 4.2. Oil produced using n-hexane as solvent

As shown in the figure the oil is transparent. It has good quality which makes it unique among other types of oils.



Figure 4.2 Oil produced using n-hexane as solvent

#### 4.3. Laboratory results for formulation of shampoo

After avocado oil has extracted, the oil was treated with activated carbon. Because, avocado oil in its nature it has chlorophyll, the oil was mixed with washed activated carbon and kept in oven at 80<sup>0</sup>c for 30 minutes. Then the mixture has filtered out using white cleaned thin close, and eventually pure avocado oil was obtained.

Using this purified avocado oil in shampoo formulation as ingredient, three trials where run to made appropriate formulation of shampoo using this three formulation (F1), (F2) and (F3). Their chemical compositions were:

Formulation (F1) = 110ml of water , 50ml of NaOH, 20ml of avocado oil, 3gm of NaCl, 1ml of perfume, and 0.6ml of formaldehyde.

Formulation (F2) = 110ml of water , 55ml of NaOH, 20ml of avocado oil, 3gm of NaCl, 1ml of perfume, and 0.4ml of formaldehyde.

Formulation (F3) = 110ml of water, 60ml of NaOH, 20ml of avocado oil, 3gm of NaCl, 1.4ml of perfume, and 1ml of formaldehyde. Since there is difference in composition for the three trials, lab result and comparison showed the following result in summarized table 4.3.

#### 1. Physical appearance/visual inspection

Physical appearance was evaluated just using our common sense using our eyes. The results of visual inspection of series of formulations are listed in Table 4.3 as can be seen; all formulations had the good characteristics with respect to foaming. The pH of shampoos has been shown to be important for improving and enhancing the qualities of hair, minimizing irritation to the eyes and stabilizing the ecological balance of the scalp. The current trend to promote shampoos of lower pH is one of the ways to minimize damage to the hair. Mild acidity prevents swelling and promotes tightening of the scales, there by inducing shine. As seen from Table 1, all the shampoos were acid and base balanced and were ranged 6.7 to 9.5, but bit by bit it has reduced and eventually reached which is near to the skin pH 7.3 which was good ph value for shampoo.

Table 4.3: Evaluation of Formulation for physical appearance, pH

<b>N<sub>O</sub></b>	<b>Formulation</b>	<b>Physical Appearance</b>	<b>pH</b>
1	F1	Deep yellow, which has good foaming	7.3
2	F2	Yellowish, which has good foaming	7.20
3	F3	Yellowish, which has good foaming	6.87

From above table 4.3 the PH value of shampoo is 6.87. This value indicates that the experiment value in the standard range (6.87-7.3).

## 2. Detergency ability

Although cleaning or soil/sebum removal is the primary aim of a shampoo, experimental detergency evaluation has been difficult to standardize, as there is no real agreement on a standard soil, a reproducible soiling process or the amount of soil a shampoo should ideally remove. As seen from the results, there is a significant difference in the amount of sebum removed by the different shampoos. Shampoos F3 being a frequent-use cleaner, was expected to have the maximum detergency. Shampoos F1, F2 and F3 also showed moderate detergency. The results are presented in Table 4.4

Table 4.4: Evaluation of Formulation for cleaning and Detergency

N <sub>O</sub>	Formulation	Cleaning %	Detergency %
1	F1	15.5	58.5
2	F2	20.51	60.8
3	F3	27.81	61.5

## 3. Foam ability and stability

Although foam generation has little to do with the cleansing ability of shampoos, it is of paramount importance to the consumer and is therefore an important criterion in evaluating shampoos. All the three shampoos showed similar foaming characteristics in distilled water. The foam retention ability of three samples is given, All three shampoos showed comparable foaming properties. The foam stability of liquid shampoos is listed in table 4.5 a point to be noted here is that there does not seem to be any direct correlation between detergency and foaming, which only confirms the fact that a shampoo that foams well need not clean well. The final formulation produced stable foams there was little bet change in foam volume.

Table 4.5: Foam ability of liquid shampoo

Time (minutes)	Foam volume (ml)		
	F1	F2	F3
1	150	100	160
2	153	106	161
3	155	110	165

When the concentration of surfactant decreases the value of foam formation decrease due to this the produced shampoo is preferable (i.e., the ability of cleaning is high). And also, when the concentration of surfactant (SLS) is high it produces high foam, however extra high foaming of shampoo wouldn't rinse by water easily and also it causes toxicity to the users because it has high value of sodium lauryl sulfate. But the value of surfactant is medium it has good cleaning without any side effect. This result shows that the foam stability is high and formation of foam is higher.

#### 4.4. Physiochemical properties of produced liquid shampoo

Table: - 4.6 Physiochemical properties of produced liquid shampoo

N <sub>o</sub>	Physiochemical evaluations	Result
1	Ph	6.87
2	Wash ability	Easily washable
3	Foaming capacity	Good foaming
4	Dirt dispersion	Moderate
5	Color	Yellowish
6	Texture	Fine and smooth
7	Nature of hair after washes	Soft manageable

## CHAPTER FIVE

### 5. MATERIAL BALANCE

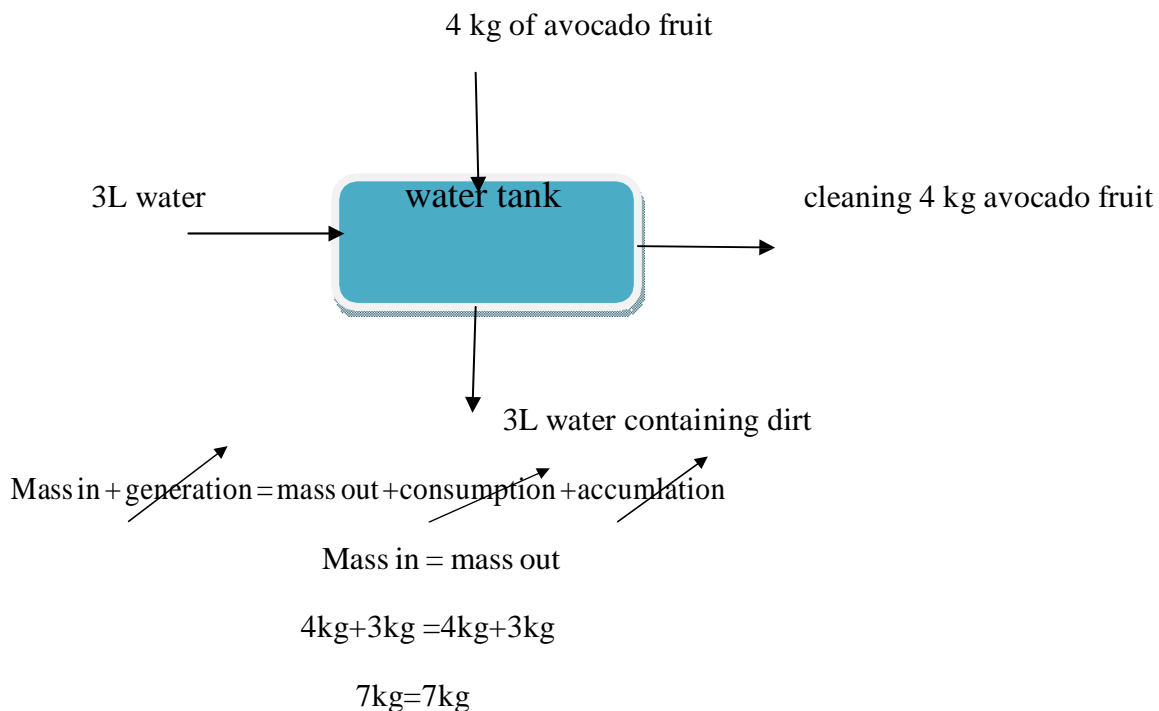
#### 5.1. Material Balance

Material quantities, as they pass through processing operations, can be de If there is no accumulation, what goes into a process must come out. This is true for batch operation. It is equally true for continuous operation over any chosen time interval. Material and energy balances are very important in an industry. Material balances are fundamental to the control of processing, particularly in the control of yields of the products.

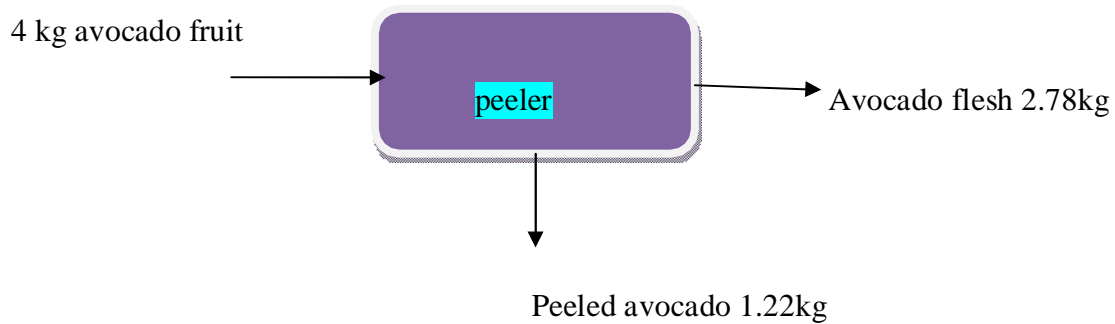
#### 5.1 Material Balance for oil laboratory experiment

##### 5.1.1 Material balance for oil extraction

###### ➤ Material balance on washing tank



➤ **Material Balance on Peeler**



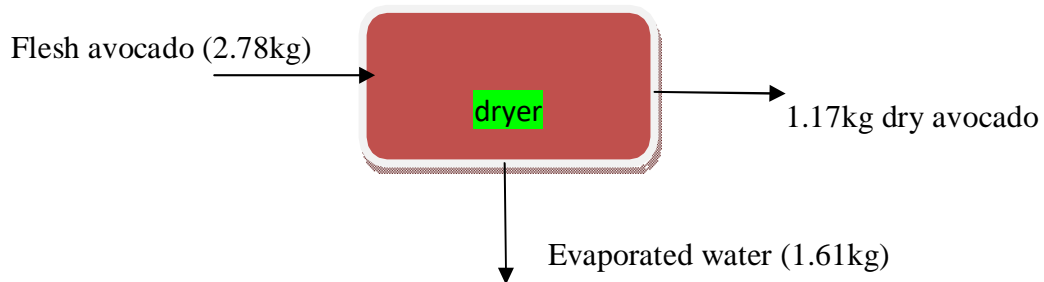
$$\text{Mass in} + \text{generation} = \text{mass out} + \text{consumption} + \text{accumulation}$$

~~Mass in = mass out~~

Mass of Avocado fruit = Mass of avocado fruit flesh + Mass of peel Avocado

$$4\text{kg} = 1.22\text{kg} + 2.78\text{kg}$$

➤ **Material Balance on dryer**



$$\text{Mass in} + \text{generation} = \text{mass out} + \text{consumption} + \text{accumulation}$$

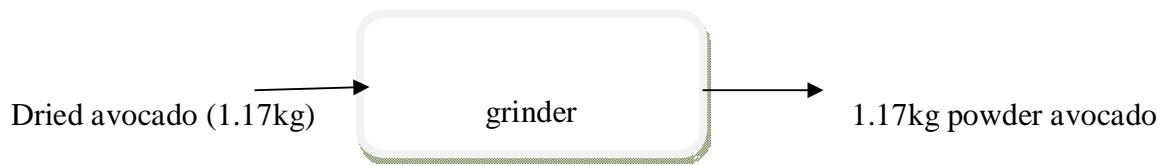
~~Mass in = mass out~~

Mass of Avocado fruit flesh = Mass of dry avocado + Mass of evaporated water

$$2.78\text{kg} = 1.17\text{kg} + 1.61\text{kg}$$

$$2.78\text{kg} = 2.78\text{kg}$$

➤ **Material Balance on Grinder**



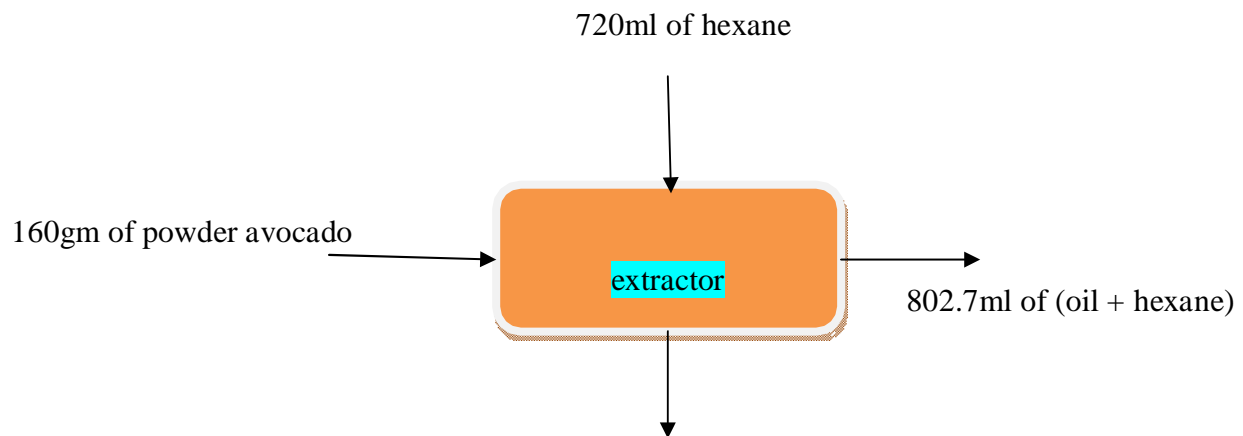
$$\text{Mass in} + \text{generation} = \text{mass out} + \text{consumption} + \text{accumulation}$$

$$\text{Mass in} = \text{mass out}$$

Mass of dried Avocado = Mass of powdered avocado

$$1.17\text{kg} = 1.17\text{kg}$$

➤ **Material Balance on Soxhlat extraction**



$$\text{Mass in} + \text{generation} = \text{mass out} + \text{consumption} + \text{accumulation}$$

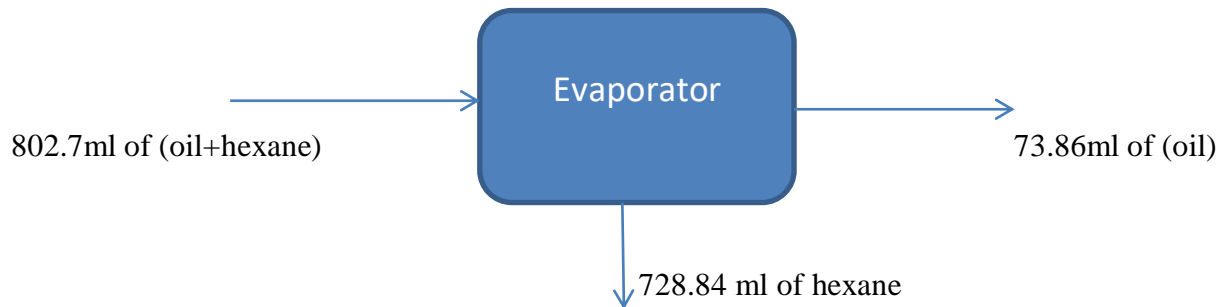
$$\text{Mass in} = \text{mass out}$$

Mass of sample powder Avocado + mass of Hexane = Mass of (oil +Hexane) + mass of residue

$$160\text{gm} + 720\text{gm} = 802.7\text{gm} + 77.3\text{gm}$$

$$880\text{gm} = 880\text{gm}$$

➤ **Material Balance on Evaporator**



$$\cancel{\text{Mass in}} + \cancel{\text{generation}} = \cancel{\text{mass out}} + \cancel{\text{consumption}} + \cancel{\text{accumulation}}$$

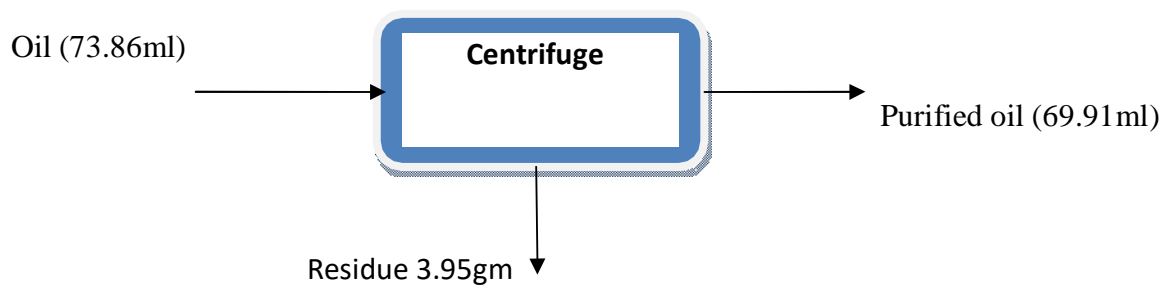
$$\text{Mass in} = \text{mass out}$$

$$\text{Mass of (Oil + Hexane)} = \text{Mass of Hexane} + \text{Mass of Oil} + \text{mass of loss Hexane}$$

$$802.7\text{ml} = 728.84\text{ml} + 73.86\text{ml}$$

$$802.7\text{ml} = 802.7\text{ml}$$

➤ **Material Balance on Centrifuge**



$$\text{Mass in} + \text{generation} = \text{mass out} + \text{consumption} + \text{accumulation}$$

$$\text{Mass in} = \text{mass out}$$

$$\text{Mass of Oil} = \text{Mass of purified oil} + \text{Residue}$$

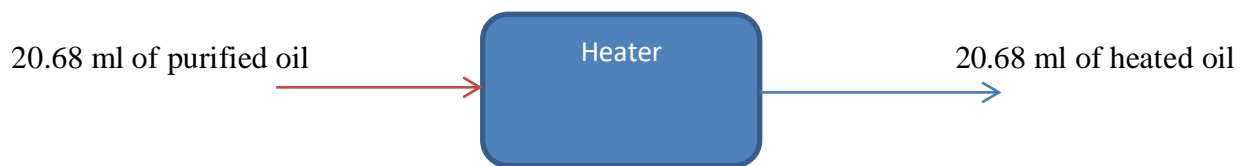
$$73.86\text{gm} = 69.91\text{gm} + 3.95\text{gm}$$

$$73.86\text{gm} = 73.86\text{gm}$$

## 5.2. Material Balance for shampoo production in laboratory experiment

### 5.2.1. Material Balance for shampoo in laboratory

➤ **Material balance on heater**



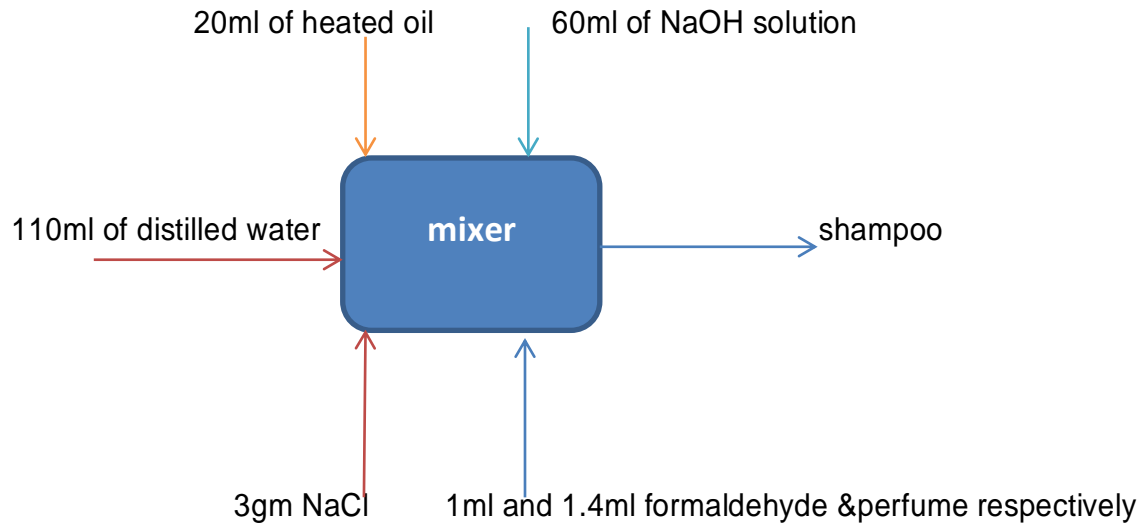
$$\text{Mass in} + \text{generation} = \text{mass out} + \text{consumption} + \text{accumulation}$$

$$\text{Mass in} = \text{Mass out}$$

$$\text{Mass of pure oil} = \text{Mass of heated oil}$$

$$20.68 = 20.68$$

➤ **Material balance on mixer**



$$\cancel{\text{Mass in}} + \cancel{\text{generation}} = \cancel{\text{mass out}} + \cancel{\text{consumption}} + \cancel{\text{accumulation}}$$

$$\text{Mass in} = \text{mass out}$$

110gm distilled water + 20gm of heated oil + 60gm of NaOH of solution + 3gm of NaCl + 1gm of Formaldehyde + 1.4gm of perfume = 195.4gm of shampoo or 195.4ml of shampoo.

## CHAPTER SIX

### 6. TECHNO ECONOMIC COST ANALAYSIS

#### 6.1 Equipment cost with specific capacity

Table 6.1 list of equipment cost

No	Name of equipment	No of equipment	Capacity or size	Cost (\$)/equipment	Cost for total equipment
1	Horizontal storage tank	1	100,000L	59500	59500
2	Pump	3	0.0508m(dia)	3900	7800
3	Vertical storage tank	3	100,000L	59500	59500
4	Mixer	1	500kg/h	800	800
5	Grinder	2	2ft	42,652.46s	85,304.93
6	Agitator	1	61.11 rpm	800	800
7	Purifier	1	0.6096m(dia)	24,171.11	24,171.11
8	Washing	1	150kg/hr	3344.48	3344.48
9	Extraction	2	1875L/Day	639,513	1,279,026
10	Evaporator	1	150kg/hr	81,700	81,700
11	Dryer	1	100ft <sup>2</sup>	47600	47,600
12	Centrifuge	1	0.508m(dia)	11,900	11,900

13	Packaging	1	0.1016m	3300	3300
14	Heater	1	150L	60	60
15	Conveyer	1	0.9144m	31100	31100
16	Peeler	1	0.6096m	49300	49,300
17	Destoner	1	0.4064m	27990.68	27,990.68
18	Shampoo packing bottles	580,000pices/year	150ml	0.08	1,773,197.2

Source (<http://www.matche.com/EquipCost/>)

Total= 1,773,197.2\$

## 6.2 Estimation of total product cost

### Fixed Capital Investment (FCI) Estimation Direct cost (DC)

#### ❖ Fixed Capital

Refers to buildings, industrial plants machinery, and tools, motor, vehicles, office equipment's (max .etal, 1973).the cost of machine and equipment is estimated at about FCI (Fixed capital investment).

#### A. Cost of equipment + Installation +Instrumentation +Piping +Electricity (50- 60% of FCI)

- ❖ Purchased equipment cost (PEC) =1,773,197.2\$
- ❖ Installation including painting (8-9% PEC) =141855.776\$
- ❖ Instrumentation and control (6 % PEC) = 106391.832\$
- ❖ Piping (80%PCE) = 141855.776\$
- ❖ Electricity (40% PEC) = 709278.88\$

#### B. Building process including services (10% PEC) = 1773197.2\$

#### C. Service utilities (20-80% PEC) = 354639.44\$

D. Land (4-8% PEC) = 70927.88\$

E. Yard (10-20% PEC) = 177319.72\$

❖ **Direct cost (DC)** = A+B+C+D+E =3652786.142\$

❖ **Indirect Cost**

A. Engineering and supervision (20% of DC) = 730557.2284\$

B. Construction expense and construction fee (18% of DC) =657501.5\$

C. Contingency (10% of FCI)

FCI = Direct cost +Indirect cost

FCI= \$5040844.87+0.1FCI

FCI=\$ 5600938.744

❖ **Working capital investment (WCI)** = 15% of TCI = 0.15 TCI

**Working Capital** is mostly referred to us circulating capital which is nonrenewable goods such as raw materials and fund require paying wages and other claims against the company (Bauman, 1984, Urich, 1986).

❖ **Total capital investment (TCI)** = FCI +

WCI TCI = \$ 5600938.744 + 0.15TCI

TCI =\$ 6589339.69

WCI = 0.15 TCI = 0.15\*\$ 6589339.69= \$988400.95

❖ **Fixed charges**

A. Depreciation (10 % of FCI) = \$560093.8744

B. Local taxes (1-2% of FCI) = \$56009.38744

C. Insurances (0.4-1% FCI) =\$22403.75

D. Rent (8-12% of FCI) = \$448075.09

Total fixed charge (TFC) = \$1086582.107

Total production cost (TPC) = WC/0.3 = \$988400.95 /0.3= \$3294669.83

Plant overhead cost (POC) = (5-15% of TPC) = \$164733.49

Manufacturing cost = TFC + TPC + POC = \$4545985.399

❖ **General expense**

General expense = Administrative + Distribution and selling cost + Research and development cost + financing (interest) cost

- Administrative costs (2-6% of TPC) = \$65893.3966
- Distribution and selling (2-20 % TPC) = \$65893.3966
- Research and development (5% TPC) = \$164734.99
- Financing (interest) (5% of TCI) = \$329466.98
- General expense = \$625988.75
- Working day = 300 day/year

Annual shampoo production = 174,000L/year \* 0.5 = 87,000L/year.

Operation time = 300 days/year for 24 hrs.

Daily shampoo production = 87,000 L/year / (300 day/year)  
= 290L/day

Unit sell price = 0.2L = 15\$ that is 75\$/L

Total selling price is = 75\$ \* 87,000 L/year = \$5,850,000\$

❖ **Profitability analysis**

Gross profit = product sales revenue - total product cost

Gross profit = \$5,850,000\$/year - \$3,294,669.83 /year = \$ 2555330.17/year

Therefore depreciation cost = Depreciation = 10% fixed capital + 2.5% building

**Depreciation** = 0.1 \* \$ 5600938.744 + 0.025 \* 177319.72 = \$564526.86

Gross profit including depreciation (Gross Profit - depreciation cost)

= \$ 2555330.17/year - \$564526.86 = \$1990803.31/year

Net profit = gross profit with depreciation (1-Ø), where,

Ø = income tax of rate Ethiopia = 30%

= \$1990803.31/year \* (1-0.3) = \$1,393,562.317/year

Minimum acceptable rate of return (Marr)

Minimum acceptable rate of return (mar) for new capacity with established corporate with low levels of risk=12%

$$ROI = \frac{\text{net profit}}{\text{total capital investment}} = \frac{\$1393562.37}{\$6589339.69}$$

$$= 0.21 * 100\% = 21\%$$

ROI ≥ Mar (12%), 21% > 12%, so the Project is feasible

### 6.3 Payback period

$$\text{pay back period} = \frac{\text{FCI} - \text{Salvage}}{\text{Net profit} + \text{depreciation}}$$

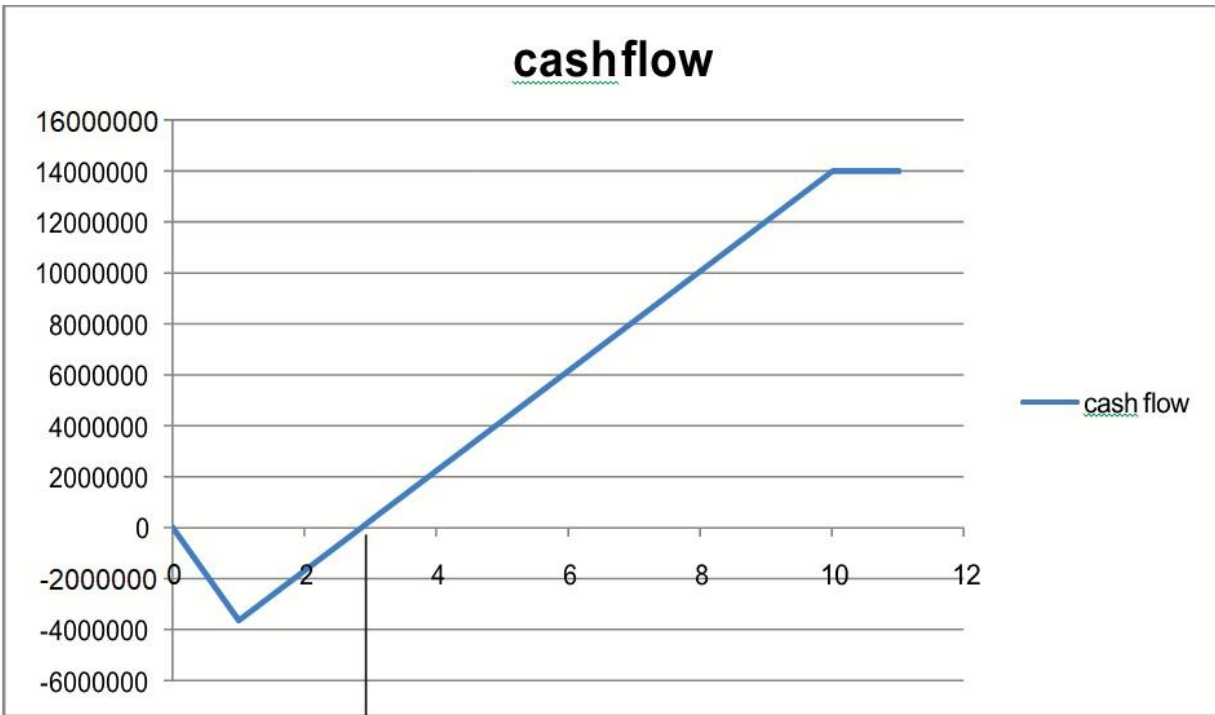
$$= \frac{\$5600938.744 - 0}{\$1393562.317/\text{year} + 564526.86/\text{year}}$$

$$= 2.8\text{year}$$

Pay Back Reference

$$P_{\text{bref}} = 0.85 / (\text{mar} + 0.85/n) = 0.85 / (0.12 + 0.85/10) = 4\text{years},$$

PBP < P<sub>Bref</sub>, so the Project is Feasible



2.8 years

Figure 6.1 payback period

## CHAPTER SEVEN

### 7. SITE SELECTION AND ENVIRONMENTAL EFFECT

#### 7.1 Site Selection

The site selection is decided based on the raw material availability, infrastructure, and other related facilities. Hence taking these things in to consideration the site for Plant erection could be around southern part of Ethiopia specifically Arbaminch, Wolita, Dilla and around these areas. In these particular areas there is enormous amount of avocado plantation with abundant source of avocado fruit. In addition to this, selecting this area also provide additional geographical advantage, because land is cheap compare to other areas especially around addis abeba. Generally this area has selected based on factors which enhance us to maximize feature targeted profit and to achieve our project with minimum obstacle.

#### 7.2. Environmental effect

Our production process is environmental friendly. Both the oil extraction and formulation of shampoo using this extracted avocado oil as ingredient do not affect the environment, because it does not generate toxic wastes. Since Production of shampoo not involves any complex process, it will not lead to generation of toxics substances. Prepared row materials inter in to mixer and all inputs will out in the form of product, so there is no generation of waste which can affect or hurt surrounding environment. Actually there is some residues which generate during oil extraction process, but this by product will not throw away like other by product, instead it utilized for animal feed stocks, therefore it enhance us to generate some money from our by product. Generally extraction of avocado oil and formulation of shampoo using this extracted oil totally has no any significant impact on environment, so establishing this plant and starting production is absolutely safe and effective.

## CHAPTER EIGHT

### 8. CONCLUSION AND RECOMMENDATION

#### 8.1. Conclusion

In this study a lot of trials and investigations were carried out to extract oil from avocado. As we observed from lab results, particle size and time of extracted oil have great effects on percentage yields of the oil. From 40gm of mass which has 1mm avocado powder and extraction time of 4hr the yield of oil found was 14.75ml and for the same mass and 0.5mm avocado powder the yield found was 18.75ml. For the remaining two trails using the same mass of 40gm and particle size of 0.5mm, but using different time of extraction 4hr and 6hrs we found 18.75ml and 20.68ml oil respectively. From this result we conclude that as particle size decreases and time of extraction increases the yield of oil content increases.

The parameters was evaluated and compared with marketed shampoos to check whether or not the produced shampoo can meet the standard of market shampoo. Since there is difference in composition for the three trials, lab result showed their ph values, percentage of cleaning ability and percent of detergency for (F1) 7.3, 15.5 and 58.5, for (F2) 7.23,20.5 and 60.8, for (F3) 7.25,27.81 and 61.5, and (market shampoo) 5.9, 32.51 and 61.8 respectively. From this three formulation we conducted the third shampoo formulation has selected, because its ph value, cleaning ability and percentage of detergency relatively similar with marketed shampoo but the formulated shampoo has better than marketed shampoo in terms of unique mineral content which exist in avocado oil.

Generally this project study presents a number of flourished abundant minerals which found in avocado oil. This oil plays a great role in the produced shampoo, because of its unique minerals, and therefore gives good quality for the produced shampoo. Since this shampoo has good quality, it can satisfy consumer anticipation demand and can be packed for use.

## **8.2 Recommendation**

In the experiment there are different parameters which affect the quantity of the oil to be produced. The effect of time and size particle was investigated in this work. Further works are recommended to know the effect of other experimental factors such as temperature and sample to solvent ratio.

Further study shall be conducted at the impurity, besides that we recommend that the detergent and cosmetics factories that imports essential oil from abroad, it is better to produce thus essential oils domestically. Because there is cheap raw material, farming land with suitable climate and cheap labor force. So that government and other stockholders has to encourage and attracting investors to participate in this sectors.

In addition to this we recommend other types of formulations to investigate or to find a way of other production mechanism to enhance change in phase such as solid or powder other than liquid shampoo. The iodine value and ash content of the oil were not determined. Beside to this, the light penetration, bond strength of shampoo and viscosity were not also characterized due scarcity of laboratory material and chemicals. Since our shampoo has unique quality for treatment of damaged hair, we recommend for those who has such problem to choose our product.

**REFERENCES**

1. Arpaia, M.; Jacman, C.R; Woolf, A; White, A; Thompson, J.F; Slaughter, D.S. 2006. Avocado Postharvest Quality. Proc. California Avocado Research.
2. Avocado Oils: Processing and its Products on human health (Bergh, 1992; Eyres et al. 2006).
3. Biochemical Composition & Physiochemical Properties of Oil production (Simental & Escalona, 2004).
4. Bizimana, V; Breene, W.M. & Csallany, A .S. 1993. Avocado Oil Extraction with appropriate technology for developing countries. Journal of the American Oil Chemists Society
5. Botha, M.B. 2004. Supercritical fluid extraction of avocado oil. South African Avocado Growers Association Yearbook,
6. Cosmetics and toiletries Formulations, Second Edition Volume 2, by Ernest W. Flick, U.S.A, 1992
7. Eyres, L.; Sherpa, N; Hendriks, G. 2006. Avocado Oil- A new edible Oil from Australasia. Institute of Food, Nutrition and Human Health, Massey University, New Zealand.
8. Human, T.P. 1987. Oil as a byproduct of the avocado. South African Avocado Growers' Association Yearbook.
9. Kardash, E. and Tur'yan, Y. I. 2005. Acid Value Determination in Vegetable Oils by Indirect Titration in Aqueous-alcohol Media. Croat.
10. Kintish, October 1995, cosmetics specialist how products are made.
11. Knowlton, John and Steven Pearce, the Handbook of Cosmetic Science and Technology, 1993.)
12. Lozano, Y.F; Mayer, C.D; Bannnon, C & Gaydou, E. M. 1993. Unsaponifiable matter, total sterol and tocopherol contents of avocado oil varieties. Journal of the American Oil Chemists Society, 70 (6), 561-565
13. Martin M. Rieger, Surfactants in Cosmetics, New York and Basel, 1985).

14. Natural Cosmetic Formulating by, Perry Romanowski, 2015
15. Nicolosi, R; & Orthoefer, F. 2004. Biological Activity of Micro-nutrients in Vegetable Oils: Impact of Oil Processing. United States, AOCS Archives.
16. Ravichandran, and Kolhapur, Evaluation of the clinical efficacy and safety of Anti Dandruff Shampoo in the treatment of dandruff', 2005
17. Sharma, Cosmetics Formulation Manufacturing and Quality control, 4th edition, 1998
18. Supercritical fluid CO<sub>2</sub> extraction of essential oil from *Marchantia convoluta*: global yields and extract chemical, Xiao, 2006
19. Time facto for extraction, Saxena, et al., (2011
20. Uzytku, Z.B.P. & Higieny, P. Z, 1997. Cold Processed Oil.
21. Werman, M.J & Neeman, I. 1987. Avocado Oil Production and chemical characteristics. Journal of the American Oil Chemists' Society
22. Woolf et al. (1999) Location and growth conditions avocado postharvest to yield higher levels of oil.
23. Xiao, J.B; Chen, J. W; Xu, M. 2006. Supercritical fluid CO<sub>2</sub> extraction of essential oil from *Marchantia convolute*: global yields and extracts chemical composition. Electronic Journal of Biotechnology.

## Appendix

### Appendix 1: some photos taken during working in laboratory

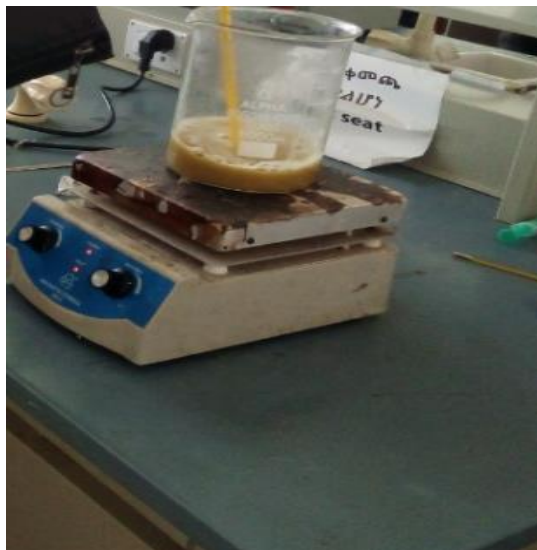
**Dried avocado fruit**



**grinding of dried avocado**



**Evaporator**



Removal of residue from avocado oil using centrifuge



**Oil produced using n-hexane as solvent**



Appendix 2: - Typical values of some measurement

<b>Measurements</b>	<b>Unit</b>
Surface tension of distilled water at room	71.9dyness/cm <sup>2</sup>
Boiling Point of Hexane	67 <sup>0</sup> c
Boiling Point of Oil	271 <sup>0</sup> c
Specific Heat Capacity of oil	2.26KJ/kg <sup>0</sup> C
Specific Heat Capacity of Hexane	1.55KJ/kg <sup>0</sup> C
Density of Water	1000kg/m <sup>3</sup>
Specific Gravity of Oil	0.9126
Ph. of Water	7
Ph. of oil	6.8
Ph. of shampoo	6.87
Free Fatty Acid value of oil	0.107%