WOLKITE UNIVERSITY

COLLEGE OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF CHEMICAL ENGINEERING

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PRODUCTION & CHARACTERIZATION OF SHAMPOO FROM MORINGA SEED OIL

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Declaration

We declare that this project entitled "production and characterization of shampoo from moringa stenepetela seed oil" is the result of our final year project. Information taken from published work of others has been acknowledged in the text and a list of references is given. The project was done under the guidance of Mr. Lamesgin from the chemical engineering department in Wolkite University.

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Abstract

The main aim of this project was production and characterization of shampoo from moringastenopetala seed kernel oil. Shampoo is a hair care product packed in a convenient way for use to wash hair and scalp. The major function of shampoo is to clean the hair, removal of oils, dirt, scalp debris and accumulated sebum. Formulation of shampoo must be safe and efficient for long use. One of the main ingredients used to produce shampoo is moringa stenopetala seed oil and SLS. This moringa stenepetela seed oil was extracted using the Soxhlet extraction method.

Shampoo formulations were classified based on the raw material which it is made from. Those are: chemical based made shampoo and natural or herbal type of shampoo. In this project we have focused on both chemicals based and natural based shampoo production. To do this we have used raw materials like Moringa oil, SLS, Nacl, citric acid, distilled water, egg yolk and Formaldehyde. This thesis also incorporates material balance and energy balance on the basic unit operation, equipment specifications and preliminary cost estimation for industrial scale plant. The produced shampoo evaluated for quality assessment tests revealed that the pH (6.5), Foam ability (25-55ml), detergency (20-30) and solid content (20–30 wt.%) were within the requirement for standard medicated shampoo.

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Acronyms

AD: Administrative Cost

DC: Direct Cost

DP: The percentage of detergency power

DSC: Distribution and Selling Cost

FCI: Fixed Cost Investment

ID: Indirect Cost

INCI: International Nomenclature of Cosmetic Ingredients

NPV: Net Present Value

PEC: Purchased Equipment Cost

POC: Plant Overhead Cost

SLS: sodium lauryl Sulfate

TCI: Total Capital Investment

TPC: Total Production Cost

Nacl: Sodium chloride

CHAPTER ONE

1.INTRODUCTION

1.1. Background

Originally, soap and shampoo were very similar products; both containing surfactants, a type of detergent. Modern shampoo as it is known today was first introduced in the 1930s with Drene, the first synthetic (non-soap) shampoo (Balsam,S.M.,Gershon 2008).

The M. stenopetala tree, locally called shiferaw (Amharic) or aleko (Konso,), grows widely in southern Ethiopia, mainly in the Keffa, GamoGofa, Bale, Sidamo, Borana and Debub Omo zones, and in Konso and Dherashe areas. Moringa leaves have been taken to combat malnutrition, especially among infants and nursing mothers, because they contain more calcium than milk, more iron than spinach, more Vitamin C than oranges and more potassium than a banana (Fahey, 2005).

Moringa oil is highly valued in the cosmetic industry for its unique property. Moringa oil is light and spreads easily on the skin. It is best for massage and aromatherapy applications. Moringa oil is used in an ageing creams, hair care products, soaps and shampoo, aromatherapy oils, face creams, perfumes and deodorants (Mulugeta&Fekadu, 2014).

Shampoo is defined as a preparation of a surfactant (surface active material) in suitable form liquid solid or powder which when used under the conditions specified will remove surface grease, dirt a skin debris from the hair shaft and scalp without affecting adversely the hair, scalp or health of the user. 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. (Sutherland, 1996).

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 60-70% of the entire formula. Deionized water, which is specially treated to remove various particles and ions, is used in shampoos. 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 (Sutherland, 1996).

1.2. Statement of the Problem

Now a day's many people who suffer from dandruff are significantly increasing as a result, the demand for shampoo also increases. In this project aimed to solve those problem by producing shampoo from locally available moringa seed.

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 anticipates like minerals, Besides this, there was high demand of shampoo in Ethiopia, and hence imported from abroad, because there are no value-added ingredients of shampoo like moringa oil which is extracted in Ethiopia. Shampoo which has moringa oil as its ingredients, can overcome those problem, because of the following special ability;

Moringa shampoos have the ability to penetrate the skin and deliver adequate amount of minerals in to the skin. A Shampoo which has moringa 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.The phytochemicals present in Moringa stenepetela oil have been reported to have an active bactericide and fungicide effect.

Moringa seed is underutilized oil source in Ethiopia due to lack of awareness of medical importance of moringa seed.

1.3. Objective

1.3.1. General objective

The general objective of the study was Production and characterization of shampoo from Moringa stenopetala seed oil.

1.3.2. Specific objectives

✓To extract Moringa stenopetala seed oil.

✓To investigate the effects of extraction process variables (particle size)

✓To do Characterization of the produced shampoo.

1.4. Significance of the study

The significances of production of shampoo from moringa stenopetala seed kernel oil were;

- It provides information about shampoo production process for researchers, students who want to study about shampoo production.
- It provides information to investor how easily invest on locally available resource.
- Shampoo production program can also be helpful to create job opportunity for the local community.
- Provides a means of exploit and use of valuable local resource.
- Gives the awareness for the utilization of available natural resources in the country for the production of important products locally.
- Shortage for the utilization of locally available raw materials and cultivating them for production of valuable product from them has multiple effects on the Scio-economic development of once country. Starting from job creation to local community, reduce lack of currency to import products and protecting the bio-diversity by cultivating and processing this valuable medicinal tree in bulk.

1.5 Scope of the study

This project was involved production of shampoo at laboratory scale by extracting oil from moringa seed and extracted oil was mixed with other ingredients in appropriate proportion to obtained desired product. It also involved characterization of produced shampoo by comparing with standardize products. The whole production process of shampoo was also described. Material and energy balance were performed on selected unit operations and market analysis, cost estimation was performed to check the feasibility of the researches.

1.6 Limitation of the project

- ✓ Shortage of time
- ✓ Absence of chemicals like SLS, Distilled water, color, perfume
- ✓ Absence of laboratory equipment like miller, oven, sieve and rotary evaporator
- ✓ Inadequate laboratory equipment such as Soxhlet extractor simple distillation column
- ✓ Malfunction of lab material

CHAPTER TWO

2. LITERATURE REVIEW

2.1. General description

Shampoo is defined as a preparation of a surfactant (surface active material) in suitable form liquid solid or powder which when used under the conditions specified will remove surface grease, dirt a skin debris from the hair shaft and scalp without affecting adversely the hair, scalp or health of the user(Balsam,S.M.,Gershon 2008). Shampoos are typically viscous liquids.

✓ Either clear or opaque.

✓ Containing 20–40% solids.

✓ Adjusted to approximately pH 6.5.

✓ Viscosities in the ratio of 500–1500 centipoises. Shampoos are of various types and forms on the basis of physical appearances, constituents and properties. Various forms are as under (Leoneetal.,2015).

❖ Liquid clear shampoos.

❖ Liquid cream or cream lotion shampoos.

❖ Cream paste shampoos.

❖ Egg shampoos.

❖ Dry shampoos & liquid dry shampoos.

❖ Baby shampoos.

2.1.1. Raw material selection and preparation

General overview of moringa essential oil Moringa of Moringaceae family there are 13 species (namely, M. arborea, indigenous to Kenya; M. rivaeindigenous to Kenya and Ethiopia; M. borziana, indigenous to Somalia and Kenya; M. pygmaeaindigenous to Somalia; M. longitubaindigenous to Kenya, Ethiopia and Somalia; M. stenopetalaindigenous to Kenya and Ethiopia; M. ruspolianaindigenous to Ethiopia; M. ovalifoliaindigenous to Namibia and Angola; M. drouhardii, M. Hildebrand indigenous to Madagascar; M. peregrine indigenous to Red sea and Horn of Africa, M. concanensis, Moringa oleifera indigenous to sub-Himalayan tracts of Northern India (Leone et al., 2015).

M. oleifera found including in our country Ethiopia, Saharan Africa and South-America. The rest species of Moringa, on the other hand, have not been studied in detail and their potential uses have not been fully understood. M. stenopetala is domesticated in East African lowlands and indigenous to southern Ethiopia. Many different ecotypes and varieties of M. stenopetala are found in Ethiopia (Seifu, 2012).

Within the first year of growth, moringa has been shown to grow up to 4 meters and can bear fruit within the same first year (Sutherland, 1996). The tree can grow almost in all type of climate and soil; however, it grows well in semi-arid tropics and sandy-loam soil (Kumar et al, 2017).The trees range in height from 5 to 10m and sometimes can be even 15m and it can grow even in hot dry lands or destitute soils and are little affected by drought. Moringa is called the "miracle tree"" because the plant can provide as a food supplement for fortification, energy drinks, creams, cosmetics, shampoos, etc. (Mulugeta&Fekadu, 2014).

Moringastenopetala belongs to the family Moringaceae and is often referred to as the African Moringa tree because it is native only to Ethiopia and northern Kenya. This tree is one of the most frequently cultivated indigenous species for its palatable leaves in the semiarid areas of Konso, Derashe and Arba Minch Zuria districts of the Southern Rift Valley of Ethiopia and locally called as ―halekoor ―shiferaw in amaharic. (Seifu, 2012).

2.1.2. Moringa stenopetala seed characteristics

The M. stenopetala fruits are trilobed capsules, and are frequently referred to as pods. Immature pods are green and, in some varieties, have some reddish color. Pods are pendulous, brown, triangular, splitting length wise in to 3 parts when dry, 30-120 cm long and 1.8 cm. wide. The moringa stenopetala seeds are round with a white to brawn and Moringa Olifera seed hulls are generally brown to black. The hulls itself has three white wings that run from top to bottom at 120^o intervals. The average weight per seed is 0.3 g for M. Olifera and 0.42 g for M stenopetala and the kernel to hull mass ratio is 75:25. M. oleifera seeds are globular, about 1 cm in diameter. The moisture content of seed is12.2%. They are three-angled, with an average weight of about 0.3 g, density of 400g/m3, 3-winged with wings produced at the base of the seed to the apex 2–2.5 cm long (Foidl et al., 2001).

Figure 2. 1 Moringa seed A) With pod B) With husk

2.2. Moringa oil and its uses

Moringa oil can be extracted from moringa seed kernels by either pressing methods or by solvent extraction. It is the most stable natural oil and it is found to be a good source of Behenic acid in nature. Perfume manufacturers; esteem the oil for its great power of absorbing and retaining even the most fugitive odors. The temperatures of the solvent extraction, seed particle size, contact (residence) time between the solvent and the seed and pre-treatment conditions are factors. This oil can be used as preservative in food industries and for cooking. The oil yield from the seeds depends on the nature. (Sutherland, 1996).

2.2.1. Uses of moringa oil

Moringa seed oil, is one of the most nutrient-rich oils in the world, with powerful anti-ageing properties that make it a prized cosmetic ingredient. Moringa for skin: Moringa oil is soft and fatty and penetrates the skin deeply to provide nutrients to the skin where the antioxidants and oleic acid work to reduce the appearance of wrinkles and provide moisture from deep down. It is used in many elite wrinkle-reduction, age-defying and moisturizer products. This keeps your complexion looking younger and healthier. (Seifu, 2012).

Moringa also helps to control blemishes and breakouts. Ben oil is one of the best moisturizers for the skin. It should be applied to the skin as a massage oil. It imparts glow to the skin and makes it well moisturized, but not too oiled. This brilliant moisturization effects is because of very high amount of omega- 9 fatty acid (oleic acid) in moringa oil. It also makes the skin quite smooth, because of the behenic acid in it. Behenic acid is used in many products for its ability to smooth the skin and condition hair. This oil slips easily on the skin and spreads well. (Sutherland, 1996).

Fungal infections - Moringa oil can deal with certain fungal infections because it contains antifungal activity. One can use it on ringworm, athlete's foot and jock itch. Moringa for hair: It is just as good for the hair as it is for the skin. Moringa oil is a powerful hair conditioner. It should be used as a hot oil conditioner to deal with nearly any hair related problem. The hot oil treatment leaves the hair well moisturized; the hair roots are nourished; dandruff is washed out and there is much less irritation on the scalp. (Sutherland, 1996).

2.3. Extraction method of moringa seed oil

The main point of extraction is the separation of the oil from the oil-bearing material with subsequent purification of the raw oil, but looking at the oil production as a whole not only the oil processing is important for the production of high-quality oil, but also the harvest, the pretreatment of the harvested material, and the storage conditions until processing have to be taken into consideration. The aim of the extraction method is to optimize the oil yield with simultaneous maintenance of the oil quality. The seeds yield 38 to 41percent oil. (Gupta, 2012).

There are three main techniques that have been identified for extraction of oil: mechanical extraction, chemical or solvent extraction, and enzymatic extraction. Besides, accelerated solvent extraction (ASE), Supercritical fluid extraction (SFE) as well as Microwave-assisted extraction (MAE) method is frequently used. It has been observed that mechanical pressing and solvent extraction are the most commonly used methods for commercial oil extraction (Atabani et al., 2013).

2.3.1. Mechanical oil extraction

Prior to the discovery of any other oil extraction method oil was extracted mechanically or cold pressed. It is the simple process of heating the plant material to low temperatures and then physically pressing the oil out. Mechanical press oil extraction is the most conventional technique. A manual ram press or an engine driven screw press can be used (Jahirul, et al, 2013). It has been found that engine driven screw press can extract 68– 80% of the available oil while the ram presses only achieved 60–65% (Bhuiya et al., 2015).

According to literature, oil extraction efficiencies calculated from data reported in more recent studies are found to generally correspond to these ranges, although the efficiency range of engine driven screw presses can be broadened to 70–80% (Atabani et al., 2012, 2013; Bhuiya et al., 2015). Problem associated with conventional mechanical presses is that the design of mechanical extractor is suited for some seeds, and therefore, the oil yield is affected if that mechanical extractor is used for other seeds (Atabani et al., 2012, 2013; Bhuiya et al., 2015; Lokanatham& K, 2013).

2.3.2. Solvent extraction

The solvent extraction is chemical oil extraction method which is the most popular method of extraction of oil because of its high percentage of oil recovery from seeds. Solvent extraction is the process in which the oil is removed from a solid by means of a liquid solvent, it is also known as leaching. Solvents are compounds that are generally liquid at room temperature and atmospheric pressure; they are able to dissolve other substances without chemically changing them. Extraction of oil using solvents is the most effective method for oil recovery of almost 98%, especially with materials having low oil content. Common solvent extraction uses a pure organic or mixed organics to extract the valuable extracts from the plant material. Typical solvents include ethyl acetate, diethyl ether, methanol, ethanol, petroleum ether, isopropyl alcohol, carbon tetrachloride and n-hexane. (Bhuiya, et al., 2016).

The liquid mixture formed on dissolving a substance (solute) in a solvent is termed a solution. The oil is then distilled and the solvent evaporated leaving the oil behind. This process leaves minimum oil residual in the cake compared to mechanical. Solvent extraction is a continuous solid/ liquid extraction. A solid which contains the material to be extracted is placed in what is called a thimble. A thimble is made out of a material which will contain the solid but allow liquids to pass through. A lot like filter paper. The thimble containing the material is placed in the solvent extractor (Soxhlet). An organic solvent is then heated at reflux. As it boils its vapors rise up and are condensed by condenser. The condensed solvent then fills up the thimble. After it fills with enough solvent it automatically siphons back down into the container of organic solvent. This process takes place over and over again until all the material to be extracted into the organic solvent. (Bhuiya, et al., 2016).

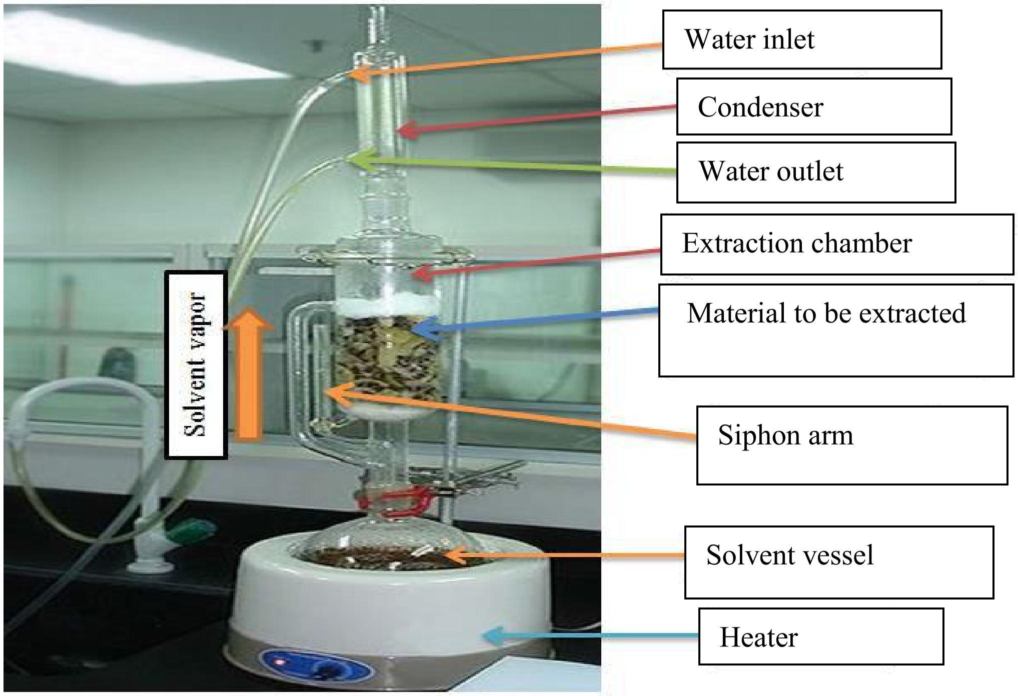


Figure 2. 2 Soxhlet extractor

Soxhlet extractor is a piece of laboratory apparatus that designed for extraction of lipids originally but, it is not limited to the extraction of lipids only. Typically, a Soxhlet extraction is only required where the desired compound has a limited solubility in a solvent, and the impurity is insoluble in that solvent. If the desired compound has a significant solubility in a solvent, then a simple filtration can be used to separate the compound from the insoluble substance. Normally a solid material containing some of the desired compound is placed inside a thimble made from thick filter paper, which is loaded into the main chamber of the Soxhlet extractor. The Soxhlet extractor is placed onto a flask containing the extraction solvent. The Soxhlet is then equipped with a condenser. The solvent is heated to reflux. The solvent vapor travels up a distillation arm, and floods into the chamber housing the thimble of solid. The condenser ensures that any solvent vapor cools, and drips back down into the chamber housing the solid material. The chamber containing the solid material slowly fills with warm solvent. When the Soxhlet chamber is almost full, the chamber is automatically emptied by siphon side arm, with the solvent running back down to the distillation flask. This cycle may be allowed to repeat many times, over hours or days. During each cycle, a portion of the non-volatile compound dissolves in the solvent. After many cycles the desired compound is concentrated in the distillation flask. The advantage of this system is that instead of many portions of warm solvent being passed through the sample, just one batch of solvent is recycled. After extraction the solvent is removed, typically by means of rotary evaporator, yielding the extracted compound. The non-soluble portion of the extracted solid remains in the thimble, and is usually discard. A rotary evaporator is a device used in chemical laboratories for the efficient and gentle removal of solvents from samples by evaporation. (Atabani et al., 2012).

2.4 Factors that affect solvent extraction

It has been observed that there are many factors affecting the rate of solvent extraction such as particle size, the type of solvent used, temperature, time and agitation speed (Atabani et al., 2012, 2013). The oil yield from Moringa stenopetala seeds depends on the nature of the solvent, the temperature of extraction, seed particle size, contact (residence) time between the solvent and the seed and pre-treatment conditions (Sayyar, Abidin, Yunus, & Muhammad, 2009).

2.4.1 Particle size

Particle size influences the extraction rate in a number of ways. The smaller the size, the greater is the interfacial area between the solid and liquid, and therefore the higher is the rate of transfer of material and the smaller is the distance the solute must diffuse within the solid as already indicated. On the other hand, the surface may not be so effectively used with a very fine material if the circulation of the liquid is impeded, and separation of the particles from the liquid and drainage of the solid residue are made more difficult (Richardson et al., 2002).

2.4.2 Solvent type

The solvent has to be selected in such a way that it would be a good selective solvent and its viscosity would be sufficiently low to circulate freely. Generally, a relatively pure solvent will be used initially, although as the extraction proceeds the concentration of solute will increase and the rate of extraction will progressively decrease, first because the concentration gradient will be reduced, and secondly because the solution will generally become more viscous. The most commonly used solvents for food processing are water, aqueous solutions of acids and nontoxic salts, commercial hexane, and in some cases other alkanes, ethanol and to a lesser extent the other lower alcohols, methylene chloride, methyl ethyl ketone, and acetone (Atabani et al., 2012, 2013).

2.4.3 Temperature

Temperature generally affects both the equilibrium and mass transfer rate of the extraction process. In the former, higher temperature results in greater solubility of compounds in the solvent, resulting in a larger K value (equilibrium constant). In the latter, the higher the temperature, the higher will be the D (diffusion coefficient), hence increasing the rate of extraction. In conventional solid-liquid (solvent) extraction processes, the temperature is limited by the boiling point of the solvent. It is also important to bear in mind that increasing the extraction temperature may also potentially degrade bioactive compounds. Thus, an optimized balance has to be determined when selecting the extraction temperature. (Sayyar, Abidin, Yunus, &Muhammad,2009).

Oil solubility in solvent increases with extraction temperature, High temperature also has a positive effect on viscosity and diffusivity of oil. Viscosity decreases while diffusivity increases as the extraction temperature increases, resulting in shorter extraction times. The energy required for solvent recovery decreases when the higher operating temperature is used for extraction. However, high temperatures may cause deterioration and denaturation of some oil and meal components. Hence, temperature selection is based on the type of oil and required specifications of the final product. It is expected that residual oil in the meal to be less than 1 percent after commercial solvent extraction (Sayyar, Abidin, Yunus, &Muhammad,2009).

2.4.4 Extraction Time

In general, a prolonged extraction time results in an increased yield of the oil until equilibrium is reached. Thereafter, the concentration of compound will not increase further but there will have greater liability for degradation. Prolonged extraction time is also not desirable from an economic standpoint of labor and energy requirements. Therefore, it is essential to find an optimum extraction time (Richardson et al., 2002).

2.5 Composition of shampoo

2.5.1 Chemical based shampoo

Shampoos are a mixture of surfactants, conditioning agents, foam boosters & stabilizers thickening agents or viscosity builders, sequestering or chelating agents, pacifying agents or pearilizers, clarifying agents, colorants, perfumes and preservatives in an aqueous base (Sayyar, Abidin, Yunus, &Muhammad,2009).

2.6 Main raw materials for shampoo production process

Important ingredients in shampoo formulations are water, detergents, foam boosters, thickeners, conditioning agents, preservatives, modifiers, and special additives.

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. (Perry Ri,2015).

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. (Natural Cosmetic Formulating Element by, Perry Romanowski, 2015).

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 alkanol amides, 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)

Thickeners: - To some extent, the alkanol amides 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).

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. Examples of conditioning agents include guar hydroxyl propyl trimonium chloride which is a polymer, moringa oil also serve as conditioning agent. (Natural Cosmetic Formulating Elements by, Perry Romanowski).

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)

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 material 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 FD&C dyes. 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).

Table 2. 1 Basic ingredients in shampoo

Ingredients	Percent (%)	function
Deionized water	60-80	Deionized water is used ensure bacterial degradation is minimized.
surfactant	4-10	The main cleaning agent surfactants also produce the foam, act as emulsifiers and wetting agents, can contribute to viscosity.

		some have conditioning properties. is function
conditioners	5-12	Traditionally fatty oils, alcohols and waxes, increasingly proteins or silicon's are used. Proteins can moisturize dry hair and increase strength and volume of the hair. Silcons can reduce hair irritation. increase the density and stability of foam and improve comb ability.
Viscosity modifier	1-3	The thickening agent.sodium chloride(common salt) is still widely used although it is less effective with some additives and surfactant system.
PH adjuster	1-3	The PH is adjusted to between 5-6 by addition of citric acid .
Preservative	1-3	Additives are sometimes used to give a pearl effect of to the product.
Coloring Fragrance	<1	Used improve the appearance of product which cannot be made clear due to some ingredients. they are added to complete formulation.

2.7 Properties of shampoo

- ✓ It should effectively and completely remove dust or soil, excessive sebum or other fatty substances and loose corneal cells from the hair.
- ✓ It should produce a good amount of foam to satisfy the psychological requirements of the user.
- ✓ It should be easily removed on rinsing with water.
- ✓ It should impart a pleasant fragrance to the hair.
- ✓ It should not cause any side-effects/irritation to skin or eye.
- ✓ It should not make the hand rough and chapped.

2.8 Cleansing action of shampoo

A cleanser is one which removes dirt, sweat, sebum, micro-organisms (bacteria etc.), dead cells (stratum corneum) and make-up if used from the skin surface. Cleansing comprises of three stages Wetting, Emulsification and removal of grease, Rinsing. (Sayyar, Abidin, Yunus, &Muhammad,2009).

Deeply ingrained dirt, particularly in the pores of the hair follicles and sweat glands can be removed by warming the skin with hot water or a mild steam bath. Normal pH of the skin is 5.5 to 6.5, this acidic pH changes to alkaline due to application of cleanser and gives a feeling of freshness in the skin. (Sayyar.Abidin, Yunus, &Muhammad,2009).

2.8.1 Types of cleansers

A. **Soaps and cleansing bars:** They are derived from fatty acids and tri-glycerides (fats and oils).
    - ✓ **Deodorant or anti-microbicidal bars**: These have an added anti-bacterial agent to eradicate bacteria. These soaps have a pH between 9 -10 and may cause skin irritation. They are good for oily skin.
    - ✓ **Moisturizing base**: These have moisturizing agents like lanolin or glycerin. Their pH is between5-7, thus they are Non-irritant. They are good for dry skin. Functions: Soaps help cleansing, perfume the bath, softens the water, forms lather and gives the skin a cool and fresh feeling

B. **Lipid free cleansers / Face wash:** These contain water, glycerin, acetyl alcohol and do not contain any fat. They clean without soap Formation and leave a thin moisturizing film. They are good for sensitive and photo aged skin.

C. **Cleansing creams:** They are oil-based products which remove grease and cosmetics on the skin by dissolving it in more oil. They are good for dry skin.

D. **Cleansing Lotion**: It is a water-based product and is good for normal and dry skin. Since it is water based, it can be easily rinsed with water. It is commonly sold as pore cleanser.

2.9 General manufacturing process

The production process starts with preparing all the required ingredients and two different beaker or containers, because of at first the water soluble and oil soluble ingredients need to blend with each other well first. Then pour the water-soluble ingredients in one of the heat safe mixer one after another with the formula formulated. Magnetic stirrer is placed on an electric heater and after the ingredients are poured in the electric heater it is turned on and the temperature is set to 60-65^{0}C. The heating will continue until there is no phase left in the mixture and when it reaches the required temperature. Then the heater gets turned off.

Then the oil soluble ingredients are poured in to the other beaker. The beaker is placed on an electric heater too. After weighed amount of each ingredient is poured in the electrical heater, it is turned on and set at a temperature of 67^{0}C and continue beating until the oils are perfectly mixed together and is at the required temperature and then heater is turned off.

After the melting is done the oil phase is pumped in to a mixer which is made of stainless steel. The stirrer in the mixture is turned on while the water component is being added to the mixer because vigorous stirring is needed to make an emulsion of the two phases. The stirring should continue until the emulsion is totally formed. One can tell the emulsion is formed when the solution starts to get thicker and thicker. After the emulsion is done the solution is given time to cool to around a temperature of 50-55^{0}C to add the remaining ingredients like the fragrance, color and preservative. After these additives are mixed well, the mixture is then pumped to an auto filling machine which automatically fills in tiny jars and cups as which can be observed in the markets (Sayyar, Abidin, Yunus, &Muhammad,2009).

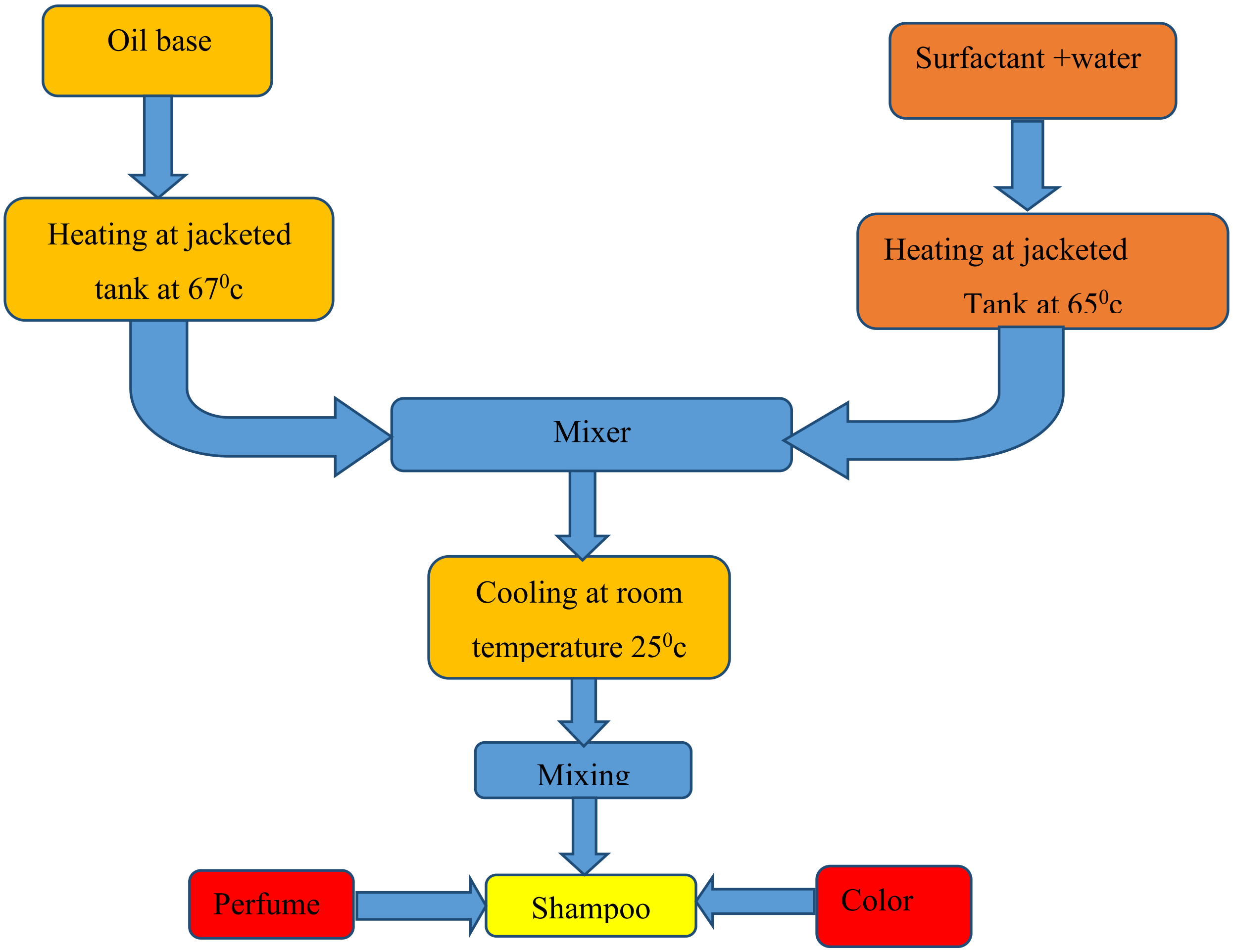


Figure 2. 3 Process flow diagram of shampoo production

2.10 Quality assessment / evaluation of the shampoo

The prepared shampoo sample was be evaluated via quality control tests including visual assessment and physicochemical analysis such as pH, solid contents, and foam ability, detergency, viscosity, were performed.

PH of shampoo

The pH of a shampoo may have definite effects upon its properties. Most liquid shampoos today are formulated to have a pH between 6.5and 8.5. Within this range a suitable viscosity and clarity can usually be achieved, as well as good stability and lathering properties.

A few generalizations can be made concerning the effects of pH on a typical clear shampoo formulation:

1.Shampoos formulated on the high side of the pH range will exhibit a greater degree of foaming and cleansing as well as a greater ability to strip the natural oils from the hair.
2.Conversely, shampoos on the low side of the range will generally leave the hair in better condition with a greater degree of manage ability and comb ability.
3. Shampoos with pH's above and beyond the high side of the range cause eye irritation more readily than those within the range.
4. It is easier to maintain clarity on the high side of the pH range.
5.Viscosity generally increases as the pH is lowered. This is especially true of alkylolamidelauryl sulfate shampoos.

Viscosity of shampoo

The viscosity of the shampoo sample was determined using the Brookfield dial viscometer (Model DV-1, LVT USA). The sample was placed in a small sample adapter, and then transferred into the sample cup of the viscometer. The viscometer was set at different spindle speed from 0.3 to 100 rpm. The viscosity of the tar was measured using spindle T95. The temperature was kept constants (25oC), the viscosity of the sample was then measured and recorded directly in CP (Sharma, 1998). This process was done for the different tar concentrations.

Specific gravity of shampoo

The specific gravity was determined using specific gravity bottle and according to the procedure prescribed by Standard Organization of Nigeria (SON, 2009). Empty specific gravity bottle was washed, rinsed with water then with ethanol. The bottle was dried and weighted. The empty bottle was filled with distilled water, closed with a stopper, thoroughly wiped with a clean towel and weighed. After this, the water was decanted, the bottle dried in a hot air oven and was cooled in a desiccator. The shampoo sample was introduced into the bottle filled to the neck and tightly closed with the stopper and weighed. The test was carried out at 25oC and the specific gravity was calculated as follows;

Specific gravity= $(Z-Y)/(X-Y)$

Where, x = weight of bottle filled with water

y = weight of empty bottle

z = weight of bottle filled with shampoo x –y = weight of water only

z -y = weight of shampoo only.

This was also repeated for the different coal tar concentration.

Solid contents of Shampoo

The solid content test determination was also performed using the method adopted from Standard Organization of Nigeria (SON, 2009) A clean dry evaporating dish was weighed and 4 g of shampoo was added to it. The dish and shampoo was placed on the hot plate until the liquid portion was evaporated. The weight of the shampoo only (solids) after drying was calculated as follows;

% Solid content = (weight of shampoo –weight of flash/ weight of shampoo) *100

Foaming ability and foam stability of shampoo

Cylinder shake method was use for determining foaming ability.1% shampoo solution was put into a 250 ml graduated cylinder and covered the cylinder with hand and shaken for 10 times. The total volumes of the foam contents after shaking were recorded. The foam volume was calculated as (initial foam volume-final foam volume).

CHAPTER THREE

3. MATERIALS AND METHODS

3.1. Materials

The main raw materials and chemicals used for this experiment were M. stenopetala seed, ethanol, water, SLS, Nacl, formal aldehyde, egg yolk and citric acid. M. stenopetala Seed samples were collected from ochollo district; it is a town in southern Ethiopia at 298 km distance from Wolkite. Located in the Gammo Zone of the SNNP Region, this town has a longitude and latitude of 10°00′N 39°54′E Coordinates: with an elevation of 1280 meters above sea level. All the other chemicals were taken from Wolkite university Department of Chemical and food engineering, department of chemistry.

3.2. Equipment

The main equipment's used are, soxhlet extractor, Electric heater, filter paper, Digital weighting balance, Beakers, Round bottom flask, vibrio-viscometer, pH meter, sieve, glass bottles, thermometer, condenser, crusher, separating funnel, oven, different size conical flasks, measuring cylinders and stirrer.

3.3. Methods

3.3.1. Preparation of M. stenopetala seed

The pods were collected from the tree and seeds were collected from the pods by removing the barks and 1.5kg of seeds were collected. The seeds also had extra seed husk which was separated after sun drying for a day to facilitate the separation of husk and seed kernels. The seed kernel, which is oil rich part of the seed was measured with weighting balance and 1kg of seed kernel were obtained. The seed kernels were dried in oven at 115^0c to reduce the moisture content. The dried seed were grinded manually by using coffee grinder and sieved to get two average particle size groups, which are the average size of 0.4mm, and 0.525mm to make the solvent extraction easier and to study the effect of particle size in the oil yield.

Figure 3. 1 M.stenopetalaseed

Moisture content determination of moringa stenepetela seed

%Mx (wb) = [(m2- m1) – (m3-m1)]/(m2-m1) *100%

m1 = empty container weight

m2 = empty container weight + sample before drying

m3 = empty container weight + sample after drying

%mx (wb) = moisture content.

3.3.2. Extraction of M. stenopetala Seed Oil

Solvent extraction method was used to extract oil from *M.stenopetala* seeds kernels, using ethanol as the extracting solvent and Soxhlet extractor as the extracting medium. The Soxhlet apparatus used for this solvent extraction (SE) where fitted with 100 ml round-bottom flask and a condenser. The extraction was executed in a heater; 100 ml of ethanol was poured into round bottom flask. 26 gram of prepared *M. Stenopetala* seed was placed in the filter paper and inserted in the center of the extractor. The extraction was carried out at different variable combination; particle size (0.4mm, 0.525mm), temperature (78^{o}c) and time (3 hr). When the solvent boil vapor rises through the vertical tube into the condenser at the top. The liquid condensate drips into the filter paper that, contain the sample in the center, which contains the oil to be extracted. The extract trickles through the pores of the filter paper and fills the siphon tube, where it flows back down into the round bottom flask. This was allowed for continuous extraction for extraction times (3hr.) The oil was obtained after ethanol are recovered by distillation at 78°C to remove the excess solvent from the extracted oil.

3.4. Laboratory procedure

3.4.1. Extraction of oil from moringa stenepetela seed

Experimental Setup of Soxhlet extractor consists of:

- Soxhlet Extractor
- Hot plate
- Water condenser
- Simple distillation

26-gm of moringa stenepetela seed powder was inserted in to the thimble. Then it was inserted into the Soxhlet apparatus. Here the heating mantel was adjusted at the boiling point of the solvent and condenser attached at the top and to the Soxhlet apparatus. At the bottom the round bottom flask that contains the 100 ml of ethanol was also attached to the Soxhlet apparatus.

Then extraction was done for 3 hours therefore after waiting for 3 hrs the extraction was stopped and the separation process was began using simple distillation after adjusting it at the boiling point of the solvent 78 ^{0}C. The solvent was recovered and the extracted oil was gained.

Then the extracted oil and the recovered solvent were measured for further analysis. Then the oil was inserted into the separating funnel to separate pure oil from the residue and measurement was taken after decanting.

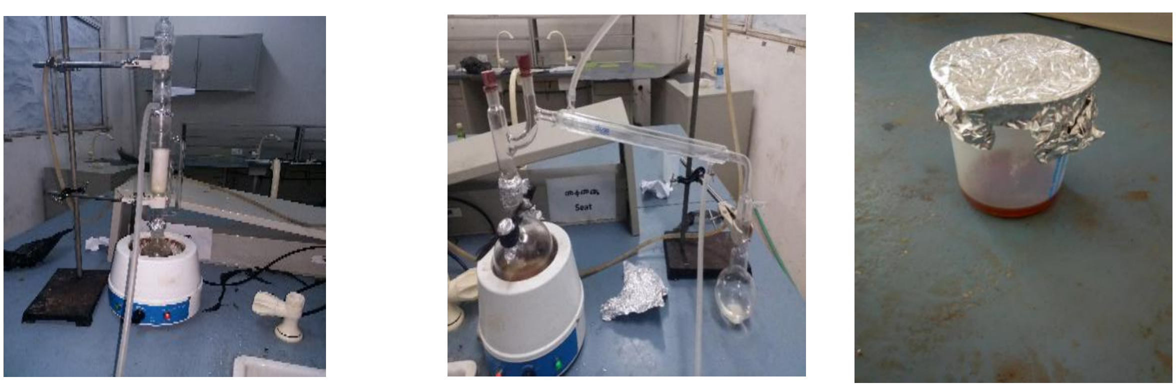


Figure 3. 2 Oil Extraction A) Extraction B) Separation C) Extracted oil

3.4.2. Production of liquid shampoo from oil and other ingredients

Table 3. 1 Basic ingredients of shampoo

Water based	**oil based**
Distilled Water	Moringa Oil
Sodium Chloride	Egg Yolk
Sodium Lauryl Sulfate	Formal Aldehyde
Citric acid	

Procedure

Two different beakers were prepared (one for the oil-based ingredients and other for the water-based ingredients). On the water based mixing beaker ingredients 80 ml of Distilled water, 4.5gm of Sodium lauryl sulfate, 4gm Sodium chloride& 3ml of Citric acid were added and the water-based beaker was placed on a heater with temperatures of 60-65℃ and it was mixed well using stirrer. On the oil-based mixing beaker ingredients 11ml moringa oil, 2 ml egg yolk & 2ml formal aldehyde were added and mixed well using stirrer.

Figure 3. 3 Water and oil base ingredients

Then a third mixing beaker was prepared and placed on a heater (for the mixing of oil and water-based ingredients). After the oil-based ingredients were mixed well, it was poured in to the third beaker. Then the water-based ingredients were poured in the third beaker while being mixed. The third beaker was mixed well using stirrer. The process was repeated with oil concentration of 12.5ml

Figure 3. 4 Production of shampoo A) mixing of ingredients B) produced Shampoo

3.5. Quality assessment of the shampoo

To evaluate the prepared formulations, quality control tests including visual assessment and Physicochemical controls such as pH, viscosity were performed. Also, to assure the quality of products, specific tests for shampoo formulations including the determination solid content, surfactant activity, foam ability were performed. The results were compared with standard Formulations.

Physical appearance/ visual inspection

The formulated product was evaluated in terms of their clarity, color, fluidity, odor and texture.

Determination of PH

By using digital pH meter, the pH of shampoo was determined at room temperature(25°C).

Viscosity of shampoo

The viscosity of the shampoo sample was determined using the Brookfield dial viscometer (Model DV-1, LVT USA). The sample was placed in a small sample adapter, and then transferred into the sample cup of the viscometer. The viscometer was set at different spindle speed from 0.3 to 100 rpm. The viscosity of the tar was measured using spindle T95. The temperature was kept constants (25^{o}C), the viscosity of the sample was then measured and recorded directly in CP (Sharma, 1998).

Determination of percentage solid content

The solid content test determination was also performed using the method adopted from Standard Organization of Nigeria (SON, 2009). A clean dry evaporating dish was weighed and 4 g of shampoo was added to it. The dish and shampoo were placed on the hot plate until the liquid portion was evaporated. The weight of the shampoo only (solids) after drying was calculated. If a shampoo has too many solids it will be hard to work into the hair or too hard to wash out. If it doesn't have enough it will be too watery and wash away quickly. A good shampoo will be between 20% – 30% solids (krunali et. (2013).

The weight of the shampoo only (solids) after drying was calculated as

% Solid content = (weight of shampoo – weight of ash) / (weight of shampoo taken) *100.

Foam ability

Cylinder shake method was used for determining foaming ability. 50 ml of the 1% shampoo solution was put into a 250 ml graduated cylinder and covered the cylinder with hand and shaken for 10 times. The total volumes of the foam contents after 10-minute shaking were recorded. The foam volume was calculated as (initial foam volume-final foam volume) (krunali et. (2013).

Cleaning action

5grams of human hair were placed in grease, after that it was placed in 200 ml. of water containing 1 gram of shampoo in a flask. Temperature of water was maintained at 35^{0}C. The flask was shake for 4 minutes at the rate of 50 times a minute. The solution was removed and sample was taken out, dried and weighed. The amount of grease removed was calculated by using the following equation:

DP = (1-T/C) *100 In which, DP is the percentage of detergency power, C is the weight of hair before washing in the control sample and T is the weight of hair after washing in the test sample (krunali et. (2013).

CHAPTER FOUR

4. RESULT AND DISCUSSION

4.1. Laboratory Result for extracted moringa oil

During extraction of moringa oil from its moringa stenepetela seed, moringa seed was dried in oven to remove the moisture in the seed and its moisture content was calculated as follow

Moisture content of Moringa seed

%Mx (wb) = [(M2- M1) – (M3-M1)]/(M2-mM) *100%

M1 = empty container weight =20gm

M2 = empty container weight +sample before drying =125gm

M3 = empty container weight + sample after drying=116gm

%Mx (wb) = [(125gm- 20gm) – (116gm-20gm)]/(125gm-20gm) *100%

%Mx (wb) = 9%

Moisture content of moringa seed was 12% from literature, the result 9% slightly differ it may be due to increase temperature and time of drying above the required level.

TablTable 1e 4.1 Raw material, volume of solvent, and the amount of residue and percentage yield of oil

Trial	Particle size (mm)	Initial mass sample(g)	volume of solvent ethanol(ml)	Final mass of residue (g)	% yield
1	0.4	26	100ml	9.2	64
2	0.525	26	100ml	9.7	62

Percentage yields:

%yield=[w1-w2]/w1%100

W1 =Weight of sample before extraction

W2=weight of sample after extraction

% yield of oil extracted by trial1= [(26-9.2)]/26*100=64%

% yield of oil extracted by trial2 [(26-9.7)]/26*100= 62%

Average % yield = 63%

The theoretical oil yield by solvent extraction is 98% so, the result 63% is far from theoretical yield it may be due to some extraction factors like time of extraction, solvent concentration and solvent type.

Color: Red yellow Color essential oil was extracted. The color of the oil extracted by ethanol was (red yellow) color.

PH value: The pH electrode was immersed into the sample and the pH value was read and recorded. Its PH value was 6.8

4.2. Laboratory Result for produced shampoo

Table 4. 2 Physicochemical properties of shampoo

Properties	produced shampoo1(S1)	Produced shampoo2(S2)	Standard
PH	6.3	6.58	5.5 - 6.5
Solid content	31	33	20 – 30
Foam ability(ml)	45	46.5	25 -55
Cleaning action	25	25.5	20 – 30
Viscosity (cp)	418.23	455.021	500-1500

4.2.1. Effect of concentration of oil on the viscosity of shampoo

Viscosity of formulated shampoo (S1) and (S2) were 418.23 and 455.021 this was below standard limit. The relative low viscosity may be due to the variation in alkylate base salt composition along the shampoo and oil concentration.

As seen from table 4. 2 the viscosity of (S2) greater than (S1) this was due to increase oil and salt concentration in the shampoo composition, but both of the products were below the standard limit.

4.2.2. Effect of concentration of oil on the pH of shampoo

The pH of formulated shampoos was 6.3 and 6.58 with in the accepted limit of standard medicated shampoo (5.0-7.0). The pH of shampoo slightly increased with increasing the amount of sodium laurel sulfate and moringa oil. The increased in pH indicates decreased in acidity. 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. Mild acidity prevents swelling and promotes tightening of the scales, there by inducing shine. As seen from table 2, all the shampoos were acid balanced and were ranged 6.3 to 6.58, which is near to the skin pH (6.5), therefore the shampoo doesn't damage the user's skin.

4.2.3. Effect of concentration of oil on the solid content shampoo

The solid content of S1, and S2 as seen in table 2 were 31and 33% respectively. These values were higher than standard value(20-30%) and this showed that the solid components present S2 are higher than S1.so those shampoo has too many solids, it will be too hard to work into the hair or too hard to was out .The increase in solid content may be due to the presence of higher molecular weight compounds.

4.2.4. Effect of SLS on the foam content of shampoo

The foam determination of presence of oil fairly accurately reflects the performance of the shampoo on the first lathering. During the first lathering the foam is often depressed because of sebum, hair dressings, and other cosmetic products which may be on the hair. The foam was increased by the amount of surfactant (sodium lauryl sulfate) because of it is used as foam boaster and the produced shampoo has the volume of 45 and 46.5 ml, with in the accepted limit of standard medicated shampoo (25-55). there for it has high foam ability.

4.2.5. Cleaning Action

From the laboratory result detergency power of produced shampoo S1and S2 were 25 and 25.5 respectively as seen in table 4.2. This was in the range of standard value (25-30).

This indicates that the formulated product in our laboratory having nearly similar result and hence our product was standardized product.

CHAPTER FIVE

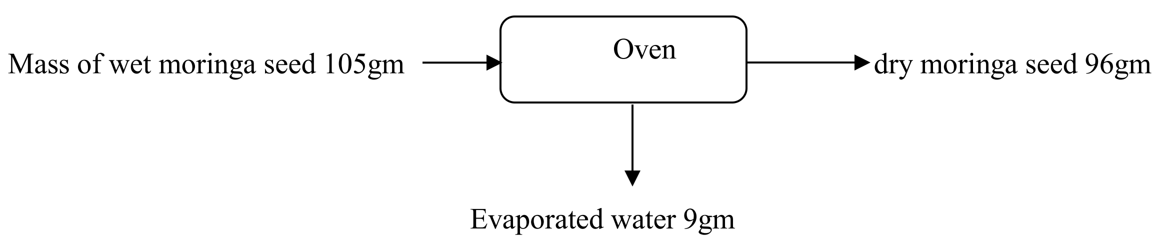
5. MATERIAL AND ENERGY BALANCE

Material and Energy Balance: - Material quantities, as they pass through processing operations, can be described by material balances. Such balances are statements on the conservation of mass. Similarly, energy quantities can be described by energy balances, which are statements on the conservation of energy. 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 and Energy Balance for oil laboratory experiment

5.1.1 Material balance for oil extraction

Material Balance on dryer



Mass in + generation = mass out +consumption +accumulation

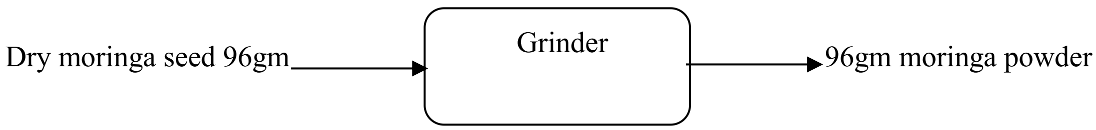
Mass in = mass out

Mass of wet moringa seed= Mass of dry moringa seed+ Mass of evaporated water

105gm = 96gm + 9gm

105gm = 105gm

Material Balance on Grinder



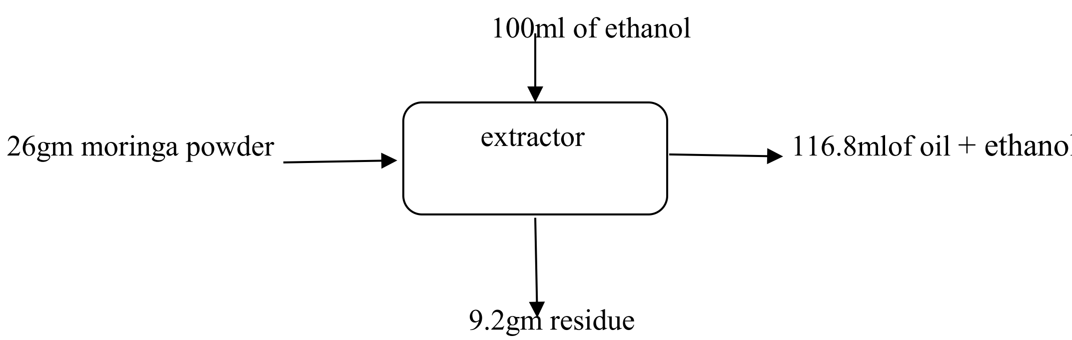
Mass in + generation = mass out +consumption +accumulation

Mass in = mass out

Mass of dried Avocado = Mass of powdered avocado

96gm= 96gm

Material Balance on Soxhlet extraction



Mass in + generation = mass out +consumption +accumulation

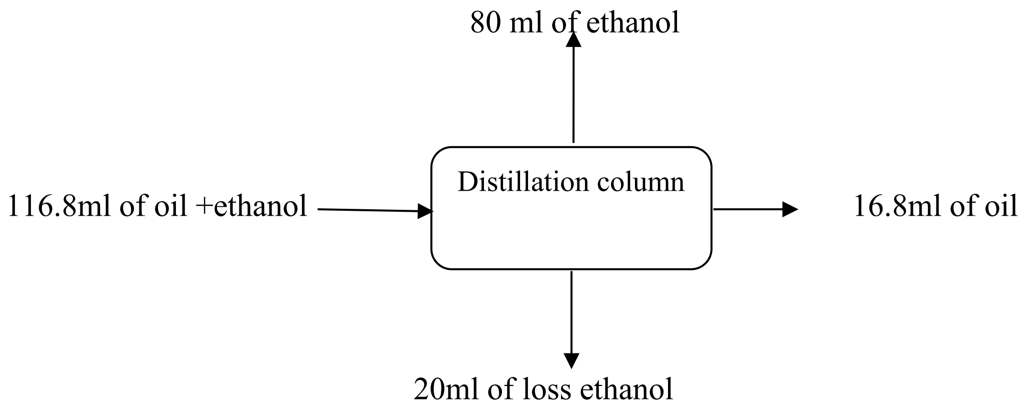
Mass in = mass out

Mass of sample moringa powder + mass of ethanol = Mass of (oil +ethanol) +mass of residue

26gm +100gm = 116.8gm+ 9.2gm

126gm = 126gm

Material Balance on distillation column



Mass in + generation = mass out +consumption +accumulation

Mass in = mass out

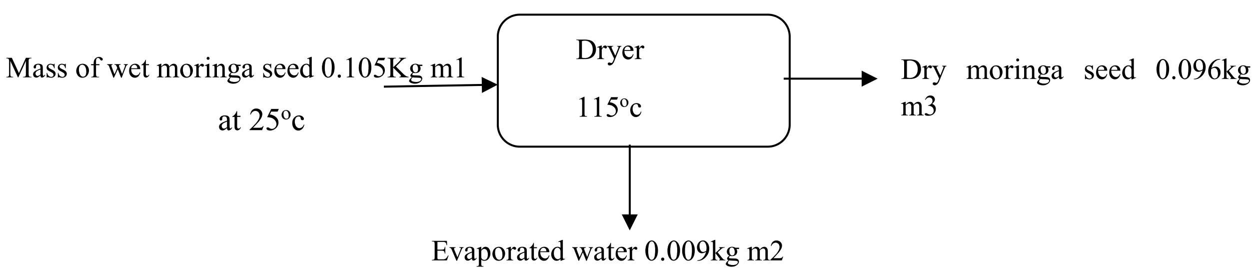
Mass of (Oil + ethanol) = Mass of ethanol + Mass of Oil + mass of loss ethanol

116.8gm = 80gm + 16.8gm + 20gm

116.8gm = 116.8gm

5.1.2 Energy balance for oil extraction

Energy balance on dryer



From conservation of energy

Energy in+ energy generation = energy out + energy consumption + energy accumulation

Energy in = energy out

The temperature in put=25°c

Steady state operation that means Q Input=Q out put

$Q=mcp\Delta T$

Cp of Moringa seed at 25°c or 298k is 2.45kj/kgk.

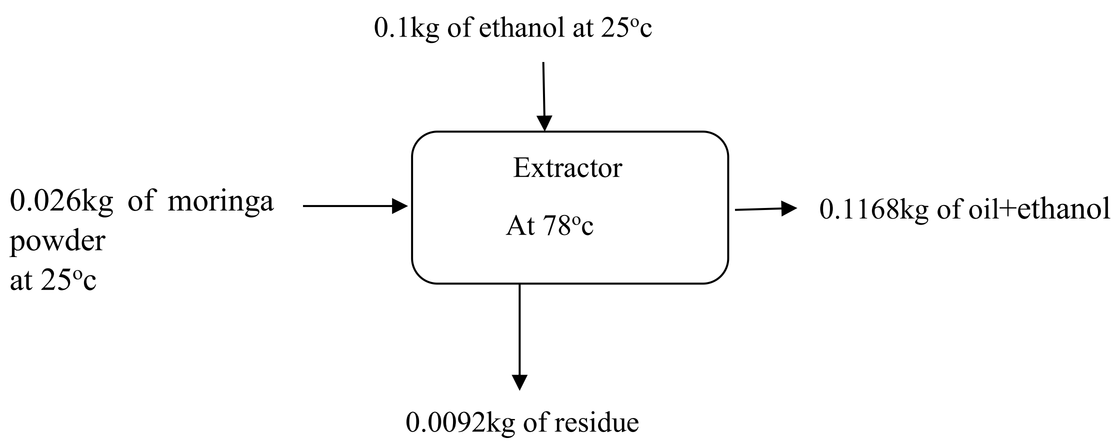
The temperature of drying is kept 115°c

m_1=0.105 kg

Qin=0.105kg×2.45kj/kgk(115-25)k

=23.1525Kj

Energy Balance on Extractor



From conservation of energy,

Energy in+ energy generation = energy out + energy consumption + energy accumulation

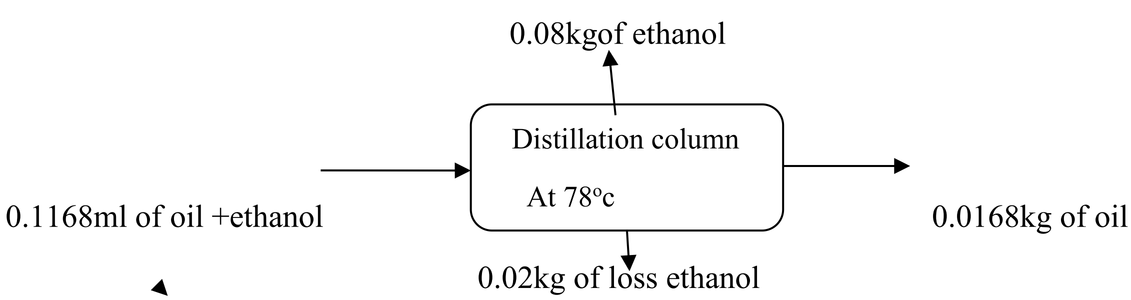
Energy in = energy out

$Q= mcp\Delta T$

$Qin=m_3cp\Delta T+M4cp\Delta T$

0.026kg×2.45× (78-25) +0.1kg×2.57×(78-25) =16.9971Kj

Energy Balance on distillation column



From conservation of energy,

Energy in+ energy generation = energy out + energy consumption + energy accumulation

Energy in = energy out

Q= mCP ΔT

Qin =Qout

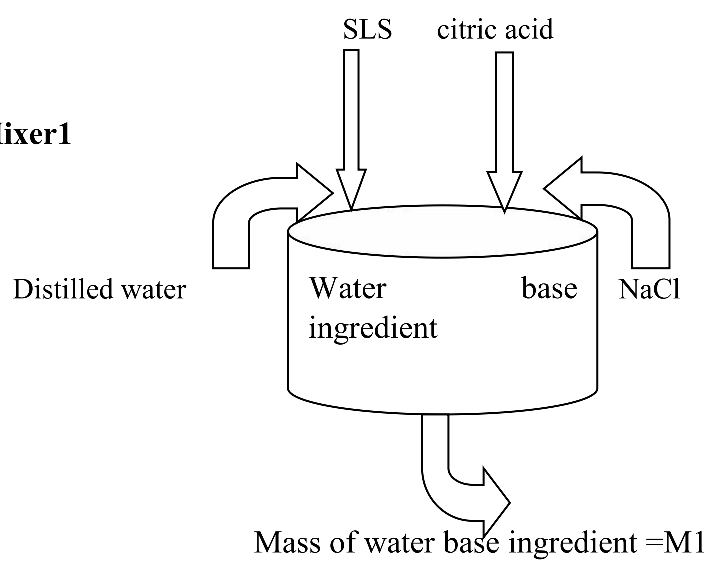
Q =mcpmix ΔT

=O.1168kg×((2.26kj/kgk+2.57kj/kgk)/2)× (78-25) k =14.94Kj.

5.2 Material and energy balance for shampoo production in laboratory

5.2.1 Material balance for shampoo production

Mixer1



Mass in + generation = mass out+ consumption +accumulation,

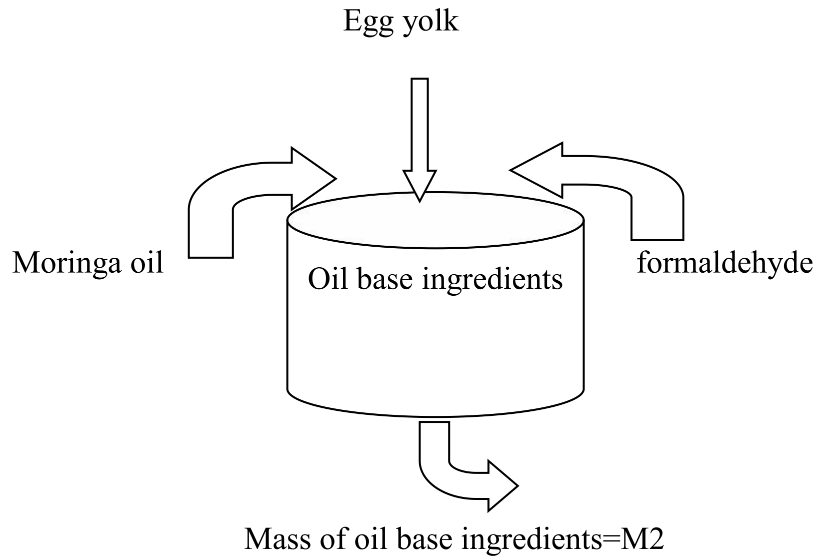
There is no generation, consumption and accumulation

Mass in = mass out

Mass of distilled water +Mass of SLS +Mass of Nacl +Mass of citric acid= M1

80gm+4.5gm+4gm+3gm=M1=90.5gm

Mixer2



Mass in + generation = mass out + consumption +accumulation

Mass in = mass out

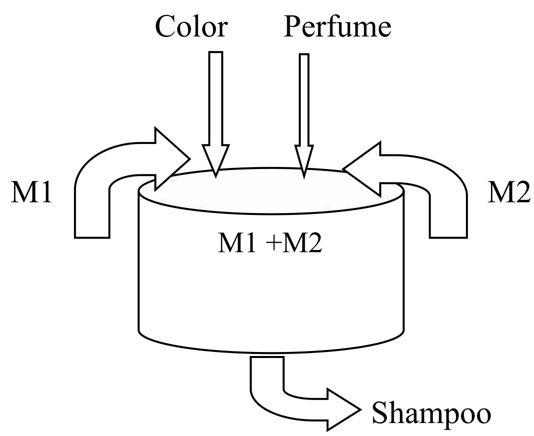
Mass of moringa oil + Mass of egg yolk + Mass of formaldehyde

= M2

11gm + 2gm +2gm=M2

M2=15gm

Mixer 3



Mass in + generation = mass out +consumption +accumulation

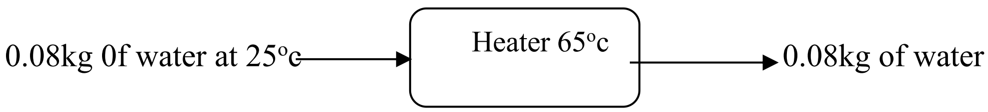
Mass in = mass out

M1 + M2 +color + perfume = Mass of shampoo

Mass of shampoo=90.5gm +15gm +1gm+0.5gm=107gm

5.2.2 Energy balance for shampoo production in laboratory

Energy balance on heater for water base ingredients



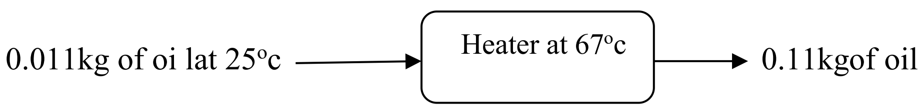
From conservation of energy

Energy in+ energy generation = energy out + energy consumption + energy accumulation

Energy in = energy out

Q= mCP ΔT   Q=0.08kg*4.18kj /kg k (65-25) k =13.376kj

Energy balance on heater for oil base ingredients



From conservation of energy,

Energy in+ energy generation = energy out + energy consumption + energy accumulation

Energy in = energy out

Q= mCP ΔT   Q=0.011kg*2.26kj /kg k (67-25) k =1.04412kj

5.3 material and energy balance for oil extraction industrial scale

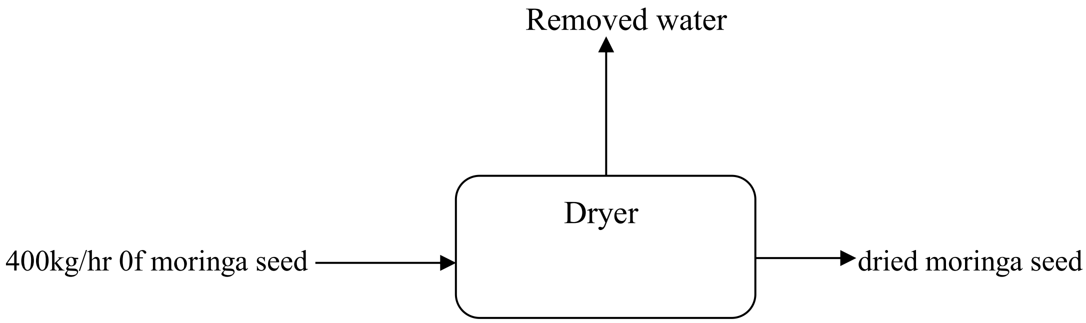
The oil production capacity is 994 tone/year which equals to 138 kg/hour and the annual working time is 300 days. To achieve this goal, we have expected to do material and energy balance at each stages of the process. Here we are trying to do the material and energy balance calculation for main equipment's.

5.3.1 Mass balance for oil extraction

- Plant capacity 994tone/year=138 kg/hr.
- Raw material required 400kg/hr.
- The seed contain 12% moisture in wet base
- 10% in dry base

- The ratio of solute to solvent 1:10
- the factory works for 300 days/year

Mass balance on drying



From conservation of mass

Mass in +generation – consumption – mass out = accumulation

Mass in = Mass out

Mass of moringa seed = Mass of removed water + Mass of dried moringa seed

400kg /hr = 400kg*0.12 +dried moringa seed

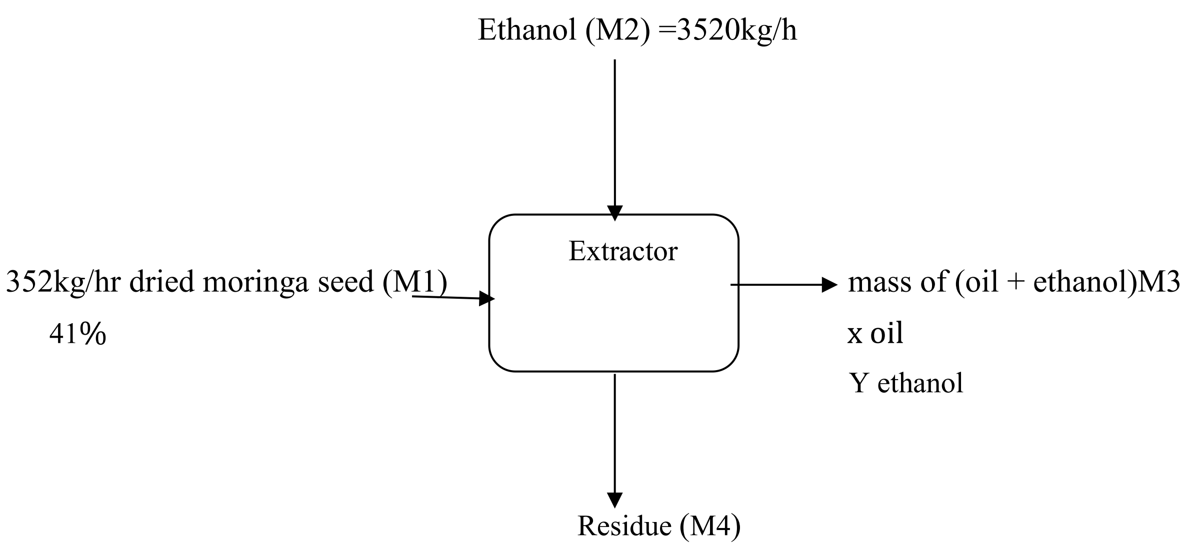
Mass of dried moringa seed=400kg/h-48kg/hr=352kg/hr

Mass of moringa seed = Mass of removed water + Mass of dried moringa seed

400kg/hr=48kg/hr+352kg/hr

400kg/hr=400kg/hr

Mass balance on extraction



Residue (60% solid 6% ethanol 3% oil)

Residue = 211.2+21.12 +10.56= 242.88kg

Mass in +generation – consumption – mass out = accumulation mass in = mass out

Mass balance

M1+M2=M3+M4 → 352kg/hr+3520kg/h= M3+ 242.88kg/hr

M3= mass of (oil + ethanol)=3872kg/hr-242.88kg/hr=3629.12kg/hr

Component balance

Oil balance

M1×0.41+M2×0=M3×Xoil+M4×0.03

352kg/hr ×0.41+3520kg/h×0=3629.12kg/hr ×Xoil+242.88kg/hr×0.03

144.32kg/-7.2864kg/hr =3629.12kg/hr ×Xoil

Xoli=137.0336kg/hr/3629.12kg/hr=0.038

Yethanol =1-0.038=0.962

Mass of oil=M3×Xoil=3629.12kg/hr×0.038=138kg/hr

Mass of ethanol=M3×Yethanol=3629.12kg/hr×0.962=3491kg/hr

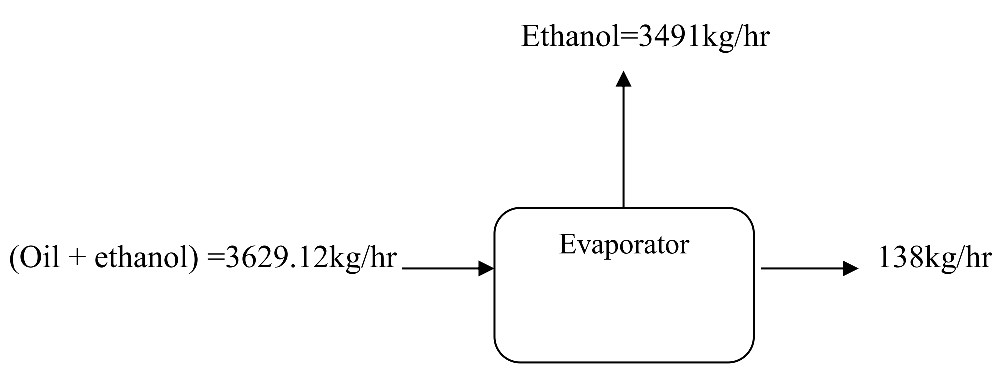
M1+M2=M3+M4

352kg/hr+3520kg/h= 3629.12kg/hr +242.88kg/hr

3872kg/hr=3872kg/hr

Mass balance on evaporator

Assume ethanol recovery is 100%



Mass in +generation – consumption – mass out = accumulation

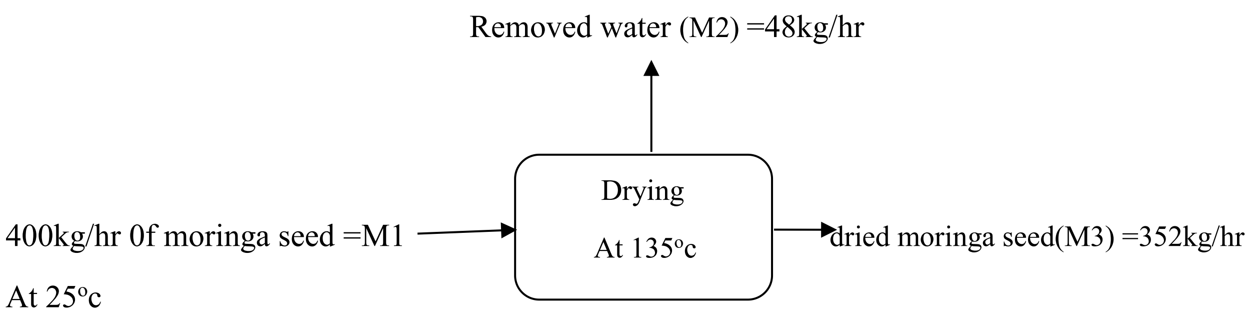
Mass in = mass out

3629.12kg/hr=3491kg/hr +138kg/hr

3629kg/hr=3629kg/hr

5.3.2 Energy Balance for oil extraction

Energy Balance on dryer



From conservation energy

Energy in+ energy generation = energy out + energy consumption + energy accumulation

Energy in = energy out

The temperature in put=25ºc

Steady state operation that means Q Input=Q out put

$Qin=m_1 cp\Delta T1$

Cp of Moringa seed at 25ºc or 298k is 2.45kJ/kg.

The temperature of drying is kept 135ºc

M_1=400kg/hr.

Qin=400kg/hr×2.45kj/kgk(135-25)k

=107,800kj//hr.

$Q\ out=m_2 cp\Delta T+m_3 cp\Delta T+m_2\lambda$

From the mass balance m_2=48kg/hr., m_3=352kg/hr.

Cp water =4.18KJ/kgk and latent heat of steam at 135^0c=2246kj/kg

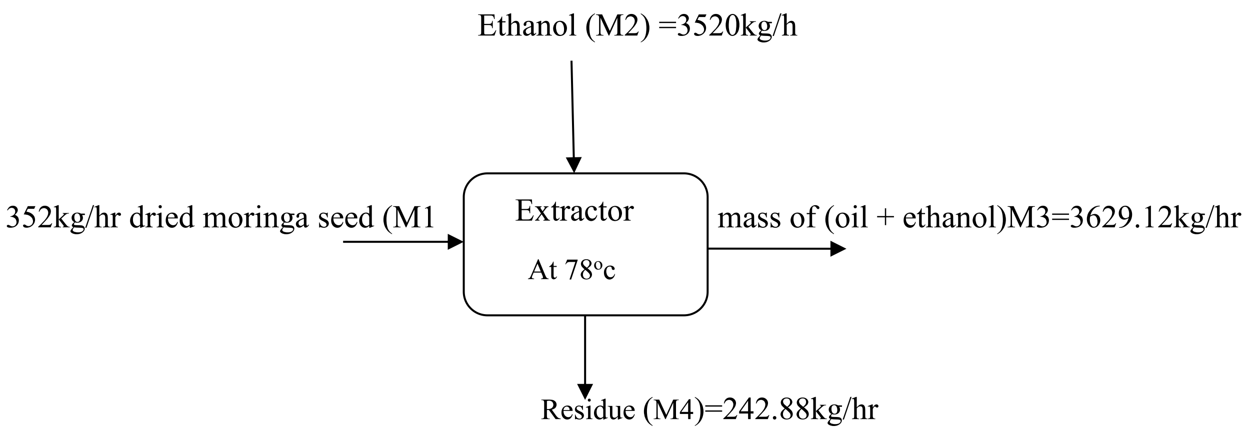
Q_{out}=48kg/hr×4.18kj/kgk×(135-25)k+352kg/hr ×2.45kj/kgk×(135-25)k +48kg/hr ×2246.5kj/kg

=224766.4kj/hr

Heat supplied to the dryer to be, Dryer =Q_{out}-Qin=116966.4kj/hr.

Heat removed by condenser =latent heat lost by vapor=m2λ =48kg/hr×2246.5kJ/hr.=107832/hr.

Energy Balance on Extractor



Residue (60% solid 6% ethanol 3% oil)

From conservation of energy,

Energy in+ energy generation = energy out + energy consumption + energy accumulation
Energy in = energy out

Q= mCP ΔT

Qin=M1cpΔT+M2cpΔT

352kg/hr×2.45kj/kgk/×(78-25)k+3520kg×2.57kj/kgk×(78-25)k =525166.4kj/hr
Cp mix=cp.x oil +cp.xethanol +cp.xsolid residue
From the mass balance mass of oil in the raffinate
=0.03×242.88kg/hr =7.2864kg/hr. mass of ethanol
in the raffinate=0.06×242.88kg/hr=14.5728kg/hr.
mass of solid in the
raffinate=0.6×242.88kg/hr=145.728kg/hr
Total mass of m_4=167.58kg/hr.

Xoil=0.0432, Xeth=0.087, Xs=0.87

Cpmix =2.26×0.0432+2.57×0.087+2.45×0.87

Cpmix =2.411kJ/kg.k

Cpmix in miscella =2.26×0.038+0.962×2.57=2.56kJ/kgk

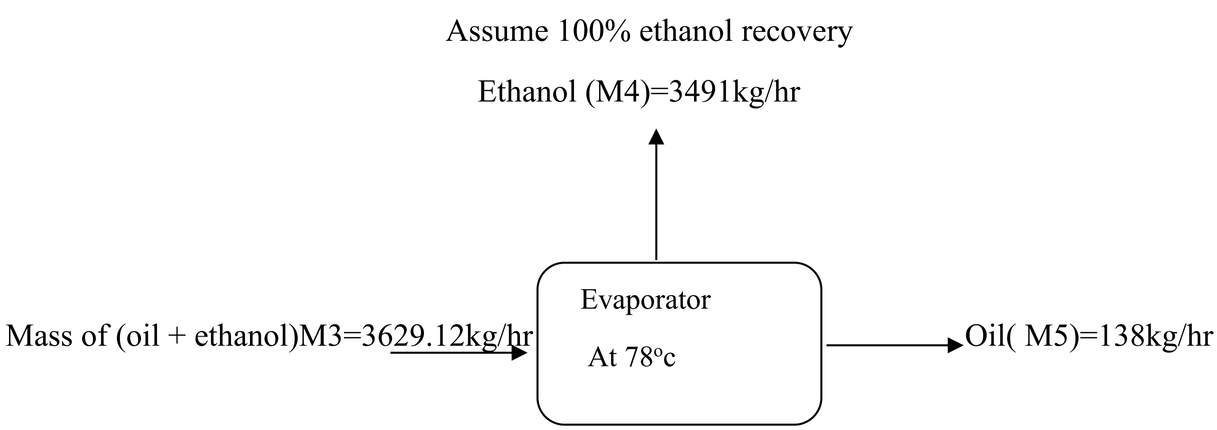
Qout=M3cpmixΔT+M4cpmixΔT+M3λ

=3629.12kg/hrkg×2.45kj/kgk×(78-25)k+242.88kg/hr×2.56kj/kgk(78-25)k+352kg/hr kg×333.146 kj/kg =621462.6 KJ/hr.

Heat supplied to the extractor =Qout-Qin=96296.1824 KJ/hr.

Heatremoved bycondenser=m3λ=352kg/hr×333.146=117267.39 Kj/hr.

Energy Balance on Evaporator



From conservation of energy,

Energy in+ energy generation = energy out + energy consumption + energy accumulation

Energy in = energy out

Q= mCP ΔT

100%ethanol M4= 3491kg/hr.

Qin =Qout

$Cpmix = cp.xoil + cp.xethanol$

$cPmix = 2.26kj/kgk \times 0.038 + 2.57kj/kgk \times 0.962 = 2.56kj/kgk$

$Q_{in} = m_3 cpmix\ \Delta T = 3629.12kg/hr \times 2.56kj/kgk(78-25)\ k = 492399kj/hr$

$Qout = m4cp\Delta T + m5cp\Delta T$

$= 3491kg/hr \times 2.57Kj/kgk \times (78-25)k + 138kg/hr \times 2.26kj/kgk \times (78-25)/k \quad = 492038.78jJ/hr.$

Heat supplied to the evaporators =Qout-Qin=96296.1824Kj/hr.

5.4 Material and energy Balance for shampoo production in industrial scale

Table 5. 1 Market demand Estimation of shampoo in Ethiopia**.**

Year	Quantity in tone
2013	146
2014	155
2015	164
2016	174
2017	185
2018	196
2019	207

Hence, in order to analyze the unsatisfied demand for detergents the data obtained from the Ethiopian Revenues and Customs Authority on the import of detergents have summarized in the above table.

Note Taking this as a base, the current demand for liquid detergent is estimated at 155 tons per year in 2014, for our project assume the manufacturing capacity of our factory covers half percent of imported liquid detergent market share in Ethiopia which is 50% i.e 78 tones /year or 78,000kg/year shampoo.

Mixing Volume of shampoo is 100,000L (including safety factor)

Working volume 78,000L

Operation time = 300 days/year

One batch feed to the mixer is every

Four hour=4hr

Total batches perday=24/4=6batches

in one batch = 78,000L/6

=13000L/four hour

From the laboratory result the composition of liquid shampoo is tabulated as follows:

Table 5. 2 Raw material mixing in laboratory scale

Raw materials	Amount in liter, L	Compos ition %
Water	0.08	75
Sodium chloride	0.004	3.7
SLS	0.0045	4.2
citric acid	0.003	2.8
Moringa oil	0.011	10.2
Formaldehyde	0.002	1.9
Egg yolk	0.002	1.9
Perfume	0.001	0.9
Color	0.0005	0.5
Total	0.107	100%

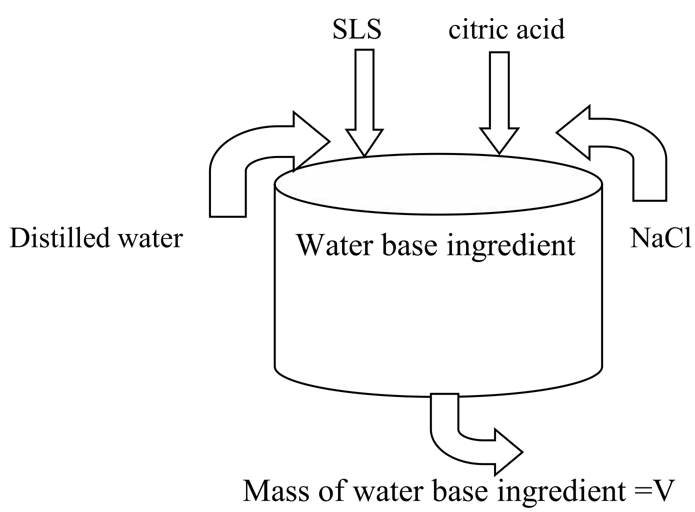
To get the same proportion in industrial level, 87,000 L of total volume should be fractionated in to components

Table 5. 3 Raw material mixing in industrial scale

Raw materials	Amount in liter, L
Water	0.75x78,000=58,500L
Sodium chloride	0.037x78,000=2886L
SLS	0.042x78,000=3276L
citric acid	0.028x78,000=2184L
Moringa oil	0.102x78,000=7956L
Formaldehyde	0.019x78,000=1482L
Egg yolk	0.019x78,000=1482L
Perfume	0.009x78,000=702L
Color	0.005x78,000=390L
Total	78000L

5.4.1 Material Balance for shampoo production in industrial

Mixer1



Mass in + generation = mass out +consumption +accumulation,

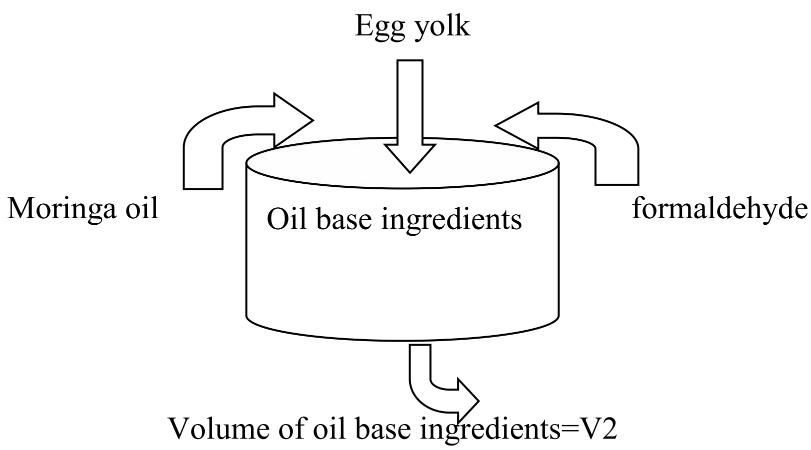
There is no generation, consumption and accumulation

Mass in = mass out

Volume of distilled water +Volume of SLS +Volume of Nacl + Volume of citric acid = (V1)

58,500L+3,276L+2,886L+2,184L=66,846 L

Mixer2



Mass in + generation = mass out+consumption+accumulation

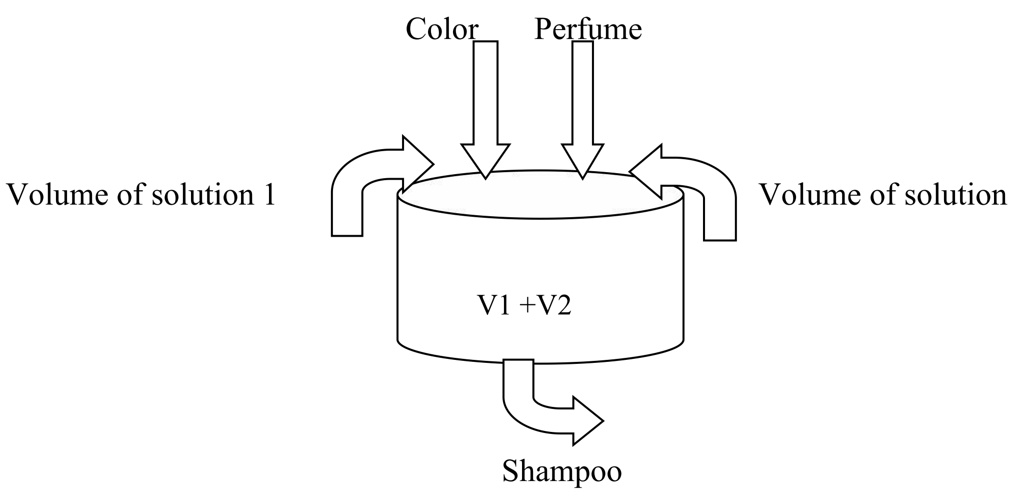
There is no generation, consumption and accumulation

Mass in = Mass out

Volume of moringa oil+ volume of egg yolk +volume of formaldehyde = (V2)

7,956L+1,482L+1,482L=10,920

Mixer 3



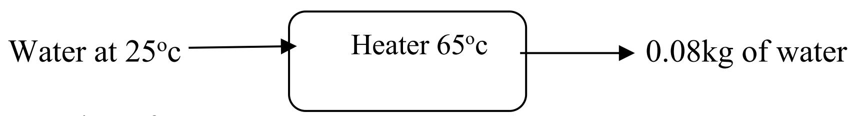
Mass in = mass out

Volume of shampoo =volume of solution1+ volume of solution2 + volume of perfume + volume of color

66,846 L+10920+702L+390L=78000L

5.4.2 Energy balance for shampoo production on industrial scale

Energy balance on heater for water base ingredients



From conservation of energy,

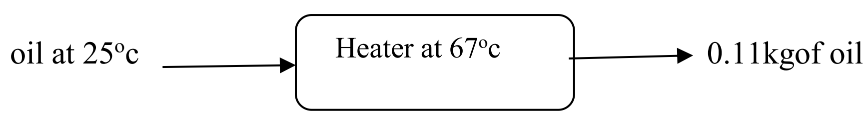
Energy in+ energy generation = energy out + energy consumption + energy accumulation

Energy in = energy out

Mass = 74,300kg/year

Q= mCP ΔT Q=58,500kg*4.18kj /kg k (65-25) k =9781200kj

Energy balance on heater for oil base ingredients



From conservation of energy,

Energy in+ energy generation = energy out + energy consumption + energy accumulation

Energy in = energy out

Q= mCP ΔT Q=7956kg*2.26kj /kg k (67-25) k =868795.2kj

5.5. Equipment selection, specification and design

5.5.1. Equipment selection and specification

Moringa seasonal harvested plant it takes 9 to ten months to mature the seed. Because of these long maturity lives; the size of the storage tank should be capable of holding at least 11-month production.

Density of raw seed = 400kg/m3

Mass of raw seed = 9600kg/day (from material balance).

Total amount of Moringa required in 11 months = 9600kg/day × 11 month × 30days/month = 3168000kg or 3168 tons

Density =mass/volume…………………………………………. (5.1)

The Volume Moringa seed required for 11 months =

mass/density = $3168000kg/400kg/m^3 = 7920m^3$

Allowance = 7920×0.06 = $475.2m3$

Total volume of storage tank

= 7920 $m3$ + 475.2 $m3$ = $8395.2m3$

Sizing of dryer

Mass of raw seed = 400kg/hr.

= 9600kg/day

Allowance 6%

Density of the seed = 400kg/$m3$

Then the volume of drying solid = mass of raw seed /density of raw seed +allowance

9600kg/400kg/m3+0.06×24m3

= $24m3$+ $1.44m3$=$25.44m3$

Area of solid

Take height to diameter ratio (1:4), since the dryer is horizontal rotary dryer the height of the dryer is its length.

H/D = 4 ………………………………………………… (5.2)

V = $\pi D2$H

25.44 = π $4D3$

$D3$=25.44/4 π

D=1.26m

Area of the drying solid (the surface area of dryer which covered by drying solid);

As = πDH

= $\pi * D *$×4D= $19.9m2$

Sizing of grinding

Mass of the seed =352kg/hr.

=352kg/hr×24hr/day=8448kg/day

Density of the seed =400kg/$m3$

Volume =mass/density +allowance

$=8448kg/day/400kg/m3 +5\%\times 21.12m3$

$=21.12m3+1.056m3=22m3$

Sizing of extractor

Density of mixture =density of ethanol + density raw of seed

$= [(789kg/m3+ 400kg/m3)]/2= 594.5kg/m3$

Total mass of the mixture =3520kg/hr + 352kg/hr.

= 3872kg/hr.

Volume = mass/density

$= 3872kg/day/594.5kg/m3 +$ allowance

$= 3872kg/day/594.5kg/m3+ 5\%\times 3872kg/day/594.5kg/m3= 10m3$

Sizing of oil storage tank

Assume the oil will store up-to two months, then the size of the storage tank will be calculated as follows;

Mass flow rate of the product = 138kg/hr.

Mass of oil = 138kg/hr. × 24hr/day × 2month × 30days/month

= 198720kg

Density of Moringa oil = 903kg/m^3

Volume of oil = mass of oil /density of oil

$= 198720/903kg =220m3$

Sizing of ethanol storage tank

The amount of solvent required for two-month operation is calculated as follows; Mass flow rate of ethanol = 3520kg/hr.

Mass of ethanol = 3520kg/hr. × 24hrday × 2month × 30day/month= 5,068,800kg

Density of ethanol =789kg/m3

Volume of ethanol = mass of ethanol/density of ethanol

= 6424m^3

Transfer pumps are used to transfer material from premix vessel to the manufacturing vessel only if the vessel is not under vacuum. If it is under vacuum the premix is automatically transferred into the main vessel through vacuum (Sinnott, R.K. 1993).

Transfer pumps are required for the following:

- Transferring surfactants to premix / main vessel.
- From main vessel to storage vessels.
- From storage vessel to filling machine.

I. Rotary pumps

Types of rotary pumps include cam-and-piston, internal-gear, lobular, screw, and vane pumps. Gear pumps are found in home heating systems in which the burners are fired by oil. Rotary pumps find wide use for viscous liquids. When pumping highly viscous fluids, rotary pumps must be operated at reduced speeds because at higher speeds the liquid cannot flow into the casing fast enough to fill it. Unlike a centrifugal pump, the rotary design will deliver a capacity that is not greatly affected by pressure variations on either the suction or discharge ends. In services where large changes in pressure are anticipated, the rotary design should be considered (Sinnott, R.K. 1993).

II. Globe valves

Globe valves are normally used, though the other types can be used. Butterfly valves are often used for the control of gas and vapor flows. Automatic control valves are basically globe valves with special trim designs. The careful selection and design of control valves is important good flow control must be achieved, whilst keeping the pressure drop as low as possible. The valve must also be sized to avoid the flashing of hot liquids and the supercritical flow of gases and vapors (Sinnott, R.K. 1993).

III. Pipeline

Interconnecting pipeline is provided for the plant as per the layout of the design. All pipelines are electro polished from inside and outside. Pipelines are used for transferring the surfactants from storage tank to premix vessels, from premix vessels to manufacturing vessels and from manufacturing vessels to storage vessel and from storage to filling line. The capital cost of a pipe run increases with diameter, whereas the pumping costs decrease with increasing diameter. The most economic pipe diameter will be the one which gives the lowest annual operating cost (Sinnott, R.K.1993).

Iv. Main shampoo manufacturing vessel

Manufacturing vessel is cylindrical vessels with dished bottom vessels. Top of the vessel is also dished end welded. Agitator assembly in the manufacturing vessel, slow speed pitch blade agitator is provided in the manufacturing vessel. However, for best results contra rotating or semi contra rotating agitators are normally preferred by most of the manufacturers for excellent quality of the shampoo produced. CIP turbo disk is provided at the top of the vessel for cleaning. Suitable nozzles, manholes, valves etc. are provided on the vessel. (Sinnott, R.K.1993).

V. Premixing vessel

Premixing vessel is cylindrical vessels with dished bottom vessels. Top of the vessel is also dished end welded or can be provided with loose lid too. Agitator assembly in the premix vessel is high speed cowl/ saw cutter type agitator. In some cases, high speed homogenizer is also provided. CIP turbo disk is provided at the top of the vessel for cleaning. Suitable nozzles, manholes, valves etc are provided on the vessel.

There is no need for any vacuum in this vessel. Normally the capacity of this vessel is 60 % the capacity of the main manufacturing vessel. (Sinnott, R.K.1993).

VI. Storage vessel

Storage vessel is simple vessel used to store shampoos. It is cylindrical type of vessel with dished bottom, loose top lid. Bottom valve is provided with din fittings to facilitate the pipeline connection. Its capacity is the same as the manufacturing vessel. Normally storage tanks are more in number so that different types of shampoos can be manufactured and stored. Filling is then done as per the requirement & market demands. (Sinnott, R.K.1993).

A basic stirred tank design consideration

i. Cost: in terms of cost the designs can be ranked, from cheapest to most expensive, as:

- simple, no baffles
- Agitation nozzles
- Spiral baffle

ii. Pressure: as a rough guide, the pressure rating of the designs can be taken as: up to 1 atm.

Select conventional type of vertical cylindrical vessel.

One of the advantages of cylindrical vessel is less crack and suitable for holding liquid than other.

Calculate volume of Vessel (tank).

V tank = V shampoo +10% shampoo

10% is given as an allowance for the mixture to swing.

= (0.10) * (v of shampoo)

For volume calculation of shampoo

Volume of shampoo per batch=1300 L

Therefore, Volume of tank =v of shampoo+0.10* v of shampoo

= 1300L+0.10 * 1300 L

=1430L

Design of impeller size and power consumption

Design considerations

Baffles

A baffle width one-twelfth the tank diameter w = D /12; a length extending from one half the impeller diameter, d/2, from the tangent line at the bottom to the liquid level (Sinnott, R.K.1993).

Impeller size

For the popular turbine impeller, the ratio of diameters of impeller and vessel falls in the range, d/D, = 0.3-0.6, the lower values at high rpm, in gas dispersion.

Impeller speed

With commercially available motors and speed reducers, standard speeds are 37, 45, 56, 68, 84, 100, 125, 155,190, and 320rpm. (Sinnott, R.K.1993).

CHAPTER SIX

6. COST ESTIMATION

Table 6. 1 Equipment cost with specific capacity.

no	Name of equipment	Number of equipment	Capacity or size	Cost ($)/equipment	Cost for total Equipment ($)
1	Grinder	1	20 m^3	137,666	137,666
2	Dryer	1	25 m^3	157,866	157,866
3	Conveyer	2	D=0.5, L=30m	50,282	100,564
4	Extractor	2	71 m^3	97,484	194,968
5	Storage tank of oil	1	210 m^3	47,766	47,766
6	Storage tank of ethanol	1	4715 m^3	247,766	247,766
7	Pump	3	0.05 m^3	46,248	138,744
8	Evaporator	1	110m^2	156,788	156,788
9	Moringa seed storage tank	3	7130 m^3	101,284	303,853
10	mixer	2	300m^3	106,160	212,321
11	Packaging bottle	570,000pice	150ml	0.08	45,600
11	total				1,818,697.6

Source; www.maches/equipmentas as follows corresponding to their size and (http;//www.alibaba.com/engcs/chemical/prters/ce.html)

6.1 Estimation of total product cost

Fixed Capital Investment (FCI) Estimation: - refers to the amount of capital requirement for buildings, industrial plants machinery, and tools, motor, vehicles, office equipment's (max. teal, 1973). the cost of machine and equipment is estimated at about FCI (Fixed capital investment)**.**

Direct cost (DC)

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

- Purchased equipment cost (PEC) =$ 1,818,697.6
- Installation including painting (8-9%PEC) = 9%PEC = 163,682.784$
- Instrumentation and control (6 % PEC) = 109,121.9$
- Piping (80%PCE) = 145,495.68$
- Electricity (40% PEC) = 727,479.04$

B. Building process including services (10% PEC) = 181,869.76$

C. Service utilities (20-40% PEC) = 30%PEC = 545,609.28$

D. Land (4-8% PEC) =5%PEC = 90,934.88$

E. Yard (10-20% PEC) = 10%PEC =181,869.76$

Direct cost (DC) = A+B+C+D+E =$ 3,964,778.684

Indirect cost

A. Eng'g and supervision (20% of DC) =$ 792,955.7368

B. Construction expense and construction fee (18% of DC) =$713,660.1631

Total indirect cost=A+B=$1,506,615.9

FCI = Direct cost +Indirect cost

FCI= $5,471,394.636

Contingency (10% of FCI) =$547,139.4636

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 to pay wages and other claims against the company (Bauman, 1984, Urich, 1986).

Total capital investment (TCI) = FCI + WCI

TCI = $ 5,471,394.636 + 0.15TCI

TCI =$ 6,436,934.9

WCI = 0.15 TCI = $965,540.2

Fixed charges

A. Depreciation (10 % of FCI) = $547,139.4636

B. Local taxes (1-2% of FCI) = 2% FCI =$109,427.9

C. Insurances (0.4-1% FCI) = 0.5%FCI = $27,356.97

D. Rent (8-12% of FCI) =8%FCI = $437,711.6

Total fixed charge (TFC) = $1,121,635.9

Total production cost (TPC) = WC/0.3 = $3,518,467.3

Plant overhead cost (POC) = (5-15% of TPC) = 5% TPC = $160,923.4

Manufacturing cost = TFC +TPC +POC=$4,501,026

General expense

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

- Administrative costs (2-6% of TPC) =3%TPC = $96,554.019
- Distribution and selling (2-20 %TPC) =2%TPC = $64,369.35
- Research and development(5%TPC) =$160,923.4
- Financing (interest)(5% of TCI) = $321,846.745

General expense = **$**643,693.5

Working day = 300 day/year

Annual shampoo production = 78,000L/year. Operation time =300 days/year for 24 hrs.

Daily shampoo production =78,000 L/year/ (300day/year) = 260L/day

Unit sell price = Total production cost (TPC) /Production capacity

=$3,218,467.3/78000=41 X0.15=$6

Total selling price is = $41/LX78000L/year= $5,198,000

Profitability analysis

Gross profit = product sales revenue–total product cost

Gross profit = $5,198,000/year - $3,218,467.3 /year= $ 1,979,532.7/year

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

Depreciation = 0.1*$ 5,471,394.636 +0.025*181869.76= $551,686.2

Gross profit including depreciation (Gross Profit - depreciation cost)

= $1,979,532.7/year- $551,686.2

= $1,427,846.5/year

Net profit = gross profit with depreciation (1-Ø), where, Ø= income tax of rate Ethiopia =30%

= $1,427,846.5/year *(1-0.3) = $999,492.5447/year

Minimum acceptable rate of return (Mar)

Minimum acceptable rate of return (mar) for new capacity with established corporate with low levels of risk=12% Rate of Return an Initial Investment (ROI)

ROI = NET PROFIT / Total Capital Investment

= ($999,492.5447 /year) / ($6436934.9)

= 0.16*100%

= 16%

ROI ≥ Mar (12%), 15% >12%, so the Project is feasible

Payback period

Pay Back Period = (FCI – Salvage) / (Net profit + Depreciation) = ($5471394.636 – 0) / ($999492.5447/year + 551686.2/year) = 3.5year.

6.2. Site selection and environment effect

6.3.1. 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, Jinka and around these areas. In these particular areas there is enormous amount of moringa stenepetela plantation with abundant source of moringa stenepetela seed. In addition to this, selecting this area also provide additional geographical advantage, because land is cheap compare to other areas especially around Addis Ababa. Generally, this area has selected based on factors which enhance us to maximize feature targeted profit and to achieve our project without any obstacles.

6.3.2. Environmental effect

Every organization (company or industry) has the moral and legal obligation to protect the health and welfare of its employees as well as that of the general public. Therefore, good safety measures have to be put in place to ensure the safety of lives and prevent damage to equipment. The primary aim of these safety measures therefore is to prevent or minimize workers exposure to the potential hazard, injury to workers, loss of lives, and destruction of properties. They are also needed to ensure safe as well as efficient operation.

Our production process is environmentally friendly. Both the oil extraction and formulation of shampoo using this extracted moringa stenepetela seed oil as ingredient do not affect the environment, because it does not generate toxic wastes. Since Production of shampoo not involves any complex process

Generally, extraction of moringa stenepetela seed 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 safe and effective.

CHAPTER SEVEN

7. CONCLUSION AND RECOMMENDATION

7.1. Conclusion

This project was intended to produce shampoo from moringa stenepetela seed oil and other ingredients. Shampoo was produced from the mixing of water based and oil-based ingredients with the heat of 65and 67^{0}c respectively. those water-based ingredients were: -water, SLS, NaCl and citric acid. oil base ingredients were - moringa stenepetela seed oil, egg yolk and formal aldehyde. moringa stenepetela seed oil was extracted by using solvent extraction of ethanol. Two trials and investigations were carried out to extract oil from moringa stenepetela seed.

As observed from laboratory results, particle size of moringa stenepetela seed oil have great effects on percentage yields of the oil. From 26gm of mass which has 0.4mm *moringa* powder and extraction time of 3hr the yield of oil founded was16.8ml and for the same mass and 0.525mm *moringa* powder the yield of oil found was 12.7ml. From this result we conclude that as particle size decreases the yield of oil content increases.

The formulated liquid shampoo preparations where based upon standard formulation ratio and to develop few parameters for quality and purity of liquid shampoo. The parameters were evaluated and compared with marketed shampoos to check whether or not the produced shampoo can meet the standard of market shampoo. In laboratory we have used the following two formulation having the composition of Formulation (S1) = 80ml of water, 4.5g of SLS, 11ml of moringa oil, 4gm of NaCl ,3ml of citric acid 1ml of perfume, 0.5ml of color,2ml of formaldehyde and 2,ml of egg yolk Formulation (S2) = 80mlof water, 5 of SLS, 12.5ml of moringa oil, 4gm of NaCl,1ml of perfume, 0.5ml of color,3ml of citric acid, 2ml of formaldehyde and 2ml of egg yolk.

we have formulated and produced a shampoo in the laboratory and characterized the physical and chemical characteristics, such as, Foam ability, pH, solid content and detergency power of our product with the standard products and the results were (45ml, 46.5ml), (6.3, 6.58), (31%, 33%), (25%, 25.5% respectively. Our product is very environmentally friendly because it doesn't possess much chemicals in it. An industry scale production process of shampoo was also described.

7.2. Recommendation

- In chemical engineering department, the laboratory facilities and set ups are not fulfilled and not sufficient. It recommended to the department should be in a position encourage motivation by upgrading the laboratory equipment's and by supplying the required important materials for the work.
- Further study shall be conducted at the impurity; besides that, it recommends that the detergent and cosmetics factories that imports essential oil from aboard, 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 encouraged and attracting investors to participate in this sector.
- Even if Moringa kernel oil has been used worldwide in food and formulation of cosmetics product, in Ethiopia the oil is not commercially produced in some extent the leave powder is available in the market. Further study needed bout the formulation of specific cosmetics product for import substitution and promoting natural cosmetics products.
- Hair color, 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, but there is no hair color in laboratory .it is recommended to use hair color chemical.
- Further studies must be conducted on the herbal and chemical based shampoo production sector, as there are still harsh chemicals being inserted in commercially available herbal shampoos for example citric acid and SLS. And it recommended, those chemicals must be replaced with alternate natural ingredients.
- For the recovery of solvent, one should use the rotary evaporator method instead of simple distillation. It recommended to the department should be fulfilling this equipment to better separate solvent and yield.

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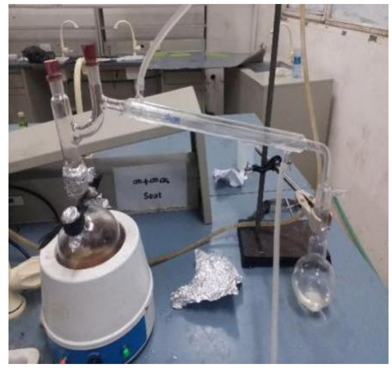
APPENDIX



Oil extraction distillation

Shampoo ingredients oil and water base ingredients

Mixing and heating produced shampoo

Typical values for some measurement

Measurements	unit
Boiling Point of ethanol	78^{o}c
Boiling Point of Oil	271oc
Specific Heat Capacity of oil	2.26kj/kgk
Specific Heat Capacity of water	4.18kj/kgk
Specific Heat Capacity of ethanol	2.57kj/kgk
Density of Water	1000 kg/m3
Specific Gravity of Oil	0.9126
PH of oil	7.2
PH of shampoo	6.5