WOLKITE UNIVERSITY

COLLEGE OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF CHEMICAL ENGINEERING

PRODUCTION AND CHARACTERIZATION OF PERFUME FROM ORANGE PEEL

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DECLARATION

We, the undersigned, declare that this is our original work, has not been presented for a degree in any other university and that all sources of material used for the thesis are duly approved.

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ABSTRACT

Perfume is a mixture of fragrant essential oils and aroma compounds, fixatives and solvents used to give the human body, objects and living spaces a pleasant smell.The objective of this study was formulate perfume from orange peel using Soxhlet extractor. Particle size and extraction time were considered parameters for investigation. Under this investigation particle size range; 0- 300µm and 300µm – 1.18mm extraction time 2 hr and 3 hr were considered.From the experiment the maximum oil yield 34.67 % was obtained at particle size range of 0- 300µm and extraction time of 3 hour. A minimum oil yield 29.33% was obtained at particle size range of 0.3-1.18mm and 2 hour extraction time.After the optimum operating condition for maximum oil yield was determined, using this operating condition the oil was extracted and the physicochemical properties(like acid value, saponification value, pH, ester value and specific gravity) were determined for characterization and quality analysis. The results were compared with standard orange peel essential oil specifications and the values were within the standards. Finally, perfume was formulated from the extracted essential oil. The blending solution having 10ml ethyl alcohol and 4ml oil exhibited relatively pleasant smell (scent).

Contents

LIST OFABBREVATIONS AND ACRONYMS

A.V	Acid value
DC	Direct cost
DOE	Design of experiment
EDP	Eau de Parfum
EDT	Eau de toilette
EDC	Eau de Cologne
EDS	Eau de splash
ESdP	Esprit de Parfum
E.y	Extraction yield
FCI	Fixed capital investment
IC	Indirec cost
M.c	Moisture content
OL	Operating labor
PDT	Perfume de toilette
PEC	Purchased equipment cost
S.g	Specific gravity
S.V	Saponification value
TCI	Total capital investment

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CHAPTER ONE:INTRODUCTION

1.1 Background

Perfume is a mixture of fragrant essential oils and aroma compounds, fixatives and solvents used to give the human body, objects and living spaces a pleasant smell. The word perfume owes its meaning to Latin word ‘per fumum’. This means through smoke. The art of making perfumes had its origin in ancient Mesopotamia and Egypt. Tapputi is the world’s first recorded chemist and perfume maker from Mesopotamia. Later, perfumes spread to Rome and Arabian countries. Most of the perfumes from these places were based on incense. Egyptians used perfumes in religious rituals like cleansing ceremonies. Perfumed oils had many medicinal properties and were in use in balms and ointments. Slowly, Egyptian women started using perfumed creams and oils as toiletries. This also led to the spread of perfumes to other countries like Greece, Arabian countries and Rome.

Grasse in Provence was then the largest production center of perfumes. Slowly, Paris became the commercial center for production of perfumes. This also led to development of different perfume houses across Europe. William Sparks Thomson set up The Crown Perfumery in 1872 with a collection of floral fragrances. Leather fragrances became popular in the 1930s. Noteworthy perfumers include Jacques Fath, Christian Dior, Pierre Bal main, Jean Patou, and Nina Ricci. Presently, there are more than 30,000 designer perfumes in the market catering to all ranges of cost and luxury in addition to their fragrance [9].

Since the beginning of recorded history, humans have attempted to mask or enhance their own odor by using perfume, which emulates nature's pleasant smells. Many natural and man-made materials have been used to make perfume to apply to the skin and clothing, to put in cleaners and cosmetics, or to scent the air. Because of differences in body chemistry, temperature, and body odors, no perfume will smell exactly the same on any two people.

Many ancient perfumes were made by extracting natural oils from plants through pressing and steaming. The oil was then burned to scent the air. Today, most perfume is used to scent bar soaps. Some products are even perfumed with industrial odorants to mask unpleasant smells or to appear "unscented." While fragrant liquids used for the body are often considered perfume, true perfumes are defined as extracts or essences and contain a percentage of oil distilled in alcohol [11].

A perfume is composed of three notes. The base note is what a fragrance will smell like after it has dried. The smell that develops after the perfume has mixed with unique body chemistry is referred to as the middle note. And the top note is the first smell experienced in an aroma. Each perfumery has a preferred perfume manufacturing process [7].

India along with Brazil, China and the United States of America account for almost half the orange production in the world [12]. Oranges are some of the most commonly utilized fruits in the world due to its pleasant taste [15]. and nutritional values.Because of the huge consumption of orange juice throughout the world, a large amount of wet solid waste is produced. This waste mainly includes orange peels. The peels [18] contain numerous oil bearing glands that enclose significant amounts of citrus oil. Therefore, instead of throwing out these peels as a solid waste can be utilized for oil extraction [22]. The composition [6, 1] of the oil extracted from orange peels varies depending on the species of citrus fruit used.

Essential oils have become an integral part of everyday life. They are very interesting natural plant products and among other qualities they possess various biological properties.Essential oil or also known as ethereal oil is a concentrated, hydrophobic liquid that contains hundreds of aromatic compounds, organic constituents, including hormones, vitamins and other natural elements. These compounds are extracted from leaves, stems, seeds, flowers, bark, roots or other elements of a plant. Essential oil contains highly volatile components. The oil is primarily used in perfumery due to pleasant odour.

1.2 statement of the problem

The main challenge is during formulation of perfume knowing the proportion in which essential oil and other materials to be mixed to avoid skin irritation. Due to demand growth, finding an alternative source for producing valuable products is becoming crucial thing at present. Most imported perfumes are synthetic odorant which are not pure natural fragrance and it is a mixture of organic compounds that are harmful when it applied.A more convenient way is to use by-products (wastes) as a potential source due not only reduce the cost of production but also environmental and health effect of wastes. Research studies have shown that citrus fruit peels like orange have an essential oil content of 8-12% and hence these fruit peels contribute several beneficial properties in cosmetics and personal care products. However, in Ethiopia people ignorantly throw away these fruit peels after using the edible fruit part and it becomes a source of environmental pollution. With this regard since the oil is essential in cosmetic industry we are highly motivated to apply scientific methodology in order to develop perfume.

1.3 Objectives

1.3.1 General objective

The general objective of this final thesis is production and characterization of perfume from orange peel.

1.3.2 Specific objectives

The specific objectives are:

- ✓ Extract essential oil from orange peel by using Soxhlet extraction method.
- ✓ Investigate the effect of extraction time and particle size on the yield of oil.
- ✓ Conduct the physicochemical characterization of essential oil produced.
- ✓ Characterize final product (perfume).

1.4 Scope of the study

This project work includes collection and preparation of orange peel from gubre town, then essential oil was extracted and perfume was formulated from orange peel and characterization of raw materials and final product. The project further entails about the economic analysis of perfume production. It also covers about the energy and mass balance of perfume production in industry.

1.5 Significance of the study

Perfume is a mixture of fragrant essential oils or aroma compounds, fixatives and solvents, used to give the human body, objects, and living-spaces an agreeable scent. Currently there is no perfume production plant established in Ethiopia. All perfume products are imported from foreign countries. Therefore this study is beneficiary for:

- To secure our perfume supply as well as to reduce its perfume import bill through the development of an indigenous perfume production.
- To reduce any side effect resulting from synthetic chemicals by substituting natural one.
- To create awareness for stockholders as it is possible to establish local industries for perfume and oil production because of available land and cheap raw materials.
- To create job opportunities.
- Minimize environmental pollution because the discarded waste used as a raw material.

CHAPTER TWO:LITERATURE REVIEW

2.1 Work review of some researchers

A study on optimization of Soxhlet extraction of oil from safou pulp was to investigate Soxhlet extraction of oil from safou using various organic solvents. The safou, fruit of the safou tree (Dacryodesedulis) is very fragile. Post-harvest spoilage, essentially due to the softening of the pulp, can affect 50% of production. Extracting oil from the pulp could offer a way to reduce losses. The safou contains 30-70% of oil in its pulp and about 10% in its seeds. It is a major oilseed plant in the countries of the Congo Bassin, where unfortunately it is still under exploited. One possibility is to extract fresh oil by cold pressing. This oil would be characteristic of a geographical area, the Congo Bassin, much like olive oil is of the Mediterranean. Soxhlet extraction of oil from safou using various organic solvents was carried out to obtain optimization data for the assessment of cold pressing extraction rates. Using a 23 factorial design and a centered composite design for the sample studied, we obtained an optimal yield of 52% after 2 hr of extraction from a finely ground safou powder containing 8% of residual moisture and with a ratio of pulp mass to solvent volume of 45 g/250 ml [11].

A study regarding the extraction and optimization of the avocado pulp oil yield using Soxhlet extraction is study investigated the oil yield using Soxhlet extraction with hexane and ethanol as solvents at different extraction times and amounts of solvents. The physical and chemical properties of the oil were determined too. The variety 240 of the Philippine avocado pulp was peeled, destoned and underwent freeze drying. After which it was dried, ground and accurately measured to 30 grams per experimental run. The constant sample mass was extracted using n Hexane and 96% ethanol as solvents at varying amount, specifically 250ml and 350ml. The extracted oil was then separated using a rotary evaporator. Best conditions were concluded from the preliminary experiments and were replicated to further stress the effects of the varying conditions. The highest oil content obtained using ethanol was 73.56% (w/w) while 40.33% (w/w) was obtained using hexane [13].

A study on production of oil from mango seed kernel and its physicochemical properties of Mango seed kernel oil was extracted using Soxhlet extraction with petroleum ether, ethanol and hexane. The physicochemical properties (acid value, iodine value, peroxide value and saponification value), the fatty acid composition and phenolic contents, of mango seed kernel oil were examined.

Oil extracted with hexane has better overall quality. Its acid, peroxide, iodine saponification values and phenolic content were 0.10 mg KOH/g oil, 8.72 mg/g oil, 38.50 mg/100 g oil, 207.5 mg KOH/g oil and 98.7 mg/g, respectively. The main fatty acids found in the mango seed kernel oil were steric acid and oleic acid. The results suggested that mango seed kernel oil is a good source of the unsaturated fatty acid, phenolic compounds and has the potential to be used as nutrient rich food oil or as ingredients for functional or, enriched foods [16].

A research on the quantitative and qualitative analysis and comparative study of essential oil extracted from orange, lemon and lime peels. They conducted the experiment by using 370gm of peels and 650ml of distilled water solvent at different distillation time (60,100,140 and 180min) and at constant temperature of 100^oC. They got maximum 20ml, 7ml and 5ml essential oil of orange, lemon and lime peel respectively at distillation time of 180 minutes [25].

formulated perfume by extracting essential oil from lemon grass using methods such as distillation, solvent extraction, and expression. Heat, chemical solvents, or exposure to oxygen in the extraction process denature the aromatic compounds, either changing their odors, character or rendering them odorless. Perfume must contain over 15% of fragrance oils in alcohol. Yield of oil from solvent extraction method is greater than the yield obtained from steam distillation method and in steam distillation method the yield from finely chopped lemon grass is more than from coarsely cut lemon grass because it provides large surface area. The extracted essential oil was formulated into perfume using a fixative and carrier solvent. The perfume which they have formulated from lemon grass has nice and pleasant smell [1].

Oil extraction from date palm seeds (Iraqi date palm) by standard solvent extraction method using a Soxhlet apparatus is aiming to investigate the extraction of palm seed oil as a cheap feedstock for producing bio-oil and determine the fatty acid composition of bio-oil. Parameters such as particle size, extraction time and type of solvent are optimized in order to enhance the yield of bio oil production. The bio-oil is characterized using Fourier Transform Infrared Spectroscopy (FT-IR) and Gas Chromatography Mass Spectrometry. Some of the basic fuel properties such as iodine value, saponification value, acid value, density, refractive index and kinematic viscosity are investigated to characterize fuel quality of the bio-oil. The extraction process was carried out on a laboratory scale with particle size 2mm, 1mm and 0.425mm for different time 1h, 2h, 4h and 6h. Particle size of 2 mm was chosen in order to study the effect of solvent type. The optimal conditions to obtain the highest oil yield of 8.5 % (w/w) were 120 min, 0.425 mm and n-hexane extracted time, particle size of grounded seed and type of solvent, respectively. The physical properties viscosity, density and refractive index were 29 CP, 0.925 g/cm2 and 1.444 respectively [12].

A comparative study on the effect of type of fixative material and the perfume formulation parameters (Concentration of ethyl alcohol, percentage of perfume and the percentage of the fixative used) were studied to determine the optimum conditions give perfume with high retention time (fixative), also the fixation time was compared with brand perfumes. Four fixative materials were studied; Sandal oil, Musk oil, Glycerin and benzyl benzoate. Design of experiments (DOE) with Minitab 15 software was done and leaded to minimum 20 runs necessary for this study. For the four fixatives the runs were eighty. The maximum fixation time of all the fixation materials are 6.3, 6.1, 5.9 and 5.9 h/g for Glycerin, Musk, Sandalwood and benzyl benzoate respectively with formulation parameters of (75% alcohol concentration, 30% perfume addition and 0.1% fixative material) for Musk, Glycerin and benzyl benzoate fixative materials and (85% alcohol concentration, 17.5% perfume addition and 0.55% fixative material) for Sandalwood as fixative material. The brand perfumes as Channel give 2 h/g fixation time and for many other brand perfumes give fixation time in the range of 2.2-2.9 h/g [19].

A research on the extraction of citrus oil from orange peels by steam distillation is carried out an experiment by keeping distillation time and solid to solvent ratio constant and varying the distillation temperature from 88-98ºC with 2oC interval, by keeping distillation temperature and solid to solvent ratio constant and varying the distillation time from 15-75min with 15min interval and by keeping distillation time and temperature constant by varying solid to solvent ratio from 100g/160ml to 100g/240ml and got maximum oil yield at 96ºC,60min and 100g/200ml respectively[25].

Essential oil extraction from orange peels was done using the Soxhlet method. The orange peels were pureed using a blender. A round bottom flask was washed, oven dried, and cooled in a desiccator. To carry out this procedure, the ground peels were sieved using a standard 0.6 mm particle size sieve. A dried mass of 10 g of the orange peel powder was weighed, and the weight recorded. The weighed sample was dropped in the Soxhlet extractor apparatus. The extraction was carried out using normal hexane, methanol, and petroleum as the extraction solvent. In the

Soxhlet apparatus, the solvent in the round bottom flask was heated from the heating mantle to become evaporated and got condensed down through the sample where it was able to extract the oil along, thereby, giving a mixture of oil and solvent, which was later separated. The percentage of oil yield are 2, 1.33 and 1.2 respectively.[10]

Essential oil extraction from orange peels was done using the Soxhlet method Particle size (mm): 0- 350µm , 350µm - 1mm and 1mm -2mm,Extraction time (hours): 3 and 4 and Solvent type: ethanol.The percentage oil extraction yield was directly related to extraction time i.e. the yield increased as extraction time increased. For fine particle size range 0-350µm the yield orange rapidly when compared to the other extreme particle mesh size (large and medium).The oil yield increased by 29.84 %as the extraction time increased from 3hour to 4 hour. However, for larger particle size i.e. 1mm-2mm the yield was lower at the beginning of the extraction and increased gradually as the extraction time increased. The yield increased to 19.61% as the extraction time increased from 3 hour to 4 hours. The result obtained in this research indicates that smaller particle size needs small extraction time to obtain maximum yield in comparison to large particle size. According to this study the maximum oil yield is obtained at 4 hours. extraction time and at lower particle size and since at 4 hours extraction time maximum yield was obtained, so extraction time above 4 hrs is wastage of time and cost. Thus, the extraction should be stopped after 4 hrs of extraction.[26]

A research on laboratory scale oil extraction and perfume formulation from essential oil used the method of solvent extraction, effleurage and hydro distillation and got 2.07%, 1.957% and 0.946% essential oil respectively per 140gm of lemongrass sample. Using fixatives and carrier solvent the extracted essential oil was formulated in to perfume [23].

A study on extraction of oil from neem seed using solvent extraction method of essential oil from neem seed was carried by Soxhlet extraction method using different organic solvents and parameters. Physico-chemical property of the extracted oil was also determined by using classical wet chemical method. Result revealed that, Soxhlet extraction using hexane has 40.35%; using ethanol-hexane mixture of 60:40% volume proportion has 43.71%, using ethanol 42.65% and using methanol 42.89%. For all solvent type particle size has 355µm, extraction time 1hr up to 3hrs and applied constant and varies temperatures. At smaller extraction time, hexane produced oil yield greater than from ethanol and methanol. Actually, ethanol not produced oil at one hour extraction time. Thus, by effective determination of factors like particle sizes, solvent type, temperature, and time it is possible to investigate the result on the quality and quantity of neem oil. Surprisingly, mixtures of Ethanol and Hexane gave admirable results. Predominantly, ethanol-hexane mixtures of 60:40, and40:60%(volume proportions) gave better oil yields of 44%, and 41.2% respectively than that of hexane (40.35%) at 3hours of process time [4].

2.2 Uniqueness of essential oils

In early work, the term essential oil was defined as the volatile oils obtained by the steam distillation of plants. This definition was clearly intended to make a distinction between "fatty oils" and the oils which are easily volatile. It was found that the oils contain many classes of organic substances with varying volatility. Although a list of all the known oil components would include a variety of chemically unrelated compounds. It is possible to classify these into main groups of essential oils [2].

- ✓ Terpenes, related to isoprene
- ✓ Straight-chain compounds, not containing any side branches
- ✓ Benzene derivatives
- ✓ Essential oils are volatile: Essential oils are the volatile fragrant components from various indigenous and exotic plants which have been traded internationally for several centuries [2].
- ✓ Essential oils are aromatic: Essential oils are highly aromatic and therefore, many of the benefits can be obtained by simply inhaling them. This can be done by breathing in the fragrance from the bottle or they can be diffused into the room. Essential oils when diffused can be the best air filtration system in the world. They will purify the air by removing metallic particles and toxins from the air increase atmospheric oxygen; increase ozone and negative ions in the house which inhibits bacterial growth, destroy mold, cigarettes and animal odors; fill the air with a fresh herbal aromatic scent [2].
- ✓ Essential oils have penetrating characteristics: The penetrating characteristic of essential oils greatly enhances their ability to be effective. Essential oils will penetrate into the body when applied to the skin. Essential oils rubbed into the feet will be distributed to every cell in the body in minutes. They will even penetrate a finger or toe nail to treat fungal infection underneath. Other vegetable oils do not have this propensity to penetrate [12].

- ✓ Pure essential oils have very high frequency: The effectiveness of essential oils is sometimes also described in terms of frequency. It has been reported that the human body has an electrical frequency and that much about a person's health can be determined by frequency. Tainio has determined that the average frequency of the human body during the day time is 62-68 MHz (a healthy body frequency is 62-72). When the frequency drops, the immune system is compromised. If the frequency drops to 58 MHz, cold and flu symptoms appear, at 55 MHz, diseases like Candida take hold, at 52 MHz, Epstein bar and at 42 MHz, cancer. According to Dr. Royal R. Every disease has a frequency He found that certain frequencies can prevent the development of disease and that others would destroy disease. Substances with higher frequency will destroy diseases of a lower frequency. The study of frequencies raises important questions, concerning the frequencies of substances we eat breath and absorb. Many pollutants lower healthy frequency. Processed canned food has a frequency of zero. Fresh produce has up to 27 MHz Essential oil start at 52 MHz and go as high as 320 MHz, which is the frequency of rose oil. Clinical research shows that essential oils have the highest frequency of any natural substance known to man, creating an environment in which disease; bacteria, virus, fungus, etc. cannot live [2].

2.3 Extraction methods of essential oil production

Essential oils can be extracted using a variety of methods, although some are not commonly used today. The specific extraction method employed is dependent upon the plant material to be distilled and the desired end product.

Soxhlet Extractor

A Soxhlet extractor is a piece of laboratory apparatus invented in 1879 by Franz von Soxhlet. It was originally designed for the extraction of a lipid from a solid material. However, a Soxhlet extractor is not limited to the extraction of lipids. 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. Citrus fruit powder 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 arms and floods into the chamber housing the thimble of mango kernel powder. The condenser ensures that any solvent vapor cools, and drips back down into the chamber housing of the kernel powder. The chamber containing the kernel powder slowly fills with warm solvent. Some of the oil will then dissolve in the warm solvent. When the Soxhlet chamber is almost full, the chamber is automatically emptied by a siphon side arm, with the solvillation flask. The advantage of this system is that instead of many portions of warm solvent being ent running back down to the distillation flask. The thimble ensures that the rapid motion of the solvent does not transport any powder to the still pot. 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 dist passed through the sample, just one batch of solvent is recycled [25].

2.4 Factor affecting the rate of solvent extraction

The efficiency of solvent extraction of oil from oil seeds (mango seed kernel) can be influenced by different factors such as particle size, solvent type used, temperature, extraction time, geographical variation that the seed is originated (Genetic variation), moisture content of the seed, solid to solvent ratio.

- ✓ **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 circulation of the liquid is impeded, and separation of the particles from the liquid and drainage of the solid residue are made more difficult [13].

- ✓ **Temperature**

Temperature generally affects both the equilibrium and mass transfer rate of the extraction process. In the former, a 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 rate of extraction. In conventional solid-liquid (solvent) extraction processes, 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 thermo labile bioactive compounds. Thus, an optimized balance has to be determined when selecting the extraction temperature [25].

- ✓ **Solvent Type**

The liquid chosen should be a good selective solvent and its viscosity should be sufficiently low for it 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.

Most methods that use solvent extraction have used a trial and error approach. The Delaney amendment to the Food and Drug Act prohibits the use in food production of materials that exhibit any evidence of carcinogenicity. Therefore, even though great efforts are made to reduce solvent residues in products to extremely low levels, for example, parts per billion, many common solvents, such as benzene, and most chlorinated solvents, with the notable exception of methylene chloride, cannot be used in food processing as well as Pharmaceuticals and cosmetics. 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 [10].

The use of alcohols and alcohol-water mixtures for extracting vegetable oil has attracted attention recently. These solvents can provide greater selectivity than hexane, which is currently used for most vegetable oil extractions. Alcohols and alcohol-water mixtures can also be separated from extracted oil more readily and with less expenditure of energy. As is usually the case, it is desirable for solvents to be cheap, noncorrosive, nonflammable, nonexplosive, nontoxic, easily removable, and easily recoverable. It obviously may be impossible to meet all these objectives. The characteristics of the matrix to be extracted, mass transfer mechanisms also have to be considered in developing an optimal extraction system. Since oil extracted from mango seed kernel has an application on cosmetics due to good source phenolic compound, and this phenolic compounds are highly dependent on solvent type used for the extraction [7].

- ✓ **Time of extraction**

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 [7].

2.5 Important Physical properties of essential oils

2.5.1 Specific gravity

Specific gravity is an important criterion of the quality and purity of an essential oil. Values for essential oils vary between the limits of 0.696 and 1.188 at 15. In general, the specific gravity is less than 1.0 Hence essential oil can be collected over (floating on) water [14].

2.5.2 Solubility in water

Most of essential oils of commercial interest are steam volatile, reasonably stable to action of heat and practically insoluble in water and hence suitable for processing by steam distillation [14].

2.5.3 Concentration of Perfume

Perfume types reflect the concentration of aromatic compounds in a solvent (which in fine fragrance) is typically ethanol or a mix of water and ethanol. Various sources differ considerably in the definitions of perfume types. The intensity and longevity of a perfume is based on the concentration, intensity and longevity of the aromatic compounds (natural essential oils or perfume oils) used as the percentage of aromatic compounds increases, so does the intensity and longevity of the scent created. Specific terms are used to describe a fragrance's approximate concentration by percent/volume on perfume oil which is typically vague or imprecise. A list of common terms (Perfume-Classification) is as follows [7].

- ✓ Perfume extract or simply perfume (Extract): 15-40% aromatic compounds.
- ✓ Esprit de Parfum (ESdP): 15-30% aromatic compounds a seldom used strength concentration in between EDP and perfume.
- ✓ Eau de Parfum (EDP), Parfum de Toilette (PdT): 10-20% (typical 15%) aromatic compounds.
- ✓ Eau de toilette (EdT): 5-15% (typical 10%) aromatic compounds.

- ✓ Eau de Cologne (EdC): Chypre citrus type perfumes with 3-8% (typical 5%) aromatic compounds.
- ✓ Perfume mist: 3-8% aromatic compounds (typical non-alcohol solvent).
- ✓ Splash (EdS) and Aftershave: 1-3% aromatic compounds.

2.6 SOURCES OF PERFUMES

2.6.1 Aromatics sources

Plant sources

Plants have long been used in perfumery as a source of essential oils and aroma compounds. These aromatics are usually secondary metabolites produced by plants as protection against herbivores, infections, as well as to attract pollinators. Plants are by far the largest source of fragrant compounds used in perfumery. The sources of these compounds may be derived from various parts of a plant. A plant can offer more than one source of aromatics, for instance the aerial portions and seeds of coriander have remarkably different odors from each other. Orange peels, blossoms, fruit, leave seed and wood are the respective sources of perfumes [14].

Bark: Commonly used barks include cinnamon and cascarilla. The fragrant oil in sassafras root bark is also used either directly or purified for its main constituent, safrole, which is used in the synthesis of other fragrant compounds [14].

- ✓ Flowers and blossoms: Undoubtedly the largest and most common source of perfume aromatics. Includes the flowers of several species of rose and jasmine, as well as Osman thus, plumeria, miosa, tuberose, narcissus, scented geranium, Cassie, ambrette as well as the blossoms of citrus and ylang-ylang trees. Although not traditionally thought of as a flower, the unopened flower buds of the clove are also commonly used. Most orchid flowers are most commercially used to produce essential oils or absolutes, except in the case of Vanilla, an orchid, which must be pollinated first and made into seed pods before use in perfumery [14].
- ✓ Fruits: Fresh fruits such as apples, strawberries, cherries unfortunately do not yield the expected odors when extracted; if such fragrance notes are found in a perfume, they are synthetic. Notable exceptions include litseacubeba, vanilla, and juniper berry. The most commonly used fruits yield their aromatics from the rind; they include citrus such as

oranges, lemons, and limes. Although grapefruit rind is still used for aromatics, more and more commercially used grapefruit aromatics are artificially synthesized since the natural aromatic contains Sulfur and its degradation product is quite unpleasant in smell [14].

- ✓ Leaves and twigs: Commonly used for perfumery are lavender leaf, patchouli, sage, violets rosemary, and citrus leaves. Sometimes leaves are valued for the "green" smell they bring to perfumes, examples of this include hay and tomato leaf.
- ✓ Perfumery include labdanum, frankincense, myrrh, Perusbalsam, gum benzoin. Pine and fir resins are a particularly valued source of terpenes used in the organic synthesis of many other synthetic or naturally occurring aromatic compounds. Some of what is called amber and copal in perfumery today is the resinous secretion of fossil conifers. Roots, rhizomes and bulbs: Commonly used terrestrial portions in perfumers include iris rhizomes, Vetiver roots, various rhizomes of the ginger family.
- ✓ Seeds: Commonly used seeds include Tonka bean, carrot seed, coriander, caraway, cocoa, nutmeg, mace, cardamom, and anise.
- ✓ Woods: Highly important in providing the base notes to a perfume, wood oils and distillates are indispensable in perfumery. Commonly used woods include sandalwood, rosewood, Agar wood, birch, cedar, juniper, and pine. These are used in the form of macerations orry-distilled (rectified) forms [4].

Animal sources

- ✓ Ambergris: Lumps of oxidized fatty compounds, whose precursors were secreted and excelled by the sperm whale. Ambergris should not be confused with yellow amber, which is used in jewelry. Because the harvesting of ambergris involves no harm to its animal source, it remains one of the few animalic fragrance agents around which little controversy now exists.
- ✓ Castoreum: Obtained from the odorous sacs of the North American beaver
- ✓ Civet: Also called Civet Musk, this is obtained from the odorous sacs of the civets, animals in the family Viverridaemon goose. The World Society for the Protection of Animals investigated African civets caught for this purpose.
- ✓ Hyraceum: Commonly known as "Africa Stone", is the petrified excrement of the Rock Hyrax.

- ✓ Honeycomb: From the honeycomb of the honeybee. Both beeswax and honey can be solvent extracted to produce an absolute. Beeswax is extracted with ethanol and the ethanol evaporated to produce beeswax absolute.
- ✓ Deer musk: Originally derived from the musk sacs from the Asian musk deer, it has now been replaced by the use of synthetic musk sometimes known as "white musk"[4].

2.6.2 Synthetic sources

Aroma compound Many modern perfumes contain synthesized odorants. Synthetics can provide fragrances which are not found in nature. For instance, Calone, a compound of synthetic origin, imparts a fresh ozonous metallic marine scent that is widely used in contemporary perfumes. Synthetic aromatics are often used as an alternate source of compounds that are not easily obtained from natural sources. For example, linalool and coumarin are both naturally a fresh ozonous metallic marine scent that is widely used in contemporary perfumes. Synthetic aromatics are often used as an alternate source of compounds that are not easily obtained from natural sources. For example, linalool and coumarin are both naturally occurring compounds that can be inexpensively synthesized from a terapnes Orchid scents (typically salicylates) are usually not obtained directly from the plant itself but are instead synthetically created to march the fragrant compounds found in various orchids. One of the most commonly used classes of synthetic aromatic by far are the white musk. These materials are found in all forms of commercial perfumes as neutral background to the middle notes. This musk is added in large quantities to laundry detergents in order to give washed clothes a lasting "clean" scent [4].

2.7 Perfume Notes

Perfume is described in a musical metaphor as having three sets of notes making the harmonious scent accord. The notes unfold over time with the immediate impression of the top note leading to the keeper middle notes and the base notes gradually appearing as the final stage. These notes are created carefully with knowledge of the evaporation process of the perfume.

Top notes: The scents that are perceived immediately on application of a perfume. Top notes consist of small light molecules that evaporate quickly. They form a person's initial impression of a perfume and thus are very important in the selling of a perfume.

Middle notes: The scent of a perfume that emerges just prior to when the top notes dissipate. The middle note compounds form the "heart" or main body of a perfume and act to mask the often unpleasant initial impression of base notes which become more pleasant with time. They are also called the heart notes.

Base notes: The scent of a perfume that appears close to the departure of the middle notes. The base and middle notes together are the main theme of a perfume. Base notes bring depth and solidity to a perfume. Compounds of this class of scents are typically rich and “deep" and are usually not perceived until 30 minutes after application. The scents in the top and middle notes are influenced by the base notes as well the scents of the base notes will be altered by the type of fragrance materials used as middle notes [7].

2.8 Component of Perfume

There are three basic parts of perfume that make up components for the formulation:

Basics: The base is the most important component of any perfume. A base can be any fragrance or scent that is a not as volatile. This scent can be added to the perfume which will result in a product that meets consumer desires.

Fixatives: Fixatives are ingredients in the perfume that prolong the odor effect and delay the evaporation rate of volatile materials. The component tends to have no odor to be miscible in polar and non-polar solutions and to be at a higher boiling point temperature. The fixative bonds to polar compounds within the perfume through hydrogen bonding reducing the overall vapor pressure of the mixture. They retain a high concentration of the top and middle notes and release them slowly over time. Examples of fixatives are vetyver, dipropylene glycol, diethyl phthalate and glycerin [14].

Solvents: The solvent is the portion of the perfume in which all the components are dissolved. Solvents are used to dilute the mixture in order to increase the surface area of application without ting an excessive amount of the fragrance. It is also used to reduce the intensity of the fragrance of the solution. Solvents decrease the price of the perfume per milliliter while increasing the amount of applications per bottle. Ethanol is the most common solvent that used for perfume formulation [14].

2.9 Perfume Formulation from orange peel essential oil.

Production Process of perfume from orange peel essential oil

- **Blending:** Once all of the oils for the perfume have been extracted, they need to be blended together. The oils are blended accorded to a formula that has been predetermined by a master in the perfume industry, often referred to as a "nose." One perfume can contain hundreds of different ingredients and can take multiple years to develop. Once the perfume oils have been blended, the scent is mixed with alcohol. The amount of alcohol added to the perfume oils varies depending on what the final product will be being. Eau de parfum will have a lower concentration of alcohol while scents such as body mists will have a much higher concentration of alcohol. Most perfumes are made of about 10-20% perfume oils dissolved in alcohol and a trace of water [10].
- **Aging**: Higher quality or fine perfumes are oftentimes aged for months or potentially even years after the scent has been blended. This is done to ensure that the proper scent has been created. Aging allows the different scents or notes to really blend together. Perfumes are made up of top notes that provide the scent with body as well as base notes which create an enduring fragrance [10].

CHAPTER THREE:MATERIALS AND METHODS

The experimental work was done in Wolkite University college of engineering Technology department of Chemical engineering laboratory.

Raw materials: Discarded orange fruit peels

3.1 Equipment and chemicals

3.1.1 Equipment

Table 3.1 equipment and their function

Equipment	Function
Electric heater	source of heat
Soxhlet extractor	extract essential oil
Digital weighting balance	to determine the mass of orange peel sample
Water bath	as heat source to separate the solvent from oil
pH meter:	to determine acidity of essential oil and perfume
Oven:	to dry orange peel sample.
Sieve	to sieve the crushed sample
Disk mill	to crush the dried orange fruit peel
Beaker	to mix samples
Measuring cylinder	to determine the specific gravity of essential oil
Phenolphthalein indicator	as indicator

3.1.2 chemicals

Table 3.2 chemical and their function

Chemical	Function
Glycerin	as fixative
Potassium hydroxide	for titration of oil
Oxalic acid:	to titrate potassium hydroxide in saponification and acid value
Ethanol	as solvent for oil extraction
Sodium hydroxide	to titrate oil

3.2 Design of the Experiment

For essential oil extraction using Soxhlet extraction method there are two factors; extraction time and particle size, and four number of experimental runs that need to be performed.

The factors and their levels

The levels that were selected for each factor are: Particle size (mm): 0- 300µm, 300µm – 1.18mm, Extraction time (hours): two and three with Solvent(ethanol).

Table 3.3 combined parameters for oil extraction

Particle size(mm)	Time(hr)	
	2	3
0-0.3	Yield 1	Yield 3
0.3-1.18	Yield 2	Yield 4

3.3 Process flow diagram and description of perfume.

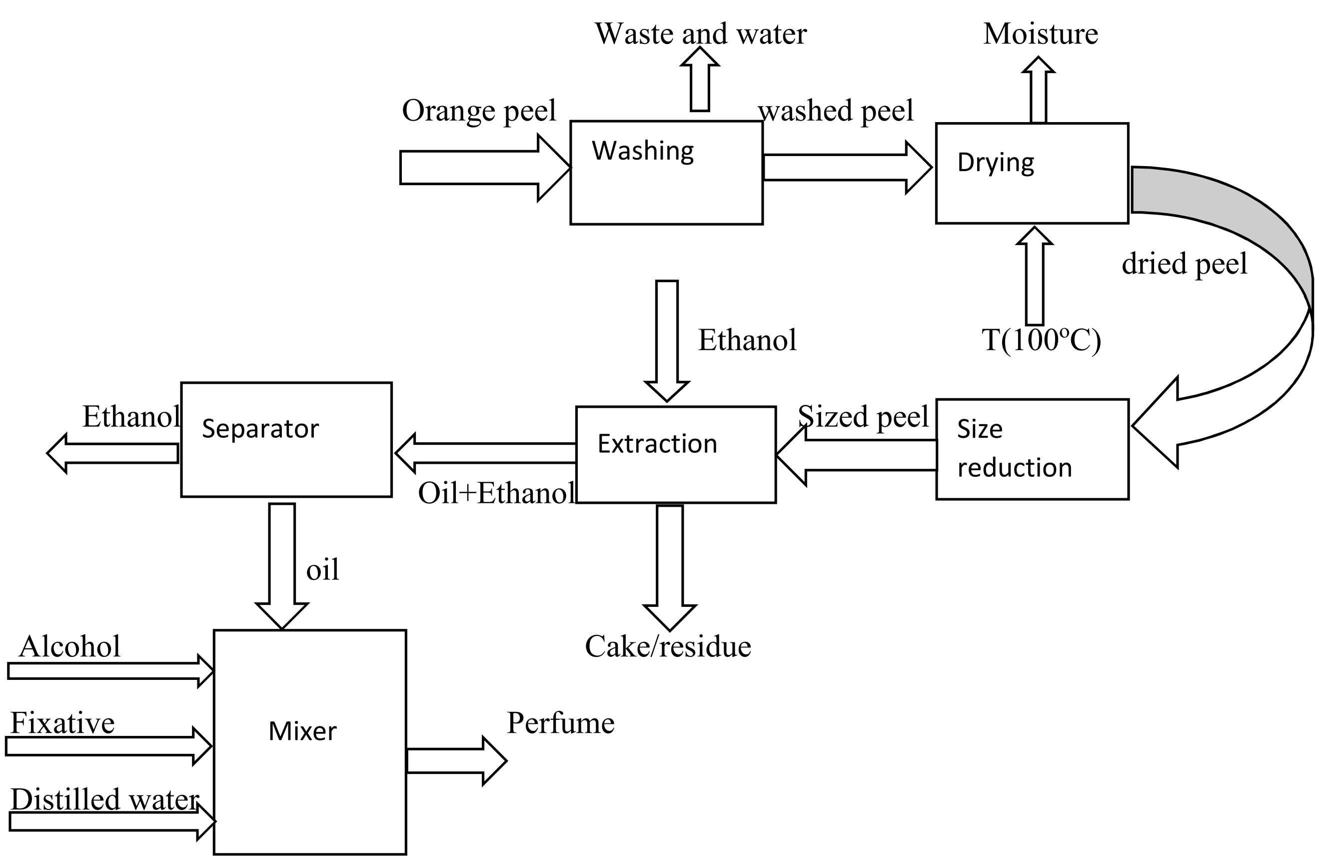


Figure 3.1 process flow diagram of perfume production

3.4 Experimental procedures

3.4.1 Raw material preparation

The raw material orange peels were collected from market. Then washed with water to remove undesired dirty components on the fruits. After that the peel part was removed from the edible components of the fruits by knife and then it was collected.

Figure 3.2 orange peel

Orange peel characterization

Raw material characterization plays an important role in the quality control process of product manufacture or development, ensuring that contaminants, residual solvents, water, particles, and/or gradients meet specifications.

3.4.2 Determination of Moisture Content of the sample

A randomly selected sample weight of 1 kg of orange peel was weighed and dried with sun light for 1 day and further with oven at 100^0C.Its weight was measured after drying. The percentage of moisture in the sample was calculated using the next equation.

$$m.c = \frac{w1 - w2}{w1} * 100$$

Where M.c = moisture content

W1= Original weight of the sample before drying

W2=weight of the sample after drying

3.4.3 Size reduction and Sieve analysis of orange peels

The moisture content was removed by exposing to sun light for 1 days and then by oven at 100^0C. The dried orange peels were crushed in disk mill and then the sample was sieved using set of sieves sizes arranged in descending order 1.18mm,0.3mm and 0 mm to obtain particular sizes range of 0-300µm and 300µm – 1.18. This was aimed to investigate the effect of particles size of oranges peels on the yield of oil.

Figure 3.3 reduced size of orange peel and sieve analysis

3.4.4 Extraction method of orange peels oil

The extraction of oranges peel oil was carried out with different extraction time, particle size ranges and constant solvent type ethanol, pressure and temperature of 1atm and 100^0C using Soxhlet extraction method. For the current experimental work, 15 gram of orange peels with different particle size ranges of 0- 0.3mm and 0.3mm – 1.18mm were fed to a Soxhlet extractor with 100ml solvents for two different extraction times: 2 hour and 3 hours at constant temperature of 100^0C.The resulting extracts, obtained under different operating conditions were separated by evaporating the solvents using water bath in which the setup was established in the laboratory under reduced pressure and temperature of 80^0C.

Figure 3.4 oil extraction using soxhlet extracter

3.5 Determining orange peel oil yield

The percentage oil extraction yield was calculated according to the following equation.

$$E.y = \frac{m.o}{m.s} * 100$$

Where E.y = percentage of extraction yield

m.o = mass of oil

m.s = mass of sample

3.6 Determination of the physicochemical properties of extracted orange peel oil

Physicochemical properties used to determine the quality of extracted orange fruit peel oil. Some of these properties are PH value, specific gravity, acid value and saponification value.

3.6.1 Determination of specific gravity of orange peels essential oil

A clean and dry measuring cylinder of 25ml capacity was weight(W_0). Then it was filled with the oil and reweight to give (W1). After that the oil was substituted with water after washing and drying the measuring cylinder and weighed to give (W2). Finally, the specific gravity of the extracted oranges peel oil was determined accordingly the following formula.

$$S.g = \frac{W1 - Wo}{W2 - Wo}$$

Where $S.\ g$ = specific gravity

W1 = weight one

W2 = weight two

3.6.2 Acid value determinations

Acid value is the mass of potassium hydroxide (KOH) in mg that is required to neutralize one gram of chemical substance. The acid number is a measure of the amount of carboxylic acid groups in a chemical compound. The acid number is used to quantify the amount of acid present, in oranges peel essential oil sample. Acid value will be determined according to the method of European Pharmacopeia. 1g of oranges peel oil will accurately weighted and dissolved in 10 ml of 96 % ethanol and 2-3 drops of phenolphthalein indicator will be added. The free acid will then titrate with standard 0.1 Normality of aqueous sodium hydroxide solutions by adding the alkali drop-wise at a uniform rate of about 30 drops per minute. The content of the flask will be continuously agitated. The primary manifestation of the red coloration that did not fade within 10 seconds will considered the end point. Afterward, the acid value is determined using the following equations.

$$A.V = \frac{5.61 * 0.1\ \text{NaOH}}{\text{W.s}}$$

Were A.V = Acid value

W.S = weight of sample in gram

Figure 3.5 titration of oil to determine acid value

3.6.3 Saponification value determination

Saponification value represents the number of milligrams of potassium hydroxide or sodium hydroxide required to saponify 1g essential oil under the condition specified. Saponification value will be calculated by European Pharmacopeia standard procedure.

1gram of orange essential oil will accurately weighed and dissolved in 10ml of ethanol and then 10ml of 2.5N NaOH solution will be added. This procedure will be performed together with blank experiment which will also performed by omitting the oil. The mixture will reflux for two hours then cooled. The unreacted NaOH will be titrated with standard 0.5N of oxalic acid by adding 2-3 drops of phenolphthalein indicator. After that, the saponification value was determined using the following equation.

$$S.V = \frac{56.1 * V1 - V2}{2 * W}$$

Where S.V = Saponification value

W=weight of oil

V1=volume of 0.5N oxalic acid for blank

V2=volume of 0.5N oxalic acid for sample

3.6.4 Ester value determination

The determination of the ester content is of great importance in the evaluation of many essential oils. Most esters, which occur as normal constituents of essential oils, are esters of monobasic acids. Ester value may be defined as "the number of milligrams of potassium hydroxide required to neutralize the acids liberated by the hydrolysis of esters present in 1g of the essential oil materials". The value of ester can be calculated as follow:

Ester value = saponification value - acid value

3.6.5 Determination of pH Value

The pH value of oil will be measured using automatic pH meter.

3.7 Determination of the optimal blending ratio of ethyl alcohol to essential oil in perfume production.

After extraction of essential oil from the fruit peels the following experimental procedure will be carried out to determine the optimal blending ratio of ethyl alcohol to essential oil in perfume production.

4 pure beakers were prepared for perfume formulation. Then 4 ml of essential oil will be added into each beaker containing 10ml,11ml,12ml and 13ml of ethyl alcohol (Perfume usually contains 20-25% oil and 70-85% alcohol), and then will be shacked by shaker. After blending ethyl alcohol and essential oil, 0.07 ml of glycerin will be added into the solution mixture to improve the longevity of the perfume. Finally, 1ml of distilled water will be added into beaker in order to homogenize the undissolved ingredients. The beaker will be stirred well, closed tightly and allowed for 1 week -1 month. The beaker should be away from heat, sunlight and preferably in cool, dark place. Finally, the scent of the perfume will be judged by chemical engineering students.

Figure 3.6 perfume formulation

3.8 Characterization of perfume

The final product perfume will be characterized by measuring its solubility in water, specific gravity, PH value, and odor.

3.8.1 Solubility of perfume in water

2ml of perfume was added on a cleaned test tube. After that 2ml ofwater was added on the test tube containing the perfume. The test tube was shackedand stirred well with stirring rod. Finally the solubility of perfume was checked by observing the creation of two phase layer on the beaker.

3.8.2 Determination of specific gravity of perfume by weight

The aggregate weight (W) of beaker containing 2ml ofperfume measured. After that the weight of empty beaker (Wb) was determined and hence the weight of perfume inside the beaker is the difference between W and Wb(Perfume=W-Wb).Then other beaker was filled with 2ml of water at the same temperature condition. Then similarly the weight of water in the beaker was calculated(W1). Finally the specific gravity of perfume was determined using this equation .

$$S.g = \frac{W - Wb}{W1 - Wb}$$

3.8.3 colour analysis of perfume

Color perception plays amajor role in consumer evaluation of pefume quality.most of them are light,even golden,while others retain some of the colour from the flower petels from which they are derived.most essential oil have subtle,even transparent hues,some however, have very intensive shades.

3.8.4 Sensory analysis of perfume

Sensory attributes such as color, aroma and overall acceptability of the formulated perfume will be judged by Wolkite University chemical engineering students by method recommended by Ranganna (1994) using a Hedonic Rating test. Their judgments will be recorded and appropriate analysis will be carried out to determine the significance of the variation of blending ratio of ethyl alcohol to essential oil. Samples were served to the panelists and they were asked to rate the acceptability of the product on 1–9 points scale, ranging from the extreme like (9) to dislike extremely (1).

CHAPTER FOUR: RESULTS AND DISCUTION

4.1 Moisture content of orange peel

A randomly selected sample weight of 1000 gram of orange peel was weighed and dried by oven at 100^0C till it became constant mass.

Table 4.1 moisture content of sample

Time	Weight of sample(g)
Initial mass	1000
Mass after 30 minutes	730
Mass after 60 minutes	530
Mass after 90 minutes	355
Mass after 120 minutes	245
Mass after 150 minutes	200
Mass after 180 minutes	200

The moisture content of the orange peel was calculated using an equation:

$$MC = \frac{W1 - W2}{W1}$$

$$MC = \frac{1000-200}{1000} * 100\%$$

$$MC = 80\%$$

4.2 Percentage extraction yield of oil

The percentage extraction yield of oil was calculated by using equation 3.3 and the result is summarized in the table 4.2 below.

Table 4.2 percentage extraction yield of orange peel oil

No of runs	Factor 1	Factor 2	Factor 3			
	Particle mesh size range	Extraction time (hours)	Constant solvent	Extracted oil(ml)	Oil yield(gm)	Extraction yield(%)
1	0-0.3mm	2	ethanol	5.5	4.9	32.67
2	0-0.3mm	3	ethanol	6	5.2	34.67
3	0.3-1.18mm	2	ethanol	4.8	4.4	29.33
4	0.3-1.18mm	3	ethanol	5.1	4.6	30.67

From table 4.2 the maximum percentage oil yield obtained was 34.67% at particle mesh size range of 0-0.3mm, for the extraction time of 3 hours whereas the minimum percentage oil extraction yield was 29.33% obtained at particle mesh size range of 0.3mm-1.18mm, for the extraction time 2 hour.

4.3 Effect of particles size and extraction time on yield of oil

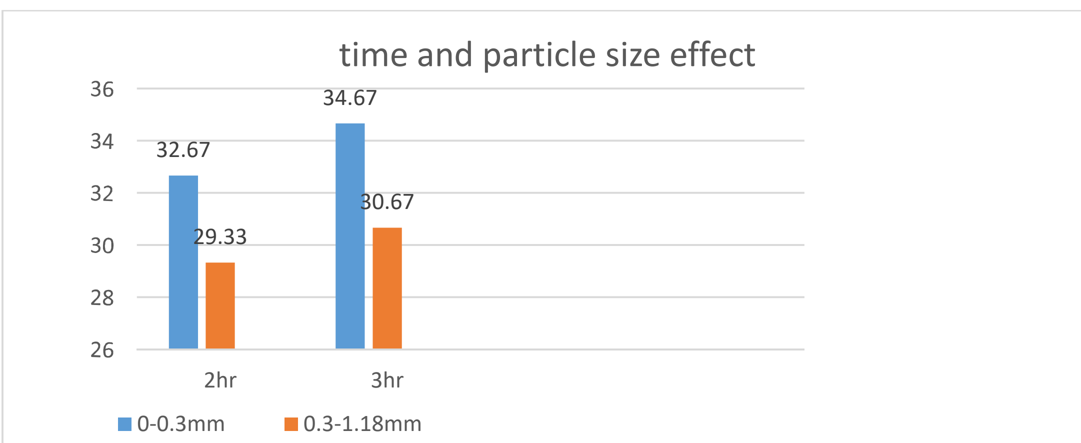


Figure 4.2 effect of both extraction time and particle size in extraction yield of essential oil(chart method).

Table 4.3 oil yield calculated by interpolation

Time	Yield 1(small)	Yield 2 (large)
2	32.67	29.33
2.25	33.17	29.665
2.5	33.67	30
2.75	34.17	30.335
3	34.67	30.67

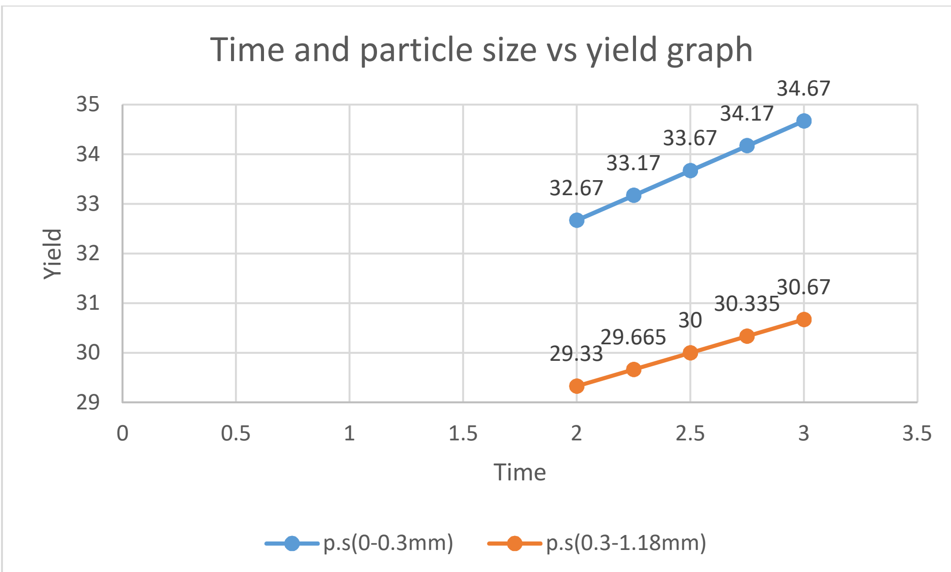


Figure 4.2 7effect of both extraction time and particle mesh size on the extraction yield of essential oil.(graphical method).

The percentage oil extraction yield was directly related to extraction time i.e. the yield increased as extraction time increased (figure 4.1 and 4.2). For fine particle size range 0-0.3mm the yield orange rapidly when compared to the other extreme particle mesh size (large). The oil yield increased by 2% as the extraction time increased from 2 hours to 3 hours. However, for larger particle size i.e. 0.3mm-1.18mm the yield was lower at the beginning of the extraction and increased gradually as the extraction time increased. The yield increased by 1.31% as the extraction time increased from 2 hours to 3 hours. The result obtained in this research indicates that smaller particle size needs small extraction time to obtain maximum yield in comparison to large particle size. According to this study the maximum oil yield is obtained at 3 hours. extraction time and at lower particle size and since at 3 hour extraction time maximum yield was obtained.

As compare with Tewodros Andargachew exeprmtal work,s different oil extracted from orange peel by using constant solvent. maximum percentage oil yield obtained was 29.84% at particle mesh size range of 0-350μm, for the extraction time of 4 hours whereas the minimum percentage oil extraction yield was 16.92% obtained at particle mesh size range of1mm-2mm, for the extraction time 2 hour.this value is less compered with our experment due to the varation of amount of sample and particle size,as particle size decrase,and the sample of raw material incrase gives high yiled and viese versa.

4.4 Determination of the physicochemical properties of extracted orange peel oil

4.4.1 Specific gravity

Measuring cylinder was used to determine the specific gravity of oil as the detail experimental procedures were stated in

$$S.g = \frac{W1 - Wo}{W2 - Wo}$$

W_1 is weight in gm of measuring cylinder with oil at 25^0C = 41.4g

W_0 is weight in gm of measuring cylinder at 25^0C = 30g

W_2 is weight in gram of measuring cylinder with water = 43.3g

Substituting the above values in the equation

$$S.g = \frac{41.4-30}{43.3-30}$$

$$S.g = 0.85$$

which is some extent closer to the standard range (0.84 – 0.86).

4.4.2 pH value of oil

The pH value of oil was determined by using digital PH meter and its value was found to be 4.2 which is slightly neutral. In preparation of cosmetic material, the preferable pH value is in the range of 3.5 – 6.5 and therefore the obtained pH value of orange peel oil is in the range to be used in producing cosmetic materials.

4.4.3 Saponification value

Saponification number was determined by using titration. Saponification is a number that expresses in milligram of quantity of potassium hydroxide required to saponify 1 gram of oil/fat.

The required solutions were prepared with the required concentration.

- Preparation of 2.5N sodium hydroxide solution

$$\frac{2.5\text{mol} * 56.1\text{g/mol}}{1000\text{ml of } H_2} = 1.4gm \text{ NaOH}$$

1.4gm of NaOH in 10ml of H_2O was dissolved.

- Preparation of 0.5N of oxalic acid

$$\frac{0.5\text{mol} * 90.034\text{gm/mol}}{1000\text{ml}} = 4.5\ gm$$

4.5gm of oxalic acid in 100ml of H_2O was dissolved.

1gram of orange essential oil was accurately weighed and dissolved in 10ml of ethanol and then 10ml of 2.5N KOH solution was added and then it was titrated with oxalic acid to the end point. Similar titration was done for the blank. In both case the value of oxalic acid was recorded.

$$S.V = \frac{56.1 * V1 - V2}{2 * 1} * 2.5 = 16.129\ mg\text{Na}OH/gm$$

V1 is volume of oxalic acid required for the blank = 10ml

V2 is volume of oxalic acid required for the sample = 9.7/7ml

N is normality of oxalic acid = 0.5N

W is weight of oil taken for the test = 1 gm

Substituting the above values in equation 3.5

$$S.V = \frac{56.1 * 10 - 9.77 * 2.5}{2 * 1} = 16.129\ mg\mathrm{Na}OH/gm$$

16.129mgNaOH/gm which is agreeable with the standard value (13.23-16.19).

4.4.4 Acid value

Titration method was used to determine the acid value. The required solutions were prepared with the required concentration as follows.

Preparation of 0.1N sodium hydroxide solution: 0.4 gram of NaOH was dissolved in 100 ml of distilled water.

V is volume of NaOH used by the sample during titration = 2ml

N is normality of NaOH = 0.1N

W is weight of oil taken for test = 1gm

$$A.V = \frac{\mathrm{MwNaOH} * \mathrm{V} * \mathrm{N}}{\mathrm{Ws}}$$

Substituting the above values

$$A.V = \frac{40*0.55\mathrm{ml}*0.1\mathrm{N\ NaOH}}{1\mathrm{gm\ of\ oil}}$$

=2.2 mg NaOH

2.2mg NaOH of oil which is relatively smaller.

The low acidity of oil is an indication of oil which is free from hydrolytic acidity and enables the direct use of such oil without further neutralization. There for the result obtained indicated that the extracted essential oil can be used directly for perfume production without further neutralization.

4.4.5 Ester value

Ester value is the number of milligrams of potassium hydroxide required to neutralize the acids liberated by the hydrolysis of esters present in 1g of the essential oil materials and using next equation the value of ester value can be determined as follows:

EV = SV – AV= 16.129 – 2.2

= 13.93mgNaOH/g of oil which is found within the range of standard value.

Table 4.4 physiochemical property of essential oil of orange peel

Physicochemical property	Measured value	Standard value
PH value	4.2	3.5 – 6.5
Acid value(mgKOH/g of oil)	2.2	1.99 – 2.2
Saponification value(mgKOH/g of oil)	16.129	13.23 – 16.19
Ester value (mgKOH/g of oil)	13.93	11.24 – 14
Specific gravity	0.85	0.84 – 0.86

4.5 Determination of the optimal blending ratio of ethyl alcohol to essential oil in perfume production.

In this experimental study 4 different blending ratios of ethyl alcohol to essential oil were investigated. however, among them the blended solution having 10m,11ml,12ml and 13ml of ethyl alcohol and 4ml of essential oil was exhibited relatively better smell (scent) in contrast to the other. So, the optimal blending ratio of ethyl alcohol to essential oil was found to be 10ml of ethyl alcohol to 4ml of essential oil.

4.6 Characterization of perfume

4.6.1 Solubility of perfume in water

In this experimental study a sample of 2ml of perfume was mixed with 2ml of water and some what 2 light phases were created during mixing of them but slightly soluble during mixing. So, perfume is slightly soluble in water because of high amount of alchol in perfume.

4.6.2 Determination of specific gravity of perfume by weight

Measuring cylinder was used to determine the specific gravity of 1.48g of perfume as the detail experimental procedures were

W1 is weight in gm of measuring cylinder with perfume at 25^0C = 43.6g

W0 is weight in gm of measuring cylinder at 25^0C =30.60g

W2 is weight in gram of measuring cylinder with water = 46.1g

$$S.g = \frac{W1 - Wo}{W2 - Wo} = \frac{43.6-30.60}{46.1-30.60} = 0.84$$

0.84which is some extent closer to the standard range (0.8005 – 0.897).

4.6.3 colour of perfume

The colour of oil was golden.it fulfil the standard colour of must perfumes,but it depends on raw materials used to produced perfume or oil.

4.6.4 pH value of perfume

The pH value of oil was determined by using digital pH meter and its value was found to be 5.1 which is slightly neutral.

4.6.5 Sensory analysis of perfume

Sensory attributes such as color, aroma and overall acceptability of the formulated perfume was judged by chemical engineering students.

Table 4.5 Sensory analysis results of perfume in terms of aroma, color and acceptability

Samples	Each attributes	scored of each attributes based on ten student rating								
		1	2	3	4	5	6	7	8	9
1	Color						1(10%)	6(60%)	2(20%)	1(10%)
	acceptability							7(70%)	2(20%)	1(10%)
	Aroma						1(10%)	7(70%)	2(20%)	
2	Color						5(50%)	2(20%)	2(20%)	1(10%)
	acceptability					2(20%)	4(40%)	3(30%)	1(10%)	
	Aroma						4(40%)	4(40%)	2(20%)	
3	Color						4(40%)	1(10%)	3(30%)	2(20%)
	acceptability					3(30%)	5(50%)	1(10%)	1(10%)	
	Aroma					1(10%)	5(50%)	3(30%)	1(10%)	
4	Color					3(30%)	6(60%)	1(10%)		
	acceptability				5(50%)	4(40%)	1(10%)			
	Aroma			4(40%)	4(40%)	1(10%)	1(10%)			

Hedonic scales: 1 = dislike extremely, 2 = dislike very much, 3 = dislike moderately, 4 = dislike slightly, 5 = neither like nor dislike, 6 = like slightly,7 = like moderately,8 = like very much,9 = like extremely.

According to their judgment the blending solution having 10ml of ethyl alcohol and 4ml of essential oil was relatively better in scent and color. The results of sensory evaluation showed that perfume can be developed from orange peel essential oil.

CHAPTER FIVE: DETERMINATION OF TECHNO-ECONOMY FEASIBILITY OF PERFUME PRODUCTION

5.1 Material balance

Assumption: orange peel was collected from Market, hotels and juice house.

Base: A plant production capacity is 699.047 ton/year and the annual working time is 300 days. Therefore, the daily production capacity is about 97.08 kg/hr. To achieve this objective, we have expected to do energy and material balance on main stages of the process. From our experiment we get 5.2g of essential oil from 15g of orange peel. From our experiment the essential oil that used to produce perfume is 34.67 % which mean that,

we used 1000 gm of orange peel for drying.

And from this 1000gm, 90gm of orange peel powder was obtained.

For 1000gm orange peel = 90 gm powder and for 15 gm powder will be:

1000 gm orange peel* 15 gm powder = 90 gm powder*X

Therefore, for 15 gm 166.67gm orange peel is needed (before drying)

This means, if for 0.015 kg powder = 0.16667 kg orange peel

And 15 gm orange peel powder = 5.2 gm oil yield

This means, 15 gm = 0.015 kg and 5.2 gm = 0.0052 kg oil yield

For 0.0052 kg oil yield = 0.16667 kg orange peel

For 97.08 kg oil yield (plant capacity) =?

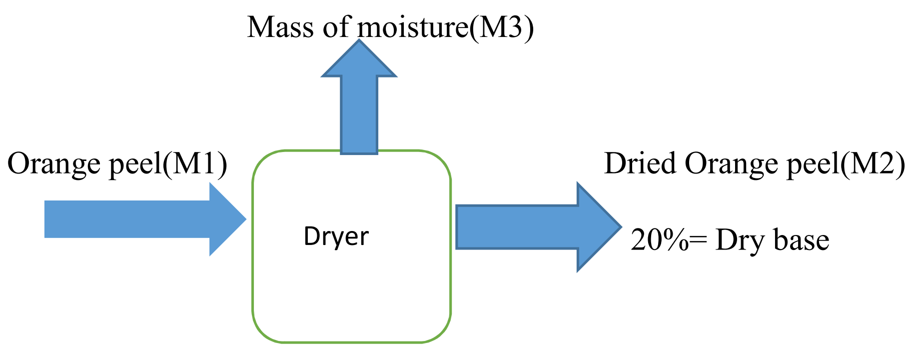
97.08 kg × 0.16667kg = 0.0052 kg* X

X = 3111.6 kg orange peel is needed for the given plant capacity

M1 = 3111.6 kg/hr – feed to dryer or before drying

5.1.1 Material Balance on Dryer

Assume cleaned orange peel its moisture content should be decreased by sun light



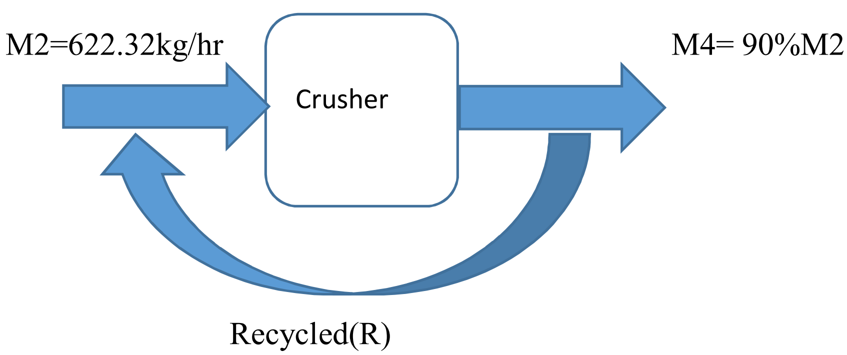
Cleaned orange peel (Kg/hr) =20%dried orange peel+80%moisture

Removed water(M3) = cleaned orange peel(M1) – dried orange peel(M2)

$$M3=3111.6-0.2*3111.6$$

$$M3 =2489.28kg/hr$$

5.1.2 Mass Balance on the crusher



Input = out put

Since the efficiency of the crusher is 90%, the recycled amount is 10%M2

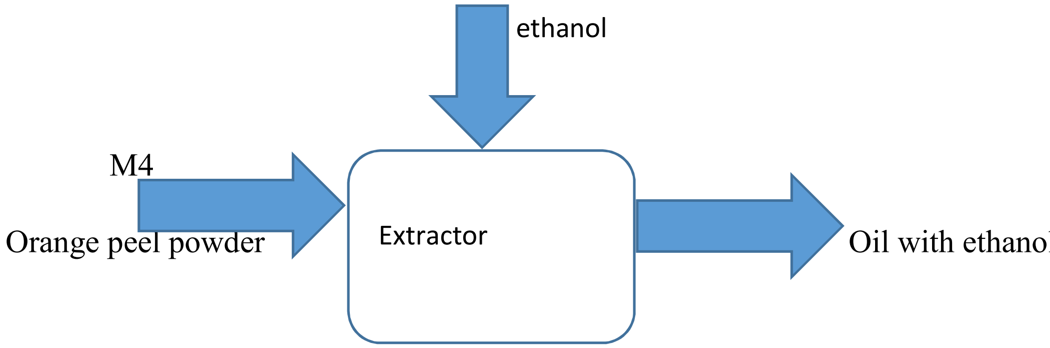
$M4 = 0.90\times 622.32kg/hr$

$M4 = 560.088$ kg/hr

$R= M2 – M4 = 622.32-560.088$

$R=62.232kg/hr$

5.1.3 Mass Balance on Extractor



Assumption: It is steady state. There is no chemical reaction (mechanical unit operation).

Depending up on the above assumption

Accumulation=generation=consumption=0

Then; input =out put

Dried orange peel (Kg/hr) + ethanol = extracted orange peel oil with ethanol

From the experimental work the ratio of oil to ethanol=0.116

Amount of ethanol = Dried orange peel/0.116

=622.32/0.116= 5364.83kg/hr of ethanol as solvent and input for extraction.

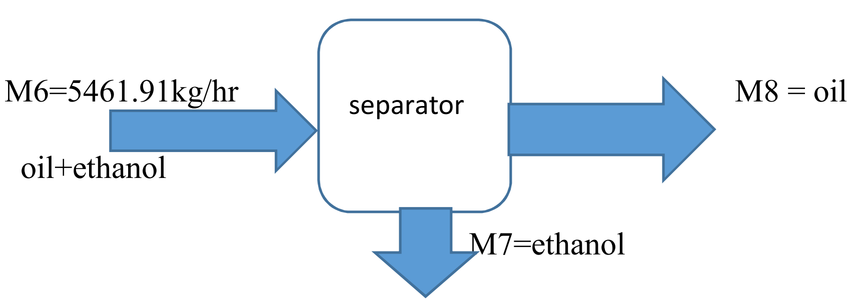
From our objective, production capacity the extracted orange peel oil =97.08 kg/hr

Therefore, biomass = dried orange peel + ethanol – amount of orange peel oil with ethanol

= 622.32Kg/hr+5364.83kg/hr – (97.08 +5364.83) kg/hr

= 525.22 kg/hr

5.1.4 Mass Balance on the Separator



Orange peel oil with ethanol = Extracted oil with ethanol–loss of ethanol– amount of ethanol

Extracted oil with ethanol = 5461.91kg/hr

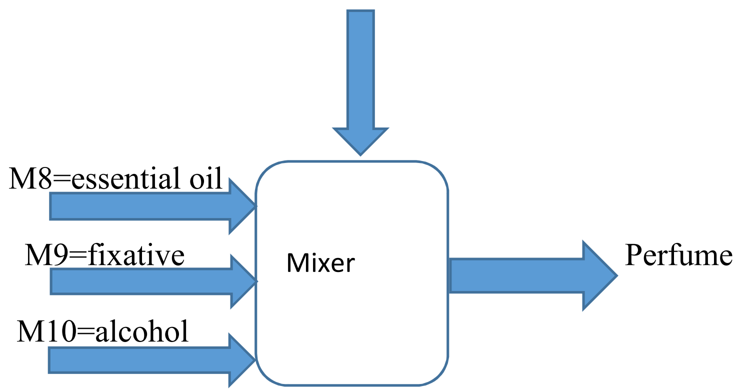
Loss of ethanol = 0.12*5461.91kg/hr = 655.43 kg/hr for 12% loss

The orange peel oil with ethanol=5461.91kg/hr – 5364.83kg/hr=97.08kg/hr

5.1.5 Material balance in perfume formulation

Mixing machine

Note: let 20% concentrated of perfume and 75%of alcohol



From our experiment procedure 10.4g or 0.0104kg of perfume are produced .by using 10ml or 0.01L alcohol,0.04Lof oil ,0.07ml or 0.00007L of fixative and 1ml or 0.001L of distilled water are used.

Over all material balance

M8+m9+m10+m11=m12

So 0.0048kg/hr of oil=0.00007kg/hr of fixative

For 97.08kg/hr =X?

M9=1.42kg/hr of fixative are used

So 0.0048kg/hr of oil=0.00052kg/hr distill water are used

For 97.08kg/hr=X?

X11=10.52kg/hr of distill water

And for alcohol

So 0.0048kg/hr of oil=0.0062kg/hr of alcohol are used

For 97.08kg/hr of oil=X?

M10=125.4kg/hr of alcohol are used

M8+m9+m10+m11=m12

M12=(97.08+1.42+10.52+125.4)kg/hr

M12=234.42kg/hr

5.2 Energy Balances

Energy Balance on Extractor

From conservation of energy principle law

$\Delta H+\Delta KE+\Delta PE=Q-W$

Where ΔH is enthalpy (change of enthalpy)

ΔKE is change of Kinetic Energy

PE is change of potential energy

Q is heat

W is work

Assumption:

- The systems not accelerating and falling or rising

  $\Delta KE+PE=0$

- There is no moving parts at system boundary

  $W=0$

Therefore ΔH+ΔKE+ΔPE=Q - W

T he general energy balance reduce to ΔH=Q

Where Q =MCPΔT then H=McpΔT

Mh = vhph

Were vh = volumetricflowrate of ethanol

Mh =mass flowrate of ethanol

Q = mcpΔT = (Methanol + M orange peel)cp ethanol + cp orange peel)ΔT

Q = (5364.83 kg/hr + 622.32Kg/hr)∗(2.57+3.77)kJ/kg * k *(75−25)k

Q=1897926.6kJ/h=1897926.6kJ/3600s

Q=527.2kw

The amount of heat need for heating is 527.2kw

5.3 Sizing of major equipment

Sizing and Equipment Listing For the Production of Perfume The engineer developing a process design must be the responsibility of preparing specific action for individual places of equipment and design data must be developed. Safety factor: is a factor to represent the amount of our design that would be used to account for the changes in the operating performance with time. As a general, safety factor = (10-20) % of capacity of the equipment.

5.3.1 Mixing tank

$$Vm = \frac{\text{mass of impurite ingerident} + \text{mass of impurity ingerident} * \text{safety factor}}{\text{density of impurity ingerident}}$$

$$Vm = \frac{97.08+10.52+1.42+125.4+0.15(234.42)}{881.25}$$

$$= 0.31\ m3/\text{hr}$$

Vm = 0.31m3/hr×24hr/day×2day= 14.88m3. Assume mixer height 0.8m, the diameter will be calculated as follow = $14.88m^3 = \frac{\pi d^2}{4} \times h$, $d^2 = 23.69m^2$, d=4.87m.

5.3.2 Still tank

$$Vs = \frac{\text{mass of orange peel} + \text{mass of orange peel} * \text{safety factor}}{\text{density of orange peel}}$$

$$Vs = \frac{560.088 + 560.088 * 0.15}{881.25}$$

$= 0.73\ m^3/hr$

Vs $= 0.73m^{3*}4/16$ hr = 0.18m3

Assume the length of still tank can be estimated 1m.Then the diameter will be calculated as follow.

Volume $= \frac{\pi d^2}{4} \times lengt = \frac{\pi d^2}{4} \times 1$, Vs = 0.18m3 $= \frac{\pi d^2}{4} \times 1 \rhd d^2 = 0.229m$, d=0.48m

5.3.3 Storage of ethanol tank

$$Ve = \frac{mass\ of\ ethanol + mass\ of\ ethanol * 0.15}{\text{density of ethanol}}$$

$$Ve = \frac{5364.83 + 5364.83 * 0.15}{789} = 7.82\ m^3/hr$$

= 7.82 $m3$/hr, seven day residence time (day) ,Ve = 7.82 hr× 7hr =54.74 $m3$

5.4 Economic analysis of perfume formulation from orange peel additive

5.4.1 Building, equipment and manpower requirement

Plant parameter

Capacity per year = 34,602.82kg/yr

Number of shifts /day = Working days/year = 300 day

Land area covered, $=1000m^2$

Machinery and equipment

Table 5.1 Specification and purchased equipment cost

Purchased equipment	Capacity	Req.no	Material	Total cost(birr)
Belt conveyor	L=7m	3	Carbon steel	382,807.5
Rotary Cutter	2kg/s	1		267,653.5
Mixing tank	$0.38m^3$	1	Stainless steel	119,626
Extractor	D=1.09m	1	Carbon steel	137,858
Condenser	$0.07m^3/s$	1	Carbon steel	179,095
Filter gravity	$1m^2$	1	Carbon steel	255,850
Boiler	-	1	Stainless steel	355,395
Ethanol Storage	$0.89m^3$	1	Carbon steel	70,950
Homogenizer	$1m^3$	1	304 Stainless steel	569,664
Filter (1PCS)	Db=0.5m	1	Carbon steel	320,350
Filler/bottling machine	1.05bt/min	1	-	430,000
Pump	$0.009m^3/s$	1	Centrifuge Cast steel	119,045.5
Pump	$0.004m^3/s$	2	Diaphragm	150,672
Water storage tank (H)	L=4.4m	1	Carbon steel	330,734.5
Total				3,689,701
Contingencies on Equipment 10%				368,970.1
Transportation cost = 10% of equipment cost				368,970.1
Grand total				4,427,641.1

Table 5.2 manpower requirement & cost

Sr.No	Manpower	Req. No	Monthly Salary (Birr)	Annual Salary (Birr)
1	General manager	1	10000	120000
2	Secretary	2	3000	72000
3	Accountant	2	4000	960000
4	Production and Technical Head	1	5000	60000
5	Mechanic	2	6000	144000
6	Electrical	2	5000	120000
7	Store keeper	2	2000	48000
8	Quality control	2	4000	96000
9	Operators	6	5000	360000
10	Ass. Operators	3	3000	108000
11	Guards	2	2000	48000
Total		25		1272000

5.4.2 Cost estimation

Cost of raw materials

Table 5.3 Cost of raw materials

Particulars	Unit price	Quantity per annum	Total cost(birr)
Orange peel	5birr/kg	1,015,504.54kg/yr	5,077,522.7
Ethanol	17.95birr/lit	26,214.26lit/yr	470,545.967
Water	0.005Bir/lit	6,407,268.97lit/yr	3,497.2
Glycerin	24/lit	122.3lit/yr	2,935.2
Total raw material cost			5,554,501.07

Fixed capital cost estimation

Table 5.4 Estimation of Fixed Capital Investment

Component	Factor	Cost (birr)
1.Total direct cost	Purchased equipment cost (PEC)	4,427,641.1
Installation	0.25 PEC	1,106,910.275
Instrumentation	0.1PEC	442,764.11
Electrical installed	0.1PEC	442,764.11
Piping installed	0.2PEC	885,528.22
Building including service	0.1PEC	442,764.11
Yard improvement	0.4PEC	1,771,056.44
Land		
Total direct cost (DC)		9,519,428.365
2.Total indirect cost Engineering and supervision	0.06 DC	571,165.702
Construction expense and contractors fee	0.05DC	475971.418
Total indirect cost (IC)		1,047,137.12
3. Fixed capital investment (FCI)	FCI = DC + IC	10,566,565.485
4.Working capital	0.15TCI	1,864,688.03
5.Total capital investment (TCI)	WC + FCI	12,431,253.512

FCI =DC + IC, FCI =10,566,565.485birr

TCI = FCI + WC, since working capital cost = (10-20) % of total capital investment

TCI =FCI + 0.15TCI, TCI = 10,566,565.485 + 0.15TCI

$$TCI = \frac{10,566,565.485}{1-0.15} = 12,431,253.512 \text{birr}$$

Estimation of total product cost

Total production cost(x) = Manufacturing cost + General expense

Manufacturing cost = Direct production cost + Fixed charges + Plant overhead cost.

A. Fixed Charges (FC)

1. Depreciation =10% of equipment cost+2.5% of building

= 442,764.11+442,764.11×0.025

=453,833.212birr,

2. Local taxes = 2.5% of FCI =0.025×10,566,565.485 = 264,164.14 birr

3. Insurance = 0.7% of FCI = 0.007×10,566,565.485= 73,965.9583birr

Thus, Fixed Charges =453,833.212birr +264,164.14 birr +73,965.9583birr =791,963.31birr

B. Direct Production Cost: (about 60% of total product cost) Let, the total product cost be X

Raw materials cost = 5,554,501.07birr

Operating labor (OL): Operating labor cost = 1,272,000

Direct Supervisory and Clerical Labor (DS & CL): (10-25% of OL)

Consider the cost for Direct supervisory and clerical labor = 14% of OL

Labor cost = 0.14*1,272,000birr=178,080birr

Utilities: (10-20% of total product cost)

Consider the cost of Utilities = 15% of total product cost Utilities cost = 0.15 *X

Maintenance and repairs (M & R): (2-10% of fixed capital investment)

Consider the Maintenance and repair cost = 5% of fixed capital investment

Maintenance and repair cost = 0.05×10,566,565.485 = 528,328.27birr

Laboratory Charges: (10-20% of OL)

Consider the Laboratory charges = 15% of OL

Laboratory charges = 0.15*1,272,000birr =190,800birr

Direct Production Cost (DPC),

Xb= 5,554,501.07birr+1,272,000birr+178080birr + 0.15* X+528,328.27birr +190800birr
=7,723.709.34+0.15 * X,

Xb = 0.15* X +7,723,709.34 birr,

Xb = 15,483,041.18×0.15 birr+7,723,709.34=10,046,165.52

C. Plant overhead Costs :

(50-70% of Operating labor, supervision, and maintenance or 5-15% of total product cost) includes for the following: general plant upkeep and overhead, payroll overhead, packaging, medical services, safety and protection, restaurants, recreation, salvage, laboratories, and storage facilities. Plant overhead cost 10% of total product cost, Plant overhead cost = 0.1* X

Manufacture cost = Direct production cost + Fixed charges + Plant overhead costs.

Manufacture cost = 0.15* X +7,723,709.34 birr +791,963.31birr +0.1* X

D. General expenses

Administration cost (4% of TPC) = 0.04∗*X*

Distribution and selling cost (11% of TPC) = 0.11*X

Research and development cost (5% of TPC) = 0.05*X

General expense = 0.04∗*X*+0.11∗X+0.05*X

Total production cost(x) = Manufacturing cost + General expense

X=0.15* X +7,723,709.34 birr +791,963.31birr +0.1*X +0.04*X+0.11*X+0.05*X

X=0.45X+8,515,672.65birr, X - 0.45=8,515,672.65birr

TPC(X) = 8515672.65birr/0.55 = 15,483,041.18birr

Gross earning/ income

Total income from product = unit selling price × Quantity of product manufactured

Annual income = 40 birr/60mlbottle × 35,208.046lit/yr×1000ml/lit = 23,472,030.8br

Total income from solid cake = unit selling price × Quantity of by product...

Annually earning of solid cake =2.00birr/kg*(431,510.575kg/yr) = 863,021.15birr

Total Income = Income of product + earning of solid cake =23,472,030.8br +863,021.15birr

Total income =24,335,052birr

Gross income = Total Income – Total Product Cost

= 24,335,052birr -15,483,041.18birr =8,852,010.82 birr

Let the tax rate be 35% (income tax of Ethiopia)

Taxes = 0.35* 8,852,010.82 birr = 3,098,203.79birr

Net profit = gross income - tax =8,852,010.82 birr -3,098,203.79birr = 5,753,807.033birr

Rate of return

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

$$ROI = \frac{\text{Net profit}}{\text{Total capital investment}} *100\%$$

$$= \frac{5,753,807.033\text{birr}}{12,431,253.512} *100\%$$

$$= 46.29\%$$

Since ROI ≥ Mar, 46.29 ≥ 12% the project is feasible

$$\text{Payback period} = \frac{\text{FIC}}{\text{NP + Depre}}$$

$$= \frac{10,566,565.485}{5.753.807.033\text{br}+453,833.212\text{br}}$$

$$= 1.7\text{yrs}$$

Break even analysis

Breakeven point is the point when total annual production cost equals total annual sales. That is the point where profit equals zero. The breakeven point is determined from the relation:

$$BEP = \frac{TFC}{(Sup - Vcup)} = \frac{TPC - DPC}{Sup - Vcup}$$

Where BEP = Break-even point (units of production),

Vcup = variable costs per unit of production,

Sup = selling price per unit of production,

TPC = total production cost ,

DPC = direct production cost.

Vcu=$Directproductioncost/Amountofperfumeproduced$

=10,046,165.52birr/yr/35,208,046ml/yr = 0.285birr/ml

Sup = 0.667birr/ml

$$BEP = \frac{(15{,}483{,}041.18birr - 10{,}046{,}165.52birr)/yr}{0.667 - 0.285\ birr/ml}$$

=14,232,660.45 ml/yr

BEP (%) = 11,994,560.36 ml/yr/35,208,046ml/yr ×100% = 40.42%

Perfume development from essential oil using soxelet extraction from orange peelis profitable as it is clearly observed from the above cost estimation. The rate of return investment 46.29% implies the plant returns 46.29% of its total capital investment in seventeen month. The payback period tells us the plant return its total investment cost in around seventeen month. Totally the income statement and the other indicators of profitability show that the project is viable. The project can be implemented after detailed feasibility study has been done.

CHAPTER SIX: CONCLUSION AND RECOMMENDATION

6.1 Conclusions

In this research essential oil was extracted from citrus fruit peel using soxhlet extractor. Particle size and extraction time were the considered parameters for this investigation. Under this investigation particle size range 0- 300µm and 300µm – 1.18mm and extraction time 2 hr and 3 hr were considered.

From the experimentation 34.67 % oil was obtained at particle size range of 0- 300µm and extraction time of 3 hour and 32.67% at particle size range0- 300µm and 2 hour extraction time. A 29.33% was obtained at particle size range of 0.3-1.18mm and 2 hour extraction time followed by a yield of 30.67% at particle size range of 0.3-1.18mm and 3 hour extraction time.

After the optimum operating condition for maximum oil yield was determined,and the physicochemical properties of essesntial oil and perfume(like acid value, saponification value, pH, ester value and specific gravity) and (PH,specific gravity, solubility in water, and cloor) respectivly were determined for characterization and quality analysis. The results were compared with standard orange peel essential oil specifications and the values were within the standards.

6.2 Recommendations

Even if orange peels essential oil had been used worldwide in formulation of cosmetics product, in Ethiopia peoples ignorantly throw away the peels after eating the fruit part and it becomes a source of pollution.

The present study has enables as the use of orange peel essential oil in cosmetics formulation so we recommend further studies to be performed if necessary on the performance of the oil and to be used in cosmetics industry for the production of perfume and production of the oil in large scale and exporting and can be a source of income for the country.

If any researcher wants to optimize the yield of essential oil from orange peels it can be recommended that it is better if he/she works optimum temprature and at high extraction time.

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APPENDICES

Annex A: Percentage extraction yield of orange peel oil for two factors, two levels and one replication experimental design.

No of runs	Factor 1	Factor 2	Factor 3			
	Particle mesh size range	Extraction time (hours)	Constant solvent	Extracted oil(ml)	Oil yield(gm)	Extraction yield(%)
1	0-0.3mm	2	ethanol	5.5	4.9	32.67
2	0-0.3mm	3	ethanol	6	5.2	34.67
3	0.3-1.18mm	2	ethanol	4.8	4.4	29.33
4	0.3-1.18mm	3	ethanol	5.1	4.6	30.67

Annex B: physicochemical property of orange essential oil

Physicochemical property	Measured value	Standard value
PH value	4.2	3.5 – 6.5
Acid value(mgKOH/g of oil)	2.2	1.99 – 2.2
Saponification value(mgKOH/g of oil)	16.129	13.23 – 16.19
Ester value (mgKOH/g of oil)	13.93	11.24 – 14
Specific gravity	0.85	0.84 – 0.86

Annex C: Formulas and Equations used for characterization of the oil and perfume:

1. Moisture content= $\frac{(W1-W2)}{W1} * 100$

Where

W1= Original weight of the sample before drying

W2=weight of the sample after drying

2. Percentage extraction yield= (mass of oil/mass of sample)*100

3. Specific gravity= (W1-W0)/ (W2-W0)

W0 = Mass of measuring cylinder of 25ml capacity

W1 = mass of measuring cylinder with oil

W2 = mass of measuring cylinder with water

4. Acid value= $A.V = \frac{MwNaOH * V * N}{Ws}$

5. Saponification value=56.1*(V1-V2)/ (2*W)

Where W=weight of oil

V1=volume of 0.5N oxalic acid for blank

V2=volume of 0.5N oxalic acid for sample

6. Ester value=saponification value - acid value

Raw material preparation

Sieve analysis

Soxlet extraction

Extracted oil

Titration of oil

Perfume(final product)