Comparative Analysis of Extraction of Oil from Lemon Grass & Its Usage as DEET Free Insect-Repellent

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Abstract— The work done will focus on the study and optimization of extraction of ingredient oil from lemongrass. This study investigates the influence of operating parameters like time, size, and type of grass on the extraction of oil. Lemon grass is an important herbal and aromatic plant and its oil is one of the major essential oils used in the perfumery and cosmetic industry. It is widely used in the scented soaps, sprays, deodorants, polishes and medicines. The extracted oil is rich in Citral A & P. Citral is the starting material for the manufacture of vitamin A. In the present experiment citral is isolated by Hydro-distillation of lemon grass, by using both bath and continuous methods. The distillate contains 90 % citral and 10 % neral, the isomer about the 2, 3-bond. Various experiments are carried out on a lab scale to optimize the parameters and get the maximum yield. The extracted oil is analyzed by using gas chromatography. The result indicates that the wet grass gives the maximum extract. The Yield can be raised from 8% to 12% by using Hydro-distillation and pre heated water as solvent. During the comparative study it is clearly seen that the batch experiments with wet grass as raw material gives maximum yield. The repellent effects of different doses of the essential oils from the lemon grass, Cymbopogon citratus were evaluate in laboratory. The results of lemon grass oil testing were compared with those that were obtained when test animals were treated with an equivalent dose of diethyl-3-methylbenzamide, which is a repellent that is commonly used as a positive control.

Key words: Lemongrass, Ingredient Oil, Optimization, Extraction, Time, Size, Gas Chromatograph, Repellent

I. INTRODUCTION

Lemon grass (Cymbogencitratus) is found in many parts of world. It is mainly grown as an ornamental plant however lemongrass has many other uses such as a food crop eg. It is used in herbal tea because of its sharp lemon flavor. It is used as the perfume in soaps and a medicine to treat various health ailments, decreasing acne, athlete's foot, flatulence, muscles aches and scabies [1]. Further, bioactivity studies have shown that the various components of this ingredient oil contains antimicrobial, antifungal, antibacterial and mosquito repellent properties make it a valuable product to be extracted [2]. The citral isolated from oil is used in the manufacturing of vitamin A, Because of those attributes lemon grass is of great use and value in the agriculture sector, especially for the protection of stored agricultural product. Crude essential oils are obtained by steam distillation of variety of natural products like plants, grasses, wood stumps saw dust, flowers, kernel and social hygiene of mankind in terms of their use in cosmetics, toiletries, medicinal formulations, aroma therapy, surface coatings etc. [3].

Most of the essential or ingredient oil occurring in nature consists of mixture of hydrocarbons like terpens [4] sequiterpenes, oxygenated compounds like alcohol esters, ether, aldehydes, ketones, lactones, phenols and waxes. Out of these oxygenated compounds like alcohols are the principal odour carriers [2]. They are more stable against oxidation agents. The unsaturated hydrocarbon like terpenes are less stable and are responsible for degrading oils. To make essential or ingredient oils more stable, so that they retain most of their odor and flavor, these terpenes are removed so that only oxygenated compounds are retained.

The lemon grass oil is obtained by steam distillation or hydrodistilation of lemon grass. It is the most common and cheapest oil available in market [5]. The steam distillation or hydrodistilation process to obtain ingredient oil from leaves and the aromatic industry use this method because it is cheap when compared with technologically advanced methods as supercritical fluid extraction. [6].

The main objective of this work is to optimize the lemongrass oil extraction process variables (parameters) to define the best operational conditional with regard of yield and composition of lemon grass oil considering as function of time and raw state material.

II. MATERIALS & METHODS

A. Materials

Wet and dry lemon grass, water, distillation column, condenser, heating element, measuring cylinder, conical flasks, burette, glass bottles with stopper, gas chromatography.

B. Experimental Methods

Lemon grass (chopped or un-chopped) and water is filled in the distillation still and the lid is fitted tightly, so that oil and vapor do not leak. As steam forms it carries the oil from the plant material i.e. lemon grass and both oil and steam pass to condenser through vapor line. Where the vapors get condensed and oil and water are separated in separators. Oil being lighter is separated from the top and water being heavier is separated from the bottom of the separator. Same procedure is repeated in continuous process by using a packed column.

Essential oils are highly sensitive as such that distillation is carried out at low temperatures. Further direct heat contact provided by steam, initially gives wet ability to grass at high temperatures, enhancing diffusion and osmosis of the oil. Rate of oil vaporization of the plant material in distillation is not influenced by relative volatility of oil components but by their solubility in water. Extraction of oil from lemon grass is a rate process. Also oil removed per unit is directly proportional to oil remained in grass. The balance equation for batch distillation can be given by first order kinetics;

$$- dx/dt = kx \quad (1)$$

$$- dx/x = kdt \quad (2)$$

$$\ln X/x = kt \quad (3)$$

$$\ln(1/1-y(t))=kt \quad (4)$$

Where x is average concentration of oil in grass at time t X is initial concentration of oil in grass before distillation starts; t is time of distillation, y(t) is the fraction of oil extracted.

If above model holds good then the plot of 1/ 1- y versus t shall produce a straight line passing through origin. The analysis of oil can be done qualitatively and quantitatively with the help of gas chromatography – mass spectroscope apparatus.Mean percent repellency for each concentration was calculated based on the data of the three replicates at the given times of observation. Percent repellency for the test oils and DEET was calculated using the formula:

$$\text{Repellence (\%)} = (N - R)/N \times 100$$

Where, N = number of flies landing on the negative control side; R = number of flies landing on side treated with test oil or DEET. Thus, efficacy of the candidate repellent could be assessed relative to DEET.

III. EXPERIMENTAL WORK

The grass and water are mixed in desired quantities and are filled in the distillation apparatus. The temperature is set and after the boiling point of water the vapors start generating with oil extract. The oil distillate is collected in measuring flask and extract of oil is measured. The experiments are carried out in batch and continuous methods.

The kinetic data i.e oil yield at half hour interval of time in all the experiments carried out in the lab will be presented in table. Using this data we will plot he graph as oil yields verses time for these experiments. Fractional yield of oil y is calculated as the ratio of oil extracted till time t to the cumulative amount of oil extracted. To verify the model we again plot the graph of 1/1-u versus t to show the straight line behavior. This will also show that oil extracted is directly proportional to the oil remaining in grass.

IV. RESULT & DISCUSSION

The following are the results obtained from the batch experiments conducted to extract the ingredient oil from lemon grass;

Experiment no	Weight of dry grass in gm	Chopped in cm approx.	Packing	Temperature in ºC	Oil extracted In ml
1.	300	2	Loose	100	25
2.	250	1.5	Loose	100	23
3.	300	1	Loose	100	35
4.	300	0.6	Loose	120	30
5.	250	0.3-0.4	Loose	120	54
6.	300	Below 0.1	Loose	130	49
7.	300	Fine	Loose	130	50

Table 1: For Dry Grass

Experiment no	Weight of wet grass in gm	Chopped in cm approx.	Packing	Temperature in ºC	Oil extracted In ml
1.	300	2	Loose	100	31
2.	250	1.5	Loose	100	42
3.	300	1	Loose	100	38
4.	300	0.6	Loose	120	33
5.	250	0.3-0.4	Loose	120	57
6.	300	Below 0.1	Loose	130	52
7.	300	Fine	Loose	130	53

Table 2: For Wet Grass

The above mentioned results are for the batch process. Similar types of experiments when carried out in continuous process following results are obtained; The results for continuous distillation of lemon grass, when raw material used is dry grass are as follows;

Experiment no	Weight of dry grass in gm	Chopped in cm approx.	Packing	Temperature in ºC	Oil extracted In ml
1.	300	2	Loose	100	20
2.	250	1.5	Loose	100	18
3.	300	1	Loose	100	24
4.	300	0.6	Loose	120	20
5.	250	0.3-0.4	Loose	120	30
6.	300	Below 0.1	Loose	130	27
7.	300	Fine	Loose	130	29

Table 3

The results obtained for the continuous distillation using wet grass as the raw material are as follows;

Experiment no	Weight of wet grass in gm	Chopped in cm approx.	Packing	Temperature in ºC	Oil extracted In ml
1.	300	2	Loose	100	25
2.	250	1.5	Loose	100	20
3.	300	1	Loose	100	25
4.	300	0.6	Loose	120	26
5.	250	0.3-0.4	Loose	120	33
6.	300	Below 0.1	Loose	130	29
7.	300	Fine	Loose	130	31

Table 4

From the above results we can clearly see that the yield is obtained maximum in batch process with the raw material as the wet grass. The maximum yield is 57ml for 120

ºC, where the weight of wet grass is taken as 250 gm and the wet grass is cut up to 0.3-0.4 cm approx.
Hence the optimized results are given as follows.

Experiment no	Weight of wet grass in gm	Chopped in cm approx.	Packing	Temperature in ºC	Oil extracted In ml
5	250	0.3-0.4	Loose	120	57.2

Table 5:

The kinetic analysis of the optimum yield is given as follows:

Time in minutes	Yield in ml	Y	ln (1/1-y)
30	16.4	0.25	0.33
60	29.9	0.52	0.73
90	47.3	0.82	1.70
120	51.5	0.90	2.30
150	54	0.94	2.80
180	55.4	0.96	3.20
300	57.2	_	_

Table 6

The graphs obtained for the optimized results are as follows;

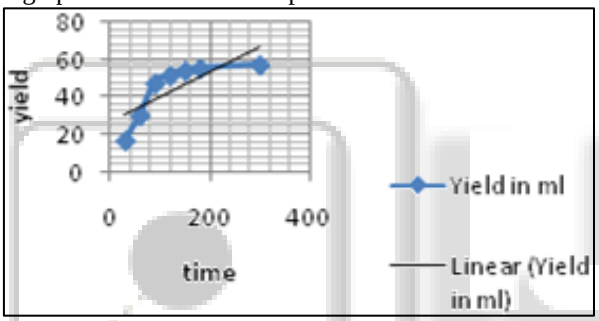

Fig. 1: Yield versus Time

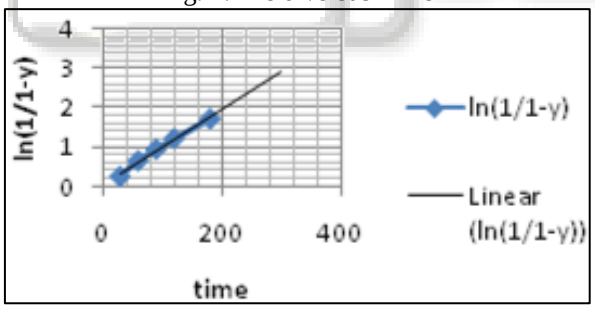

Fig. 2: ln (1/1-y) Versus Time

Therefore according to the graphs obtained the general prediction can be given as the time vs yield graph is a curve which will not pass through point 0, this is so because the extraction of oil starts after the boiling point of water. So the intercept indicates the time span required for the first drop of oil to be extracted. Further the curve goes on increasing up to certain height and then it starts decreasing indicating towards the end of process.

The graph of time vs ln 1/1-y is a straight line passing through origin which indicates the process follows the first order kinetics equation.

This study sought to determine the repellent activity of two essential oils of the lemon grass, C. citratusand T. minuta. The results of GC–MS of C. citratus demonstrated that the oils were dominated by monoterpene hydrocarbons. The monoterpene fraction for C. citratus was characterized by a high percentage of geranial (20.45%), myrcene (14.24%), neral (11.57%), and verbenene (9.26%) while that of T. minuta composed of dihydro-tagetone (21.15%), (E)-tagetone (16.21%), (Z)-tagetone (14.99%), (Z)-β-ocimene (9.84%), limonene (7.40%), allo-ocimene (6.69%) and (Z)-ocimenone (4.12%).

V. Conclusion

According to the data obtained from the experiments carried out following are the conclusions drawn;

1) The loose packing and the wet material in raw material in distillation still enhances the oil yield from plant material.
2) The kinetic studies of distillation process showed that oil is not instantly extracted and if it is the dry grass the yield is less.
3) The plot of time vs ln(1/1-y) is a straight line i.e. it follows first order kinetics.
4) Oil removed per unit time is directly proportional to the oil remaining in the grass.
5) The yield percent is raised from 8% to 12% by using water as solvent. As no chemicals are used there is no need of purification for final product.
6) The yield of continuous process is less than that of the batch process due to the volatile nature of the oil extracted.
7) The laboratory tests showed that the essential oils of the theseplants were highly repellent toflies, P. duboscqi. Thus, the essential oils are candidate natural repellents that can be used against P. duboscqi due to their high efficacy at very low doses, hence, the envisaged safety in their use over chemical repellents.

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