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Comparison of the yield and chemical constituents of essential oils extracted from lemon grass using steam distillation and hydrodistillation

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ABSTRACT

Steam distillation and hydrodistillation are the two methods used to extract essential oil from lemon grass. This study demonstrated that both the steam distillation and hydrodistillation processes are appropriate for extracting the essential oil of lemon grass because of their ability to yield higher yields of 1.05% and 1.02%, respectively, and because of their faster extraction periods. After analysis with GC-MS (gas chromatography mass spectrometry) and GLC (gas liquid chromatography), the total number of major and minor chemical molecules were found to be approximately similar. That is, the total number of chemical molecules in the lemon grass oil obtained by using steam and hydro distillation extraction methods, respectively, were 31 and 29.

Keywords: Lemon grass, Distillation, Yield, Chemical Composition

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1. Introduction

Essential oils are concentrated hydrophobic liquids made up of volatile chemical components from various plant sections that evaporate easily at room temperature [1]. Essential oil is a complex mixture of volatile organic chemicals made up of hydrocarbons and oxygenated substances such as esters, aldehydes, ketones, etc. They give plants their scent, which is essential to the food, pharmaceutical, and cosmetics sectors [2]. Plant-based perfumes are extracted using a variety of techniques, such as distillation, solvent extraction, and effleurage. The aromatic molecules that are produced from the raw materials have their smell somewhat altered by these processes [3, 4]. According to the author, there are roughly 55 species in the genus Lemongrass, the majority of which are indigenous to Australia, Southeast Asia, and South Asia. Cymbopogon citratus, or East Indian lemongrass, is native to India, Sri Lanka, Burma, and Thailand. Its West Indian counterpart, Cymbopogon citratus, is said to have

originated in Malaysia. These two main varieties are highly relevant for commercial use. With leaves up to one meter long, the plants grow in thick clumps up to two meters in diameter. According to reports, the lemongrass life zone is between 18 and 29 degrees Celsius, with 0.7 to 4.1 meters of precipitation per year and a pH of 5.0 to 5.8 (East Indian) or 4.3 to 8.4 (West Indian) in the soil. The plant thrives in full sun, sandy soils with good drainage, and warm, humid climates. The quality of lemongrass oil is mostly determined by citral, the aldehyde that gives lemons their scent. According to the author, terpineol, myrcene, citronellol, methyl heptenone, dipentene, geraniol, limonene, nerol, and farnesol are some more components of the essential oils. Myrcene and limonene, two of the many appealing aromatic chemicals found in lemongrass essential oil, have the dual benefits of relieving pain and preventing cancer [5].

Lemongrass essential oil can be extracted by a variety of techniques, such as solvent extraction, carbon dioxide extraction, cold pressing, hydro distillation (usually with water or steam), and florasol/phytol extraction [6–9]. Chromatography coupled with mass spectrometry (GC/MS) was used to evaluate the chemical makeup of lemongrass essential oil. There are several studies being conducted right now on the chemical makeup and extraction of lemongrass essential oil.

The present investigation aims to examine the chemical composition of lemon grass oil obtained by innovative techniques including steam distillation and hydrodistillation (HD). The goal of the current research is to ascertain whether producing more or better lemon grass oil may be achieved through the use of green methods.

2. Extraction Process and Production of Lemon Grass Oils

2.1 Hydrodistillation method

The hydrodistillation process was used to extract lemon grass essential oil using the Clevenger distillation method (fig 1(a). To begin, 3000 mL of water was added to 300 g of small pieces of lemon grass leaves. The weighed pieces of lemon grass leaves were placed into a 5000 ml Clevenger distillation flask. The essential oil volume (mL) was continuously collected after 8 hours of distillation. Finally, the essential oil was dehydrated (de-moisturized) using sodium sulfate. The distillation yield of the essential oil obtained was calculated using the following equation: (1).

$$\text{Yield\% of lemon grass oil} = \frac{\text{Weight of lemon grass Oil}}{\text{Weight of lemon grass}} \times 100 \quad (1)$$

2.2 Steam Distillation

Steam distillation process carriedout as water is boiled to create steam, which then travels through a bunch of herbs (fig 1 (b). The steam breaks the structure of herbs, extracts oil, and then flows into the condenser. There, it becomes a liquid solution of water and oil and goes into a separator. The oil being lighter than water is physically separated and the water is discarded. The oils are clear.

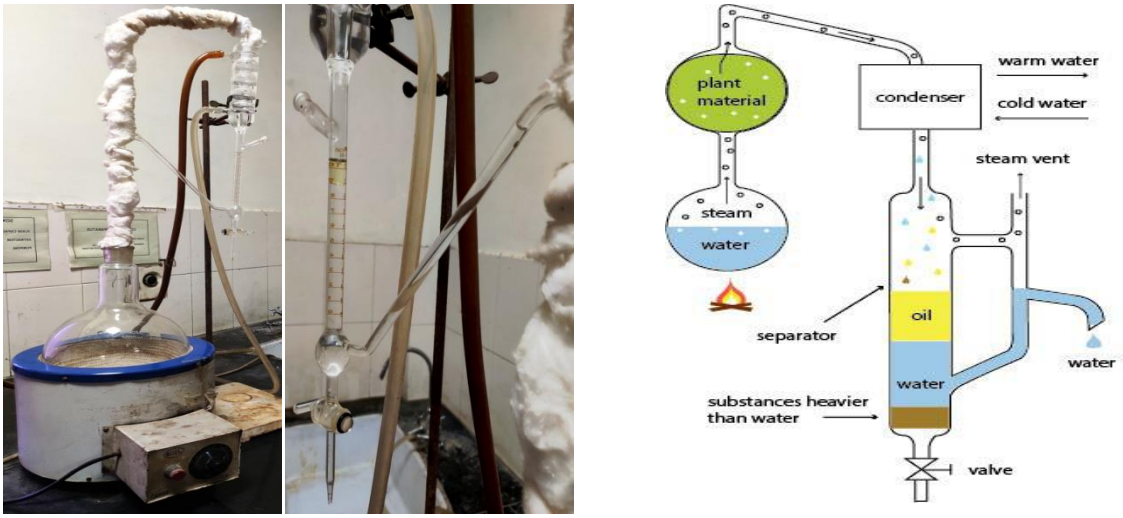

Figure-1. (a) Hydrodistillation-Clevenger method (b) Steam distillation method

2.3 Yield of Essential Oil

The yield percentage was calculated as a volume of essential oil per 100 g of Lemon grass roots weight. Essential oils acquired from Lemon grass roots by Hydrodistillation and Steam distillation methods produced a oil with colour golden-brown to amber-brown to olive. It exudes a strong aroma that smells earthy, woody, and rich. liquid with strong scent. The yield in both used distillation methods is different as shown in table 1. It indicates that the amount of essential oil yield is influenced by used distillation method.

Table 1. Effect on of Yield of Essential Oil by different distillation methods

S. No.	Distillation method	Oil yield (% v/w)
1.	Hydrodistillation-Clevenger	1.02
2.	Steam Distillation	1.05

3. Result and Discussion

3.1 Physio-chemical properties

It has been observed that physical and chemical values are almost similar. There are identified total 29 and 31 major and minor percentage of chemical molecules in the lemon grass oil obtained from the hydrodistillation and steam distillation, respectively by the GC-MS analysis.

Table 2. Physicochemical properties of Lemon grass oils extracted by different hydrodistillation & steam distillation methods.

S.N.	Physicochemical properties	Distillation Methods	
		Hydro-Distillation	Steam Distillation

1.	Colour, odour appearance	Light Yellow to Pale Yellow, Strong, fresh grassy, citrus like	Light Yellow to Pale Yellow, Strong, fresh grassy, citrus like
2.	Optical rotation	-2.75°	-2.77°
3.	Specific gravity at 27°C	0.8902	0.8905
4.	Refractive index at 27°C	1.4787	1.4785
5.	Solubility at 27°C	2.5 vol. of 70% ethanol	2.5 vol. of 70% ethanol
6.	Acid value % by mass	2.7%	2.7%

3.2 Chemical Composition of lemon grass essential Oil

The qualitative and semi-quantitative composition of the essential oils is reported in Table 3, where the components are listed according to the class of compounds. Content (expressed as %) was calculated as ratio of peak area of individual compound and total peaks area in GC-MS chromatograms. The composition of lemon grass oils obtained by both distillation techniques is approximately similar identified total compounds and also in their relative percentage amount. Figure 3(a, b), Gas Chromatogram-Mass Spectrosmetry (GC-MS) analysis revealed that 31 of the total major and minor components are separated in the lemon grass oil obtained from steam distillation method (table 3), whereas 29 molecules were determined in the lemon grass oil obtained from hydodistillation method (table 4).

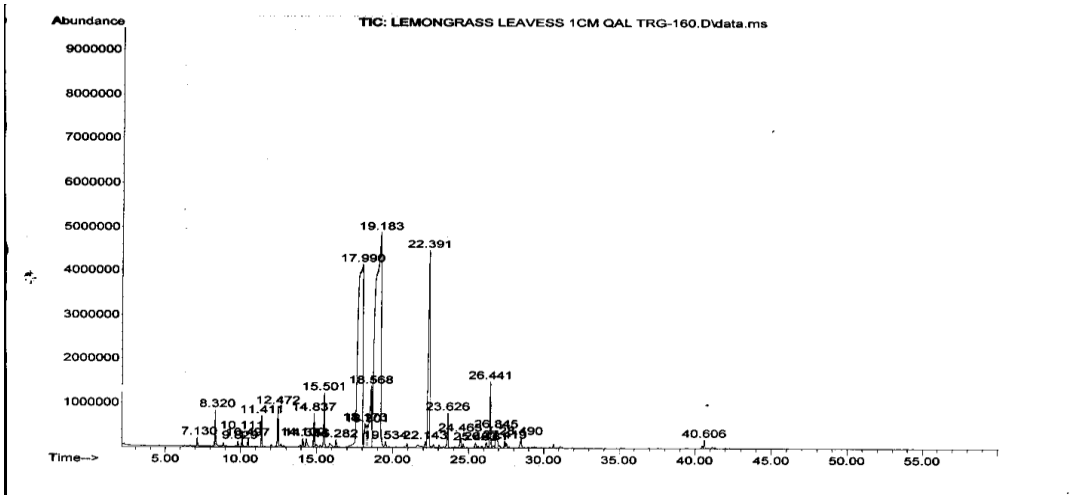

Figure 3(a) Gas Chromatogram-Mass Spectrosmetry (GC-MS) analysis for Lemon grass oil obtained from steam distillation

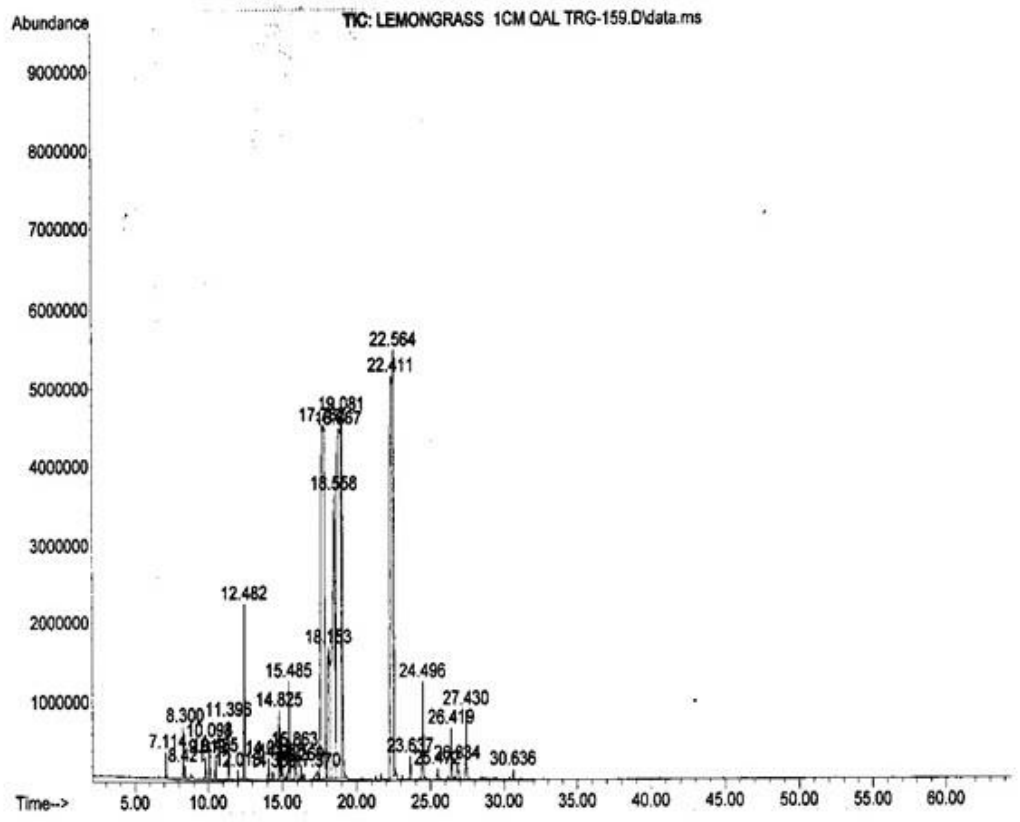

Figure 3(b) Gas Chromatogram-Mass Spectrosmetry (GC-MS) analysis for Lemon grass oil obtained from hydrodistillation

Table 3. Chemical molecules of lemon grass essential oils obtained from steam distillation extraction method.

S. No.	**Chemical compound**	**Formula**	**Retention time (minute)**	**Chromatogram area (%)**
1	Camphene	$C_{10}H_{16}$	7.115	0.28
2	6-Methyl-5- hepten-2-one	$C_8H_{14}O$	8.302	0.56
3	Myrcene	$C_{10}H_{16}$	8.420	0.14
4	Delta-3- carene	$C_{10}H_{16}$	9.821	0.29
5	(Z)- beta- ocimene	$C_{10}H_{16}$	10.099	0.40
6	(E)- beta- ocimene	$C_{10}H_{16}$	10.484	0.26
7	3-methyl-2- buten-1-ol	$C_5H_{10}O$	11.394	0.66
8	Delta-2- carene	$C_{10}H_{16}$	12.019	0.11
9	Linalyl formate	$C_{11}H_{18}O_2$	12.479	2.35
10	Neryl formate	$C_{11}H_{18}O_2$	14.095	0.28
11	Citronellyl oxy-acetaldehyde	$C_{12}H_{22}O_2$	14.389	0.13
12	Cis- verbenol	$C_{10}H_{16}O$	14.827	0.83
13	Borneol	$C_{10}H_{18}O$	14.988	0.31

14	Pulegone	$C_{10}H_{16}O$	15.485	1.22
15	Alpha- terpineol	$C_{10}H_{18}O$	15.865	0.54
16	Decanal	$C_{10}H_{20}O$	16.272	0.18
17	Citronellol	$C_{10}H_{20}O$	17.368	0.30
18	Neral	$C_{10}H_{16}O$	17.780	19.99
19	Neryl Formate	$C_{11}H_{18}O_2$	18.154	4.55
20	Nerol	$C_{10}H_{18}O$	18.555	10.69
21	Geranial	$C_{10}H_{18}O$	18.866	21.89
22	Geranial	$C_{10}H_{18}O$	19.080	6.57
23	Lavandulyl acetate	$C_{12}H_{20}O_2$	22.412	14.06
24	Lavandulyl acetate	$C_{12}H_{20}O_2$	22.567	9.24
25	(E)- caryophyllene	$C_{15}H_{24}$	23.637	0.34
26	(E)- isoeugenol	$C_{10}H_{12}O_2$	24.498	1.38
27	Germacrene D	$C_{15}H_{24}$	25.471	0.19
28	Gamma- cadinene	$C_{15}H_{24}$	26.418	0.71
29	(E)-gamma- bisabolene	$C_{15}H_{24}$	26.835	0.40
30	Elemol	$C_{15}H_{26}O$	27.429	0.99
31	Gamma- curcumene	$C_{15}H_{24}$	30.638	0.15

Table 4. Chemical molecules of lemon grass essential oils obtained from hydrodistillation extraction method.

S. No.	**Chemical compound**	**Formula**	**Retention time (minute)**	**Chromatogram area (%)**
1	Camphene	$C_{10}H_{16}$	7.131	0.23
2	6-Methyl-5- hepten-2-one	$C_8H_{14}O$	8.318	0.91
3	Limonene	$C_{10}H_{16}$	9.832	0.15
4	(Z)- beta- ocimene	$C_{10}H_{16}$	10.110	0.38
5	(E)- beta- ocimene	$C_{10}H_{16}$	10.495	0.21
6	3- octanone	$C_8H_{16}O$	11.409	0.83
7	(E)- beta- ocimene	$C_{10}H_{16}$	12.474	1.17
8	Neryl formate	$C_{11}H_{18}O_2$	14.111	0.28
9	Trans- ethyl chrysanthemumate	$C_{12}H_{20}O_2$	14.335	0.36
10	Para- menth-1-en-7-al	$C_{10}H_{16}O$	14.838	0.95
11	Pulegone	$C_{10}H_{16}O$	15.501	1.68
12	Decanal	$C_{10}H_{20}O$	16.282	0.23
13	Neral	$C_{10}H_{16}O$	17.988	30.21
14	Beta-pinene	$C_{10}H_{16}$	18.170	1.20
15	Myrcene	$C_{10}H_{16}$	18.299	1.03
16	Lavandulyl isobutanoate	$C_{14}H_{24}O_2$	18.566	4.13

17	Geranial	$C_{10}H_{18}O$	19.181	40.28
18	(E,Z)- isosafrole	$C_{10}H_{10}O_2$	19.534	0.23
19	Eremoligenol	$C_{15}H_{26}O$	22.144	0.20
20	Geranyl propanoate	$C_{13}H_{22}O_2$	22.390	9.44
21	(E,Z)- caryophyllene	$C_{15}H_{22}$	23.626	1.12
22	(E,Z)- isoeugenol	$C_{10}H_{12}O_2$	24.460	0.48
23	Germacrene D	$C_{15}H_{24}$	25.466	0.21
24	Cuparene	$C_{15}H_{24}$	26.182	0.26
25	Gamma- cadinene	$C_{15}H_{24}$	26.439	2.07
26	(E)-gamma- bisabolene	$C_{15}H_{24}$	26.846	0.90
27	Elemol acetate	$C_{17}H_{28}O_2$	27.418	0.13
28	Caryophyllene oxide	$C_{15}H_{24}O$	28.488	0.46
29	Eupatoriochromene	$C_{13}H_{14}O_3$	40.608	0.26

Conclusion

This research demonstrate that both technology i.e. hydro and steam distillations are almost similar for the extraction of lemon grass essential oil quantity and total number chemical constituents are producing similar. GC-MS analysis revealed that 31 of the total major and minor components in lemon grass oil were found in steam distilled lemon grass oil, whereas 29 number of chemical molecules were analyzed in the extracted lemon grass oil from hydodistillation method. In conclusion, it is not possible to say with certainty whether hydrodistillation or steam distillation is better because each of them has similar results in yield and chemical composition of lemon grass essential oils.

References

1. M. F. Mendes, Extraction modes. Handbook of food products manufacturing. Hoboken, New Jersey: John Wiley & Sons, Inc, 2007.
2. Mohammed, Z. R. Hail, C. Demelza, and P. F. Michael, "The growth and development of sweet basil (Ocimum basilicum) and bush basil (Ocimum minimum) grown under three light regimes in a controlled environment," Agronomy, MDPI, vol. 9, pp. 743-757, 2019.
3. Mancada, J., Tamayo, J.A., and Cardona, C.A. “Techno-economic and Environmental Assessment of Essential Oil Extraction from Lemongrass (Cynbopogon Citratus), A Colombian Case to Evaluate Different Extraction Technologies”, India Crops Product, 54, 175-184, 2014.
4. Suryawanshi, M.A., Mane, V.B., and Kumbhar, G.B. “Methodology to Extract Oils from Lemongrass Leaves: Solvent Extraction Approach”, International Research Journal of Engineering and Technology, e-ISSN: 2395-0056, p-ISSN: 2395-0072, 03, Issue: 08, 1775-1780, 2016.
5. Ranitha M., Abdurahman, H.N., Ziad, A.S., Azhari, H.N., and Thana, R.S. “A Comparative Study of Lemongrass (CymbopogonCitratus) Essential Oil Extract by Microwave-Assisted Hydrodistillation (MAHD) and Conventional Hydrodistillation

(HD) Method" International Journal of Chemical Engineering and Application", 5 (2) 104-108, 2014.

6. J.K. Parikh and M.A. Desai, Int. J. Food Eng., 7, Article 11 (2011); https://doi.org/10.2202/1556-3758.2067.
7. T. Silou, M. Malanda and L. Loubaki, J. Food Eng., 65, 219 (2004); https://doi.org/10.1016/j.jfoodeng.2004.01.018.
8. B. Marongiu, A. Piras, S. Porcedda and E. Tuveri, Nat. Prod. Res., 20, 455 (2006); https://doi.org/10.1080/14786410500277837.
9. S.R. Sargenti and F.M. Lanças, Chromatographia, 46, 285 (1997); https://doi.org/10.1007/BF02496320.