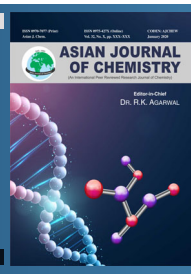
Asian Journal of Chemistry; Vol. 32, No. 5 (2020), 1248-1250

ASIAN JOURNAL OF CHEMISTRY

https://doi.org/10.14233/ajchem.2020.22258



Evaluation of Physico-Chemical Properties of Lemongrass (*Cymbopogon citratus* L.) Essential Oil Grown in Tien Giang Province, Vietnam

TAN PHAT DAO[1,2], HOANG THANG DO[3], LE QUANG KHOI[4], NGUYEN VAN GIA PHAP[5], MAI HUYNG CANG[6], TRI NHUT PHAM[1,2,*] and NGUYEN VAN MUOI[7,*]

[1]Center of Excellence for Biochemistry and Natural Products, Nguyen Tat Thanh University, Ho Chi Minh City, Vietnam
[2]NTT Hi-Tech Institute, Nguyen Tat Thanh University, Ho Chi Minh City, Vietnam
[3]Department of Chemical Engineering, HCMC University of Technology, VNU-HCM, Ho Chi Minh City, Vietnam
[4]Tien Giang Technical and Biotechnological Center, Tien Giang Department of Science and Technology, Tien Giang Province, Vietnam
[5]Phuc Nguyen-TPD Co. Ltd., Tien Giang Province, Vietnam
[6]Department of Chemical Technology, Nong Lam University, Ho Chi Minh City, Vietnam
[7]College of Agriculture, Can Tho University, Can Tho City, Vietnam

*Corresponding authors: E-mail: ptnhut@ntt.edu.vn; nvmuoi@ctu.edu.vn

Received: 6 June 2019; *Accepted*: 19 February 2020; *Published online*: 29 April 2020; AJC-19864

The lemongrass (*Cymbopogon citratus* L.) essential oil plays a vital role as an ingredient in different fields due to aromatic, antibacterial properties and antifungal activity. In this study, essential oil of lemongrass was obtained using hydrodistillation method and evaluated for chemical compositions and physico-chemical characteristics. The averaged physico-chemical parameters were determined as specific gravity (0.8865 g/cm^3), acid index (2.948), ester index (6.402) and refractive index (9.35). Moreover, the hydrodistillation process performance was achieved 0.29%. The composition of essential oils was analyzed by GC-MS, revealing a total of 18 volatile constituents existing in the lemongrass oil. The major components were α-citral (40.838%), β-citral (28.494%), β-myrcene (16.654%), 2,3-dehydro-1,8-cineole (2.264%) and geraniol (2.388%). The citral component accounts for high content (more than 70% of volume) of oil.

Keywords: *Cymbopogon citratus* L., Lemongrass, Essential oils, GC-MS.

INTRODUCTION

In recent years, essential oil is gaining increasing attention due to its high economic value and the abundance of aromatic compounds. Essential oil is a complex mixture of volatile organic compounds and formed by oxygenated compounds (esters, aldehydes, ketones, *etc*.) and hydrocarbons. They are responsible for the aroma of plants, which plays a vital role in cosmetics, food and pharmaceutical industries. Lemongrass, *Cymbopogon citratus* or *Andropogon citratus*, currently has about 55 species. The main product of lemongrass is essential oil which accumulated in leaf stems with the varying content from 0.4 to 2.0% depending on variety, ecological conditions, and extraction method. The previous studies [1-4] reported that the lemongrass essential oils play a crucial role in the treatment of different diseases such as oily skin, scabies, acnes and exhibit antibacterial and antimicrobial activities. The components with highest content in *Cymbopogon citratus* oils were neral (*cis*-citral, citral b), geranial (*trans*-citral, citral a) and myrcene. Lemongrass essential oil has many attractive aromatic compounds that can reduce pain due to its ability to relieve pain and prevent cancer (myrcene and limonene). Studies show that citronella possesses many different pharmacological activities such as amoeba resistance, antidiarrhea, and antifungal properties [5-7]. Different studies have also been studied for other effects such as antimalarial, antibiotic, antifungal, antioxidant, hypoglycemic drugs [8-10]. The method for extraction of lemongrass essential oil might include hydrodistillation (typically using water or steam), solvent extraction, carbon dioxide extraction, cold pressing as well as florasol/phytol extraction [11-14]. Among these methods, hydrodistillation is commonly used to isolate essential oils and valuable compounds from

plants. The chemical composition of lemongrass essential oil was analyzed by chromatography coupling GC / MS mass spectrometry. Currently, research works with regards to extraction and chemical composition of lemongrass essential oil are abundant [15-17]. However, it has been showed that a chemical composition of essential oil may vary depending on the location in which the plant material grows and the technique of extraction. In this study, the results on extraction and determination of the chemical composition of essential oil from lemongrass are presented. The essential oil was extracted by hydrodistillation and chemical composition was determined by GC-MS.

EXPERIMENTAL

Extraction of essential oil: Lemongrass leaves used for the study were collected in January from Tien Giang Province, Vietnam at coordinates 10º15′N106º39′E. After being harvested, fresh lemongrass leaves were cut at 10 cm from the root in the morning of the day of harvest. It was showed that lemongrass leaves were partially wilted and stored in a cool, convenient place during production for several days. Essential oils were extracted by the steam distillation process in an industrial apparatus capable of holding 200 kg to 750 kg of materials per batch. In this experiment, 710 kg of lemongrass leaves were extracted for 3 h to obtain essential oil. The obtained products were dried using anhydrous sodium sulfate and stored in sealed vials.

Physico-chemical analyses of essential oils: Some basic physical and chemical parameters of the obtained essential oils were identified. Some criteria for finished oil products were analyzed by TCVN including acid index (TCVN 8450: 2010), sensory index (TCVN 8460: 2010) and density of essential oils. The experiments were carried out three times.

Chemical identification: An Agilent Technologies HP7890A GC, coupled with a mass spectrum detector (MSD) Agilent Technologies HP5975C and a DB-XLB column (60 m × 0.25 mm, film thickness 0.25 µm, Agilent Technologies), was utilized to perform GC-MS analysis of the essential oils. The sample of analysis was 25 µL of essential oil obtained from the extraction process, added with 1.0 mL *n*-hexane and dehydrated with Na_2SO_4. The temperature of injector and detector was initiated at 250 and 280 ºC, respectively. Temperature progress of column began at 40 ºC, increased to 140 ºC at 20 ºC/min and then to 270 ºC at 4 ºC/min. Helium was used as carrier gas and its flow rate was set at 1mL/min. Injection in distillation apparatus was performed under following MSD condition: ionization voltage of 70 eV, emission current 40 mA, acquisitions scan mass range 35-450 amu under full scan. A homologous *n*-alkane series was used as a standard for determination of retention time indicates (RI) of each component in the essential oil sample. The relative amounts of individual components were calculated based on GC peak area (MSD response) without correction.

RESULTS AND DISCUSSION

The hydrodistillation of lemongrass leaves achieved the yield of 0.29% which was lower than the previous study [1, 15]. Sensory properties (Table-1) showed that the obtained lemongrass essential oil was a clear liquid having a light yellow colour, slightly spicy taste and a characteristic flavor of citronella. At room temperature, the liquid had a density of less than 1 (d = 0.8865) indicated that the essential oil was lighter than water. The acid index indicated the amount of free acid in the essential oil and depends on the extraction method and the freshness of the raw material. When being preserved for a long time, the acid index of the materials increased due to oxidation and esterification in the degraded essential oil. The high saponification index showed that there were small molecular acids in essential oils.

TABLE-1
PHYSICO-CHEMICAL PROPERTIES OF *C. citratus* ESSENTIAL OIL

Organoleptic characteristics	*C. citratus* essential oil
Aspect	Liquid
Colour	Light yellow
Odour	Specific
Density	0.8865
Acid index	2.948
Saponification index	9.35
Ester index	6.402

Identification of volatile constituents in the obtained oil was performed by GC/MS analysis. The chromatogram profiles and content results are shown in Fig. 1 and Table-2, respectively. In comparison with previous studies involving analysis of several lemongrass essential oils, the presented composition shares some similarities. To be specific, a total of 18 components, accounting for 99.8% of essential oils, with detectable amounts were found in lemongrass oil sample. Fig. 1 shows that three peaks with relatively large abundance appeared at the retention time of 24.432, 23.25 and 10.001 min, indicated that these were ingredients with high content in essential oils. The components detected with the greatest abundance were α-citral (40.838%), β-citral (28.494%), β-myrcene (16.654%), 2,3-dehydro-1,8-cineole (2.264%), geraniol (2.388%), α-phellandren-8-ol (1.853%) and isogeranial (1.909%). Remaining components were detected at the content of lower than 1%. Visually, from Fig. 1, a peak with the greatest intensity was found at the retention time of 24.442 min, indicated that the corresponding component is of great importance in the oil. This was in good agreement with previously reported works, especially from the results of Pakistani lemongrass [16].

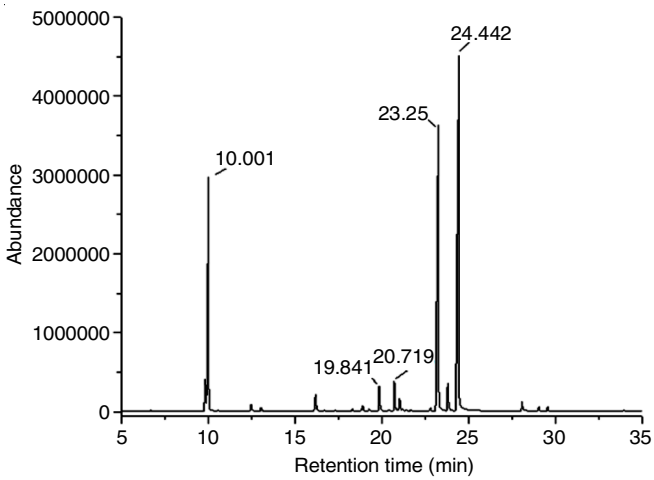


Fig. 1. GC-MS of *C. citratus* leaves essential oil

TABLE-2
CHEMICAL COMPOSITION OF THE ESSENTIAL OIL FROM *C. citratus*

Peak	R.T. (min)	Chemical name	m.f.	This study %
1	9.834	2,3-Dehydro-1,8-cineole	$C_{10}H_{16}O$	2.264
2	10.001	β-Myrcene	$C_{10}H_{16}$	16.654
3	12.479	β-*trans*-Ocimene	$C_{10}H_{16}$	0.543
4	13.044	β-*cis*-Ocimene	$C_{10}H_{16}O$	0.285
5	16.181	Linalool	$C_{10}H_{18}O$	1.519
6	18.827	6-Octenal	$C_{10}H_{16}O$	0.148
7	18.91	*trans*-Chrysanthemal	$C_{10}H_{16}O$	0.415
8	19.255	β-Citronellal	$C_{10}H_{18}O$	0.203
9	19.851	α-Phellandren-8-ol	$C_{10}H_{16}O$	1.853
10	20.719	Isogeranial	$C_{10}H_{16}O$	1.909
11	21.023	Cyclohexene	$C_{12}H_{20}O_3$	0.885
12	22.811	β-Citronellol	$C_{10}H_{20}O$	0.281
13	23.25	β-Citral	$C_{10}H_{16}O$	28.494
14	23.794	Geraniol	$C_{10}H_{18}O$	2.388
15	24.432	α-Citral	$C_{10}H_{16}O$	40.838
16	28.06	Geraniol acetate	$C_{12}H_{20}O_2$	0.722
17	29.043	β-Caryophyllen	$C_{15}H_{24}$	0.213
18	29.535	α-Bergamotene	$C_{15}H_{24}$	0.210

Saleem *et al*. [16] confirmed the presence of α-citral (40.08%), β-citral (32%), nerol (4.18%), citronellol (2.01%), geraniol (3.04%) and terpinolene (1.23%) in lemongrass essential oils from Pakistan.

In the report of Bassolé *et al*. [15], five constituents accounting for 96.3% of essential oil content of *C. citratus* were detected including geranial (48.1%), neral (34.6%), myrcene (11.0%), geraniol (1.9%) and linalool (0.7%). In another study that analyzed essential oil sample from Zambian *C. citratus*, 16 compounds accounting for 93.4% of the identified oil were determined. Among them, geranial (39.0%), neral (29.4%) and myrcene (18.0%) were the main components and geraniol (1.7%) and linalool (1.3%) were minor components [18]. This is contrary with another analysis where Ethiopian samples were found to be abundant with geraniol (40%) followed by citral (13%) and α-oxobisabolene (12%) [19]. The difference between chemical compositions of essential oils from various plant samples could be due to species, conditions of the geographical environment in different areas, climate and extraction methods.

Conclusion

The extraction and physico-chemical analysis of essential oils extracted from fresh lemongrass (*Cymbopogon citratus* L.) harvested in Tien Giang Province, Vietnam was performed. The essential oils of lemongrass were obtained from an industrial scale hydrodistillation apparatus with a yield of 0.29%, corresponding to 710 kg of raw materials. The results of phytochemical screening of obtained essential oils showed that the oil possesses desirable organoleptic characteristics and was light yellow in colour. GC-MS results revealed the presence of α-citral (40.838%), β-citral (28.494%), β-myrcene (16.654%), 2,3-dehydro-1,8-cineole (2.264%) and geraniol (2.388%) as the major compounds in the lemongrass essential oil.

ACKNOWLEDGEMENTS

This study was funded by project no. 31/2017 NTMN.TW, 30/08/2017 (Ministry of Science and Technology of Vietnam).

CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this article.

REFERENCES

1. E.H. Chisowa, D.R. Hall and D.I. Farman, *Flavour Fragrance J.*, **13**, 29 (1998); https://doi.org/10.1002/(SICI)1099-1026(199801/02)13:1<29::AID-FFJ682>3.0.CO;2-S
2. C. Menut, J.M. Bessiére, D. Samat, A.K. Djibo, G. Buchbauer and B. Schopper, *J. Essent. Oil Res.*, **12**, 207 (2000); https://doi.org/10.1080/10412905.2000.9699499
3. G. Sacchetti, S. Maietti, M. Muzzoli, M. Scaglianti, S. Manfredini, M. Radice and R. Bruni, *Food Chem.*, **91**, 621 (2005); https://doi.org/10.1016/j.foodchem.2004.06.031
4. A.A. Kasali, A.O. Oyedeji and A.O. Ashilokun, *Flavour Fragrance J.*, **16**, 377 (2001); https://doi.org/10.1002/ffj.1019
5. S.S. Ranade, *Int. J. Pharm. Sci. Rev. Res.*, **35**, 162 (2016).
6. G.O. Onawunmi, W.A. Yisak and E.O. Ogunlana, *J. Ethnopharmacol.*, **12**, 279 (1984); https://doi.org/10.1016/0378-8741(84)90057-6
7. A.K. Pandey, M.K. Rai, D. Acharya, *Pharm. Biol.*, **41**, 421 (2003); https://doi.org/10.1076/phbi.41.6.421.17825
8. H.N. Abdurahman, M. Ranitha and H.N. Azhari, *Int. J. Chem. Environ. Eng.*, **4**, 221 (2013).
9. R. Puatanachokchai, H. Kishida, A. Denda, N. Murata, Y. Konishi, U. Vinitketkumnuen and D. Nakae, *Cancer Lett.*, **183**, 9 (2002); https://doi.org/10.1016/S0304-3835(02)00111-8
10. B. Wannissorn, S. Jarikasem, T. Siriwangchai and S. Thubthimthed, *Fitoterapia*, **76**, 233 (2005); https://doi.org/10.1016/j.fitote.2004.12.009
11. J.K. Parikh and M.A. Desai, *Int. J. Food Eng.*, **7**, Article 11 (2011); https://doi.org/10.2202/1556-3758.2067
12. T. Silou, M. Malanda and L. Loubaki, *J. Food Eng.*, **65**, 219 (2004); https://doi.org/10.1016/j.jfoodeng.2004.01.018
13. B. Marongiu, A. Piras, S. Porcedda and E. Tuveri, *Nat. Prod. Res.*, **20**, 455 (2006); https://doi.org/10.1080/14786410500277837
14. S.R. Sargenti and F.M. Lanças, *Chromatographia*, **46**, 285 (1997); https://doi.org/10.1007/BF02496320
15. I.H. Bassol, A. Lamien-Meda, B. Bayala, L.C. Obame, A.J. Ilboudo, C. Franz, J. Novak, R.C. Nebi and M.H. Dicko, *Phytomedicine*, **18**, 1070 (2011); https://doi.org/10.1016/j.phymed.2011.05.009
16. M. Saleem, N. Afza, M.A. Anwar, S.M. Hai, M.S. Ali, S. Shujaat and Atta-Ur-Rahman, *Nat. Prod. Res.*, **17**, 159 (2003); https://doi.org/10.1080/1478641031000104118
17. D. Ganjewala, *Int. J. Essent. Oil Ther.*, **3**, 56 (2009).
18. J.U. Ewansiha, S.A. Garba, J.D. Mawak and O.A. Oyewole, *Front. Sci.*, **2**, 214 (2012).
19. B. Abegaz, P.G. Yohannes and R.K. Dieter, *J. Nat. Prod.*, **46**, 424 (1983); https://doi.org/10.1021/np50027a022