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Effect of drying methods on functional compounds in methanol extracts of *Centella asiatica*

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Abstract

Centella asiatica is a pre-historically utilized medicinal herb well recognized as a traditional phytotherapeutic substance for treating various diseases. *Centella asiatica* possesses pharmacological value due to the presence of phytochemicals like flavonoids and terpenoids, mainly asiatic acid, asiaticoside, and madecassoside. Its role as a functional component in developing various processed food products and packaging films is continuously being explored. The present study is focused on the effect of drying methods (shade drying, cabinet drying and hot air oven drying) on functional compounds in methanol extracts of *Centella asiatica*. The *Centella asiatica* leaves were dried through shade drying (28°C), hot air oven and cabinet drier at three different temperatures (40°C, 50°C, and 60°C). The methanol was used for the extraction of the bioactive compounds. The total yield and functional compound were identified viz., FTIR in all the dried powders and methanol extracts of *Centella asiatica* respectively. The result of extracts revealed that shade dried obtained a maximum yield than the cabinet and hot air oven-drying methods. The FTIR study reveals the presence of alkanes, amines, aldehydes, carboxylic acids, aromatic compounds, nitro compounds, esters, and alkyl halides, in all the methanol extracts of *Centella asiatica*. *Centella asiatica* is a medicinal herb that has been used for centuries to treat a variety of health conditions. It is known for its wound healing, anti-inflammatory, and antioxidant properties. The identified compounds may be responsible for health, including wound healing, skin health, and cognitive function.

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Introduction

Centella asiatica, also known as gotu kola, is a perennial herb that is native to tropical and subtropical regions of Asia. It has been used in traditional medicine for centuries to treat a variety of health conditions, including wound healing, skin health, and cognitive function (Kim *et al.,* 2017). Although *Centella asiatica* is known to contain various bioactive compounds and has been used as a medicinal herb in many cultures, there has been limited research on its flavonoid content.

The potential application of *Centella asiatica*, which is rich in potent antioxidants such as flavonoids, remains promising. However, it is important to evaluate the stability and degradation pattern of these bioactive compounds before they can be used in the development of functional foods (Mohd *et al.,* 2009). *Centella asiatica* has attracted significant research and commercial interest due to its many health-promoting bioactive compounds, especially phenolic compounds and triterpene saponins, which possess several functional capacities. Prior to use, *Centella asiatica* is typically dried to prolong its shelf life and prepare the material for subsequent pharmaceutical processing.

Drying is one of the oldest food preservation techniques which can be carried out at different temperatures and relative humidity conditions. The removal of moisture from foods retards many moisture-mediated deteriorative reactions and prevents the growth and reproduction of microorganisms. The quality of the dried product is greatly influenced by the drying conditions and the method of drying (Dincer *et al.,* 2002).

Moreover, the effect of drying on plants will depend on the initial moisture content of the product, which varies with the type of vegetable to be dried.

The drying characteristic of each vegetable is intrinsic, meaning that it is inherent to the vegetable and cannot be changed. This means that each vegetable will behave uniquely during drying, as described by Guine and Fernandes (2006). For example, some vegetables, such as lettuce, have high moisture content and will therefore dry more slowly than other vegetables, such as spinach. Additionally, the drying temperature and method will also affect the drying characteristics of the vegetable.

Due to the intrinsic drying characteristics of each vegetable, it is important to investigate the comparative effect of drying on the drying characteristics and nutrient constituents of some common edible leafy vegetables in the country (Emelike & Akusu, 2020). This will help to determine the best drying method for each vegetable and to ensure that the nutrient content of the dried vegetables is preserved. Therefore, the present study aimed to study the impact of drying methods on functional compounds through FTIR analysis in *Centella asiatica*.

Material and methods

Sample Preparation

Centella asiatica leaves were purchased from farmers directly at the Salem local market. They were washed thoroughly and dried using three different methods: shade drying (28°C), hot air oven, and cabinet drier at three different temperatures (40°C, 50°C, and 60°C). After the moisture content was removed, the leaves were ground using a pestle and mortar and stored in an airtight container to prevent degradation.

Extraction Process

The ground powders were macerated for three days in a 99.5% methanol solvent to extract the functional components. The extracts were filtered using Whatman filter paper no. 4 and dried under a rotary vacuum. The samples were then collected and stored in a refrigerator for further analysis.

Total Yield

The total yield of dried powders was calculated according to Xue *et al.*, 2013 through a determination of the powder recovered. The yield was determined using Equation as follows"

$$YE\ (\%) = W_2 / W_1 \times 100$$

Where YE is the yield (g 100 g^{-1}), W_2 is the weight (g) of the collected product

W_1 is the weight (g) of the non-solvent mass in the feed.

FTIR Study

The FTIR spectra of methanol extracts of *Centella asiatica* were recorded using an FTIR instrument (Model/Make: IFS 25, Bruker, Germany), which was operated and data processed with PC-based software. To conduct the FTIR analysis, a small amount of powdered samples was pressed into pellets using KBr, and a thin film was prepared under applied pressure. Infrared transmittance data was collected over a wave number range from 4000cm−1 to 500cm−1. Each sample was analyzed with plain KBr pellets used as blanks. The obtained spectral data were compared with a reference to identify the functional groups present in the samples.

Result and discussion

Total Yield

Table 1 shows the weight of powder (in grams per 100 grams) after drying at different temperatures (40°C, 50°C and 60°C) and using different drying methods (shade drying, cabinet drying and hot air oven drying). The results show that the weight of the powder is highest after shade drying (15.5 grams per 100 grams) and lowest after drying in a hot air oven at 60 degrees Celsius (12.31 grams per 100 grams). The weight of the powder is also slightly higher after drying in a cabinet drier than after drying in a hot air oven at the same temperature.

Table 1. Total Yield of the Centella asiatica Powder.

SL	Drier	Temperature (°C)	Weight of the powder (g/100g)
1.	Hot air oven	40	12.91
2.	Hot air oven	50	12
3.	Hot air oven	60	17.52
4.	Cabinet drier	40	14.64
5.	Cabinet drier	50	14.43
6.	Cabinet drier	60	12.31
7.	Shade drying	27	15.5

VSD- Vallai Shade Dry; V4H- Vallarai hot air oven 40°C; V5H- Vallarai hot air oven 50°C; V6H- Vallarai hot air oven 60°C; V4C- Vallarai Cabinet drier 40°C; V5C- Vallarai Cabinet drier 50°C; V6C- Vallarai Cabinet drier 60°C.

The results of this experiment suggest that shade drying is the most effective method for drying powder, as it results in the highest weight of powder. However, shade drying may not be practical in all situations, such as when the powder needs to be dried quickly or when the environment is not conducive to shade drying. In these cases, drying in a cabinet drier may be a better option. Hot air oven-drying is a low-cost drying method that uses hot air to circulate in the oven and pass over moist food, carrying moisture away from the food. This method is relatively simple and easy to use, but it does not provide the maximum yield (Lee *et al.,* 2022). Cabinet drying is a more sophisticated method that uses a controlled environment to dry food, resulting in a higher yield. However, cabinet drying is also more expensive (Chua & Chou, 2003).

Shade drying is another drying method that can produce a high yield (Abbas *et al*., 2021). However, it is a slow process that can take several days. In the present study, shade drying took 12 days to dry food, which may have been due to the climatic conditions. The best drying method for a particular application will depend on the desired yield, cost, and drying time. Hot air oven-drying is a good option for low-cost drying, but it may not produce the maximum yield. Cabinet drying is a more expensive option, but it can produce a higher yield. Shade drying is a slow process, but it can produce a high yield (Khiari *et al.,* 2019).

FTIR Analysis

In the present study, FTIR spectroscopy was used to identify the functional groups based on the peak values in the methanol extracts of *Centella asiatica*. The major findings of FTIR results indicated that the presence of the following functional groups such as free alcohol, aliphatic primary amine, alkanes, carboxylic acid, conjugated alkene, amine, aromatic amine, alkyl aryl ether, aromatic ester, primary alcohol, and halo compounds (Table 2 & Fig. 1) in all the samples such as VSD, V4C, V5C, V6C, V4H, V5H and V6H. The strong absorption band was observed around 3550-3200cm^{-1}; 1300-1250cm^{-1}; 1085-1050cm^{-1}; 690-515cm^{-1} and a medium absorption band was noticed in 1650-1600cm^{-1} and 1470-1430cm^{-1} followed by weak absorption band in 2960-2850cm^{-1} in the methanol extracts of *Centella asiatica* respectively. No noticeable changes were observed in the samples derived from cabinet and hot air oven drying with different temperatures including

the shade drying method. It denotes that the bioactive compounds present in the *Centella asiatica* were not affected by the temperature and methods. In addition, no absorption bands were observed V6C, V6H and V4H samples at 1300-1250cm^{-1} region of C-O stretching (alkyl aryl ether, aromatic ester).

Table 2. FTIR analysis

Functional Group	Intensity	Frequency Range (cm^{-1})	VSD	Cabinet drier			Hot air oven drier		
				V4C	V5C	V6C	V4H	V5H	V6H
O-H streching (Alcohol) N-H streching (aliphatic primary amine)	S	3550-3200	3402.78	3394.1	3394.1	3406.64	3394.1	3394.1	3404.71
C-H streching (Alkanes) N-H stretching (amine salt) O-H streching (carboxylic acid)	W	2960-2850	2922.59	2923.56	2922.59	2922.59	2922.59	2921.63	2921.63
C=C streching (conjugated alkene) N-H bending (amine)	M	1650-1600	1606.41	1648.84	1633.41	1630.52	1636.3	1628.59	1630.52
C=C streching (Aromatic amine)	M	1470-1430	1437.67	1439.6	1437.67	1440.56	1439.6	1437.67	1438.64
C-O stretching (alkyl aryl ether, aromatic ester)	S	1300-1250	1261.22	1259.29	1260.25	-	-	1253.5	-
C-O stretching (primary alcohol, acid)	S	1085-1050	1067.41	1065.48	1066.44	1067.41	1065.48	1062.59	1062.59
C-Br (halo compound)	S	690-515	601.682	600.717	599.753	601.682	601.682	599.753	602.646

VSD- Vallai Shade Dry; V4H- Vallarai hot air oven 40°C; V5H- Vallarai hot air oven 50°C; V6H- Vallarai hot air oven 60°C; V4C- Vallarai Cabinet drier 40°C; V5C- Vallarai Cabinet drier 50°C; V6C- Vallarai Cabinet drier 60°C

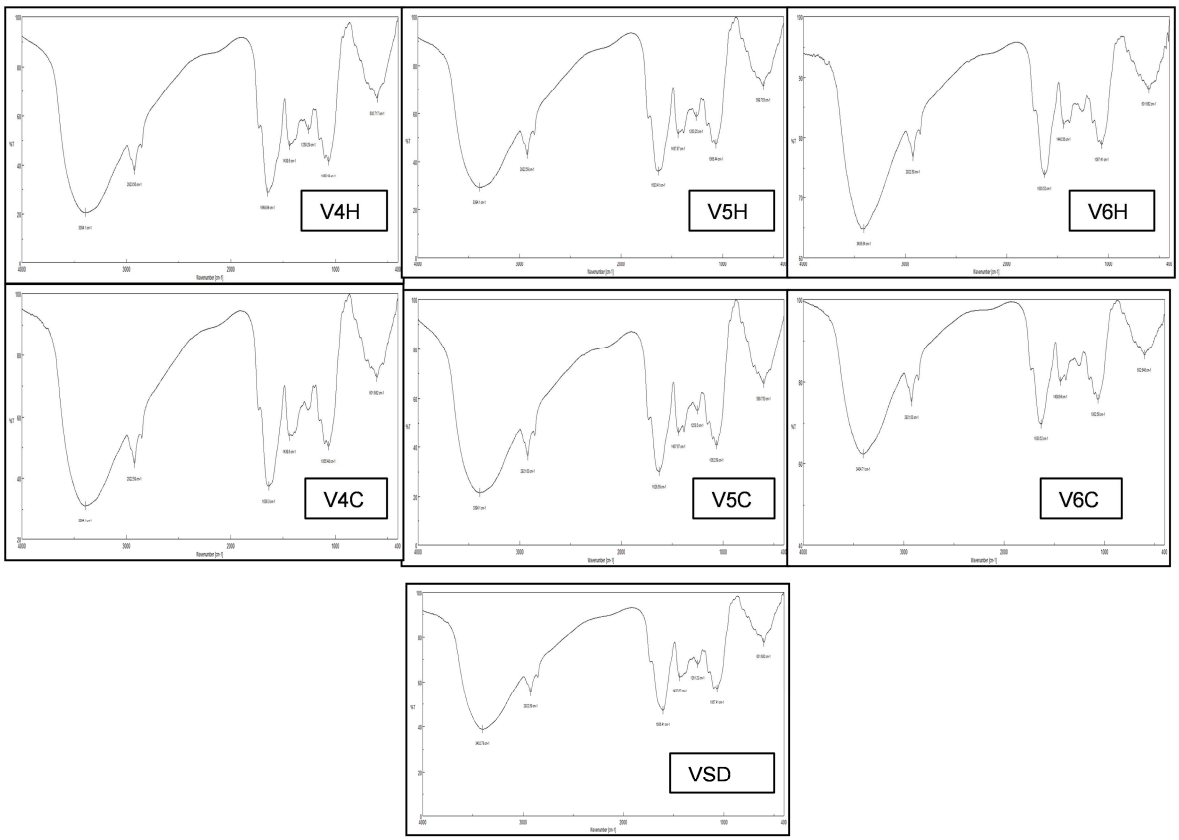

Fig. 1. FTIR analysis

VSD- Vallai Shade Dry; V4H- Vallarai hot air oven 40°C; V5H- Vallarai hot air oven 50°C; V6H- Vallarai hot air oven 60°C; V4C- Vallarai Cabinet drier 40°C; V5C- Vallarai Cabinet drier 50°C; V6C- Vallarai Cabinet drier 60°C.

The spectral region of 3400–3200cm^{-1} indicates symmetric (sym) and asymmetric (asym) stretching of a polymeric hydroxyl group (O–H) and H-bonded stretching, characteristic of polyphenolic compounds. This suggests the presence of phenolic compounds in the methanol extracts of *Centella asiatica*. According to Socrates (2004), the band position between 3450cm^{-1} and 3300cm^{-1} signifies the presence of water and also confirms the existence of compounds such as sulphoxides, sulphates, sulphites, sulphinic acids or esters, sulphones, sulphonic acids, sulphonates, sulphonamides, sulphonyl halides, ethers (aromatic, olefinic, or aliphatic), aliphatic unsaturation, and substituted aromatics between 1400cm^{-1} to 700cm^{-1}.

Phenolics are aromatic benzene ring compounds with one or more hydroxyl groups, primarily synthesized by plants as a defense mechanism against stress and pathogen attacks. Interestingly, plants rich in phenolics serve as an excellent source of antimicrobial agents (Chandra, 2019). Additionally, the observation of phenolic C–O stretching at 1200cm^{-1} indicates the presence of flavonoid C-rings, particularly the C–O of pyran (Shurvell, 2002). These group frequencies are closely associated with the presence of aromatic compounds. Peaks detected in the range of 1300-1250cm^{-1} suggest the presence of amine groups. Specifically, the C–N stretching observed at 1253-1261cm^{-1} provides confirmation of the existence of aliphatic amines.

According to Huang *et al.* (2007), the FTIR spectrum of pure casein and whey protein surfaces exhibits two characteristic bands at approximately 1648-1649cm^{-1}, which correspond to the (amide-I) band arising predominantly from the protein amide C=O stretching vibrations, and at approximately 1536 - 1547cm^{-1}, which correspond to the (amide-II) band due to the amide N-H bending vibrations and C-N stretching vibrations (Lakshmi *et al.,* 2015). Therefore, in the methanol extracts of *Centella asiatica*, the presence of the amide-I band was confirmed, as the absorption band fell within the frequency range of 1650-1600cm^{-1} and also it confirmed the presence of alkenes (-C=C- stretching vibration).

The region between 1400 and 900cm^{-1} is commonly known as the fingerprint region in FTIR analysis. It contains numerous characteristic single bands with low intensities, which are associated with specific functional groups. The methanol extracts of *Centella asiatica* confirmed the aromatic amines at the frequency range between 1470-1430cm^{-1}. Whereas, the frequency range between 1085-1050cm^{-1} indicated the presence of alcohols, carboxylic acids, esters, and ethers as revealed by the study of Chandra (2019) in *Nicotiana plumbaginifolia*.

Within this fingerprint region, wavenumbers ranging from 900 to 600cm^{-1} reveal unique weak bands that correspond to nucleic acids, such as phenylalanine, tyrosine, tryptophan, and various nucleotides (Lasch & Naumann, 2000). The methanol extracts of *Centella asiatica* confirmed the halo compounds between the frequency range of 599-602cm^{-1} denoted that the frequency range could be attributed to alkyl halides, Alkyne with C-Br stretch, C-Cl stretch, C-H bend respectively as mentioned in the study of Sugunabai *et al.* (2015) in *Centella asiatica*.

Conclusion

The present study demonstrated the presence of various chemical compounds, including alkanes, amines, aldehydes, carboxylic acids, aromatic compounds, nitro compounds, esters, and alkyl halides, in the methanol extracts of *Centella asiatica*. These diverse phytoconstituents offer promising potential for further exploration in terms of their biological activities and potential therapeutic applications. Interestingly, the study revealed that the temperature variations (40°C, 50°C, and 60°C) and different drying methods did not have a significant impact on the functional compounds present in the methanol extracts. This observation indicates that the chemical composition of *Centella asiatica* remained largely unaffected by the drying process and temperature fluctuations, ensuring the retention of its valuable bioactive compounds.

However, the study did observe notable changes in the total yield of the powdered extracts, which could be attributed to the influence of temperature and drying methods.

Specifically, the shade drying method yielded the highest amount of powder compared to other drying methods. This finding suggests that the shade drying process might be particularly suitable for preserving the overall yield and integrity of *Centella asiatica's* bioactive compounds during the drying process.

Recommendation(S)

Further investigations and biological activity assessments are warranted to fully harness the potential of *Centella asiatica* for various applications, including in the fields of medicine, agriculture, and pharmacology.

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