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# The Effect of Drying Methods on the Chemical Composition of the Essential Oil of *Caesalpinia Pulcherrima* Growing in Lagos, Nigeria

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***Abstract:*** This research studied the effects of different drying methods on the yield and chemical composition of hydrodistilled essential oil from the red variety of leaves of Caesalpinia pulcherrima. A total of 26, 23, 30 and 25 compounds were identified in the oils of the fresh, air-dried, sun-dried and oven-dried plant materials, respectively. In general, the air-dried plant yielded more essential oils than the fresh, sun-dried and oven-dried plant. The air-dried, sun-dried and oven-dried plant materials yielded 0.90 %, 0.20 % and 0.58 % of the essential oils, respectively whereas the fresh plant materials yielded oils of 0.63 %. The essential oils of Caesalpinia pulcherrima were composed mainly of sesquiterpenoids. The fresh leaf oil comprises caryophyllene, 15.51 %; α-cadinol 14.36 %; γ–muurolene, 13.28 %; nerolidol 8.32 % as the most prominent components. While, the major components common to the different drying methods are air-dried; (phytol, 12.28 %; copaene, 9.07 %; γ-pyronene, 8.95 %; neryl propanoate, 6.55 %), sun-dried (neryl propanoate, 8.18 %; copaene, 5.49 %; phytol, 4.72 %; γ-pyronene, 0.87 %), oven-dried (copaene, 18.77 %; neryl propanoate, 7.61 %; γ-pyronene, 4.59 %; phytol - 3.25 %). This results showed that similar major compounds were present in all the dried leaf oils but at varying quantities, whereas, they all differ from the major compounds of the fresh leaf oil. This disparity may be due to chemical transformation of the components in the different environments exposed to for moisture removal.

***Keywords***: Caesalpinia pulcherrima, Leaf oil, Sesquiterpene, Phytol, Copaene, γ-Pyronene

## 1.0 Introduction

Caesalpinia pulcherrima is a species of flowering plant in the pea family, Fabaceae, it is native to the tropics and subtropics of the Americas. It could be native to the West Indies, but its exact origin is unknown due to widespread cultivation [1]. Common names for this species include Poinciana, Peacock Flower, Red Bird of Paradise, Mexican Bird of Paradise, Dwarf Poinciana, Pride of Barbados, and flamboyant-de-jardin [2]. In Nigeria, it is commonly known as Eko-omode by Yorubas, Waken Bature by Hausas and Nwayi/Nwoke Ibem by Igbos [3]. The seeds of Caesalpinia species are poisonous at maturity but some are edible before they reach maturity (e.g. immature seeds of C. pulcherrima) or after treatment (4). In India, leaves of C. pulcherrima are traditionally used as purgative, tonic and antipyretic, while roots extracts are used in the treatments of convulsions, intermittent fevers, lung and skin diseases [5]. In the Amazon rain forest, the juice from the leaves and flowers are used for the treatments of fever and sores while the seeds are used to cure bad cough, breathing difficulty and chest pain [6]. Four grams from the root is also reported to induce abortion in the first trimester of pregnancy [7][8]. It is a striking ornamental plant, widely grown in domestic and public gardens in warm climates with mild winters, and has a beautiful inflorescence in yellow, red and orange. In this work, we present the effect of drying methods on the chemical composition the leaf essential oil of the red variety of C. pulcherrima growing in Lagos state, Nigeria.

## 2.0 Materials and Methods

### *2.1 Isolation of the essential oil*

Fresh leaves of Caesalpinia pulcherrima were collected at mid-day in the wet season of 2015 on the campus of University of Lagos, Lagos State, Nigeria. The plant was taxonomically identified and authenticated at the Herbarium of the Department of Botany of the University of Lagos (LUH 6392). Prior to hydrodistillation, the plant was dried by air, sun and the oven and pulverized. About 350 g each of the fresh and dried leaves of the plant were separately subjected to hydrodistillation for 4 h, using a Clevenger-type apparatus [9]. The oils were dried over anhydrous sodium sulfate and stored in a sealed vial prior to analysis.

### *2.2 GC-MS analysis of the essential oil*

The analysis of the oils was carried out using a GC (Agilent Technologies 7890A) interfaced with a mass selective detector (VLMSD, Agilent 5975C) equipped with a non-polar Agilent HP-5MS (5 %-phenyl methyl polysiloxane) capillary column (30 m × 0.32 mm i.d. and 0.25 μm film thickness) with Injector series (Agilent, 7683B). The carrier gas was helium with linear velocity of 1 ml/min. Oven temperature was set at 80 °C for 2 minutes, then programmed until 120 °C at the rate of 5 °C/min withhold time of 2 minutes, and finally increased to 240 °C at the 10 °C/min rate, isothermal at the temperature for 6 min hold time. Injector and detector temperatures were 300 °C and 200 °C respectively. Injection mode, split less, volume injected, 1 μl of the oil. The MS operating parameters were as follows: Ionization potential, 70 eV; interface temperature, 200 °C and acquisition mass range; 50-800. Relative percentage amounts of the essential oil components were evaluated from the total peak area (TIC) by apparatus software.

### *2.3 Identification of components*

The components of the oils were identified by matching their mass spectra and retention indices with those of the Wiley 275 library (Wiley, New York) in the computer library and literature [10]. The yield of each component was calculated per kg of the plant material, while its percentage composition was calculated from summation of the peak areas of the total oil composition.

## 3.0 Results and Discussion

The fresh, air-dried, sun-dried and oven-dried leaves yielded 0.63 %, 0.90 %, 0.20 % and 0.58 % of the essential oils, respectively. GC-MS analysis of the leaf essential oil of C. pulcherrima (Table 1) revealed a total of 26, 23, 30, and 25 compounds in the fresh, air-dried, sun-dried and oven-dried leaf oils, respectively.

The four essential oils were dominated by sesquiterpenoids (54.20 % – 70.0 %). The predominant compounds in the fresh leaf oil were caryophyllene (15.51 %), α-cadinol (14.36 %), γ–muurolene (13.28 %), nerolidol (8.32 %). The major components of the air-dried leaf oil were phytol (12.28 %), coapaene (18.77 %), neryl propanoate (6.55 %) and caryophyllene oxide (6.54 %), γ-elemene (6.39 %). The sun-dried leaf oil comprises of neryl propanoate (8.18 %), α-muurolene (6.20 %), coapaene (5.49 %), (-)-neoclovene-(I), dihydro (4.98 %), phytol (4.72 %) and γ-elemene (4.70 %). And in the oven-dried leaf oil copaene (9.07 %), neryl propanoate (7.61 %), viridiflorol (7.42 %), γ-pyronene (4.59 %) and α-Fenchene (4.08 %) predominates. The result revealed that the significant components identified in all the oils were phytol, copaene, caryophyllene and neryl propanoate, although in varying quantities (Table 1, Figure 1). The most abundant components differ, air dried (Phytol, 12.28 %), sun dried (neryl propanoate 8.18 %), and oven dried (copaene, 18.77 %), while the fresh leaf oil had caryophyllene (15.51 %) as the major compound.

In this research, the sun dried leaves had the most compounds, but the least yield. This could be due to the conversion of the components in the fresh plant materials to other components not present naturally in the plant. The low yield may be due to losses which may have taken place due to the high drying temperature. Asekun et al., (2005/2006) [11] reported that the volatile oil from fresh L. leonurus aerial part (0.39%) increased during air-drying and oven-drying processes to 0.62 % and 0.71 % respectively, whereas sun-drying of the plant part caused a decrease in yield to 0.30 %.

According to literature, Ogunbinu et al., (2010) reported that of the 17 components identified in the air-dried leaf oil of C. pulcherrima, α-phellandrene (36.5 %), p-cymene (15.3 %) and γ-terpinene (7.9 %) were the major components [12]. Usman et al., (2012) [13] analysed air-dried leaves of red and yellow varieties of Caesalpina pulcherrima, the yields were 0.50 and 0.52 %, the GC and GC-MS analyses of the oils revealed the abundance of α-terpinene (44.4 %) and citronellal (58.0 %) in the oils of red and yellow varieties, making the oils γ-terpinene and citronellal chemotypes respectively. The essential oil of C. pulcherrima composed majorly of sesquiterpenoids in contrast to other reports that has the dominance of monoterpenoids. The presence of phytol, a diterpenoid in significant quantity in the oils is noteworthy as it was absent in the oils earlier reported [12] [13].

There is reduction in the concentration of copaene from 18.77 % to 2.31 % and an increase in content of phytol from 3.25 % to 12.28 % in the fresh, air, oven and sun dried oils. The different drying methods exposes the components to conditions that enable oxidation, reduction, cyclisation and direct conversion of these components to other forms. The reduction of the composition of copaene and increase in phytol content may be due to their chemical transformation into other components as a result of varying ways of moisture removal. The results show that the composition of the oils was significantly affected by the drying methods employed.

**Table 1. Chemical composition of the essential oils from *Caesalpinia pulcherrima* leaves using different drying methods**.

| S/N | COMPOUND | Fresh (%) | Air dried (%) | Sun dried (%) | Oven dried (%) |
|---|---|---|---|---|---|
| 1 | Isopentyl hexanoate | - | 0.83 | 1.19 | - |
| 2 | Santolina triene | - | 0.24 | - | - |
| 3 | Elemene | 0.33 | - | - | - |
| 4 | γ-Pyronene | - | 4.59 | 0.87 | 8.95 |
| 5 | *Allo* aromadendrene | 0.29 | - | - | - |
| 6 | γ-Elemene | - | - | 4.70 | 6.39 |
| 7 | Copaene | 2.31 | **18.77** | 5.49 | 9.07 |
| 8 | β-Copaene | 4.36 | - | - | - |
| 9 | Calarene | - | - | 3.64 | 0.69 |
| 10 | Cis-β-farnesene | 4.77 | - | - | - |
| 11 | α-Muurolene | - | - | 6.20 | - |
| 12 | γ –Muurolene | 13.28 | - | 2.10 | - |
| 13 | δ-Cadinene | 4.78 | 1.74 | 1.61 | 1.52 |
| 14 | Cubebene | 0.32 | - | 2.18 | 0.09 |
| 15 | Valencene | - | - | 0.45 | - |
| 16 | Elixene | 0.33 | - | - | - |
| 17 | α –Calacorene | - | 1.78 | 4.68 | 1.00 |
| 18 | Cubenol | 3.42 | - | - | - |
| 19 | Ledane | - | 0.25 | - | - |
| 20 | γ-Terpinene | 0.43 | - | - | - |
| 21 | γ-Caryophyllene | - | 3.15 | - | - |
| 22 | Nerolidol | 8.32 | 0.82 | 2.64 | 5.24 |
| 23 | γ-Gurjunene | 2.01 | - | 0.53 | - |
| 24 | (+)-2-Carene, 4-.alpha.-isopropenyl- | - | 2.03 | - | - |
| 25 | α-Cadinol | 14.36 | - | 2.97 | - |
| 26 | α-Himachalene | - | 1.79 | - | - |
| 27 | Terpinen-4-ol | 0.08 | - | - | - |
| 28 | Aromadendrene | - | 1.34 | 0.78 | - |
| 29 | Bicyclo[5.3.0]decane,2-methylene-5-(1-methylvinyl)-8-methyl- | - | - | - | 1.24 |
| 30 | L-α-Terpineol | 0.11 | - | - | - |
| 31 | 8-(2-Acetyloxiran-2-yl)-6,6-dimethylocta-3,4-dien-2-one. | - | 4.10 | - | 2.44 |
| 32 | Linalool | 0.28 | - | - | - |
| 33 | β-Selinene | - | - | 1.44 | - |

| | | | | | |
|---|---|---|---|---|---|
| 34 | 3-Thujene-2-one | 0.04 | - | - | - |
| 35 | β-Caryophyllene | - | - | - | 2.17 |
| 36 | Caryophyllene | **15.51** | - | - | 1.17 |
| 37 | 3-Buten-2-ol, 2-methyl-4-(1,3,3-trimethyl-7-oxabicyclo[4.1.0]hept-2-yl)- | - | 6.69 | - | - |
| 38 | Caryophyllene oxide | 1.71 | - | 2.33 | 6.54 |
| 39 | Viridiflorol | - | 7.42 | 2.99 | - |
| 40 | Pinane | - | 1.96 | - | - |
| 41 | β-Ylangene | 1.12 | - | - | - |
| 42 | Sativene | 1.00 | - | - | - |
| 43 | Farnesol (E), methyl ether | - | - | 5.18 | 2.37 |
| 44 | Tricyclo[4.3.1.1.(3,8)undecane-3-carboxylic acid,methyl ester | - | 3.25 | - | - |
| 45 | Spatunelol | 2.95 | - | - | - |
| 46 | Isoaromadendrene epoxide | - | - | 3.70 | 2.23 |
| 47 | Neryl propanoate | - | 7.61 | **8.18** | 6.55 |
| 48 | Aromadendrene oxide(2) | - | 5.30 | 2.29 | 1.73 |
| 49 | Aromadendrene(1) | - | 4.80 | - | - |
| 50 | 1-Methyl-6-(3-methylbuta-1,3-dienyl)-7-oxabicyclo[4.1.0]heptane | - | 3.89 | 4.21 | - |
| 51 | Patchoulane | - | - | 3.53 | 5.31 |
| 52 | Cedrene epoxide | - | - | 4.13 | - |
| 53 | 2-Pentadecanone,6,10,14-trimethyl- | - | - | 1.93 | - |
| 54 | Humulane-1,6-diene-3-ol | 0.96 | - | - | - |
| 55 | γ-Neoclovene | - | - | - | 2.85 |
| 56 | (-)-Neoclovene-(I), dihydro | - | - | 4.98 | 3.78 |
| 57 | (-)-Isolongilofol methyi ether | - | - | - | 1.31 |
| 58 | Fenchol | - | - | - | 3.81 |
| 59 | Fenchone | - | - | 4.82 | - |
| 60 | Globulol | 1.57 | - | - | - |
| 61 | Epiglobulol | 1.19 | - | - | - |
| 62 | Phytol | - | 3.25 | 4.72 | **12.28** |
| 63 | Acetic acid, 2-acetoxymethyl-1,2,3-trimethyl ester | - | - | - | 1.19 |
| 64 | (Z)6,(Z)9-Pentadecadien-1-ol | - | 1.15 | - | 1.27 |
| 65 | 1,5-Cyclodecadiene, (E,Z)- | - | - | 0.56 | - |

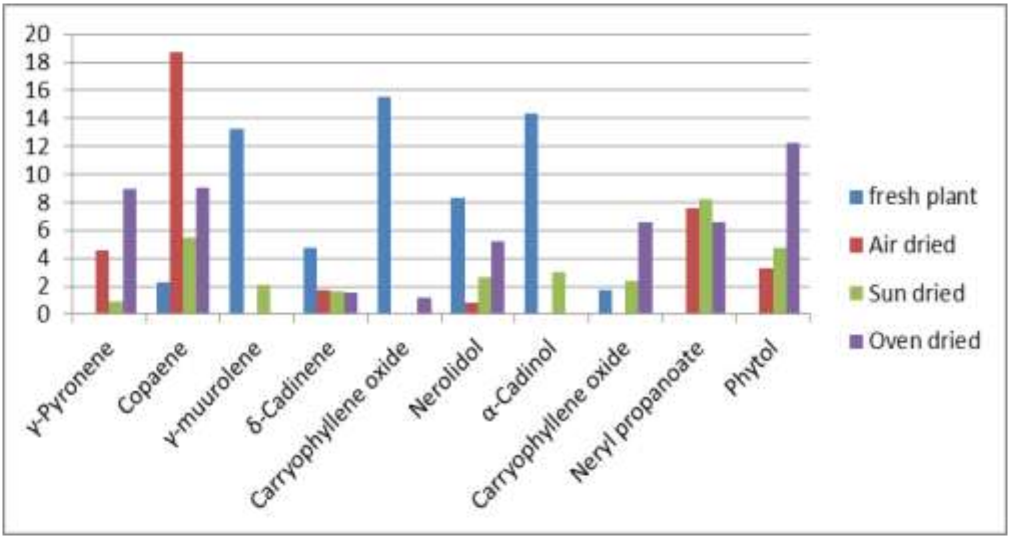


**Figure 1: Chemical composition of the major essential oil components from *Caesalpinia pulcherrima* leaves using different drying methods.**

## Conclusion

The different drying methods affected the yield and chemical composition of the essential oils of *C. pulcherrima.* Air drying method gave the highest oil yield and all the major components of the leaf oil were also identified, hence it may be considered as the best method of drying the leaves of *C. pulcherrima.*

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