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CHEMICAL CONSTITUENTS of *Allium sativum* (GARLIC) AND *Curcuma longa* (TUMERIC) ESSENTIAL OIL

Ozoude, A. E.
Department of Industrial Chemistry,
Caritas University, Amorji –Nike, Enugu State.
Email: *assumptatheo@gmail.com*
Phone: +2347035009938

Chukwu, T. E.
Department of Chemical Engineering,
Caritas University, Amorji–Nike, Enugu State.
Email: *tobechi.chukwu@yahoo.com*
Phone: +2348068781020

Abstract

Curcuma longa (turmeric) and Allium sativum (garlic) are spices that have been indicated to have several pharmacological potentials. The current study assessed the chemical constituents of turmeric and garlic. The essential oils were hydro distilled from the rhizomes of turmeric and bulbs of garlic in a yield of 0.80% (w/w) and 0.75% (w/w) respectively. The oils were analyzed by gas chromatography (GC) and gas chromatography and mass spectrometry (GC-MS). A total of fifty-four constituents were identified for both oils representing 96.3% (A. sativum) and 96.5% (C. longa). The main constituents of the oil of C. longa were ar-tumerone (28.6%), β atlantone (21.9%) and curlone (18.8%). The main constituents in A. sativum were sulfur derivative (94.1%), diallyldisulphide (15.7%), diallytrisulfied (53.9%), diallyltetrasulfide (11.7%), methylallytrisulphide (9.2%). This research shows that oil from turmeric and garlic comprises a total of 54 constituents and has 4 components in common.

Keywords: ***chromatography, constituents, turmeric and garlic, essential oils and pharmacological.***

INTRODUCTION

Medicinal Plants include various 'types plants used in herbalism and some of plants have medicinal activities. Medicinal plants are the "backbone" of traditional al medicine; over 3.3 billion people in the less developed countries utilize medicinal plants on a regular basis (Lawal*et al.,* 2015). These medicinal plants consider as a rich resource of ingredients which can be used in drug development. Besides that, these plants play a critical role in the development of human cultures around the whole world. The Indian sub-continent has a very rich diversity of plant species in a wide of ecosystems. There are about 17.000 species of higher plants. Of which approximately 8.000 species are considered medicinal and used by villages, communities, particularly tribal communities, or in traditional medicinal systems, as the Ayurveda (Lawal*et al.,* 2015; Ogunwade *et al.,* 2012). The use of traditional medicine and medicinal plants in most developing countries, as a basis for the maintenance of good health, has been widely observed. Furthermore, during the past decade, traditional systems of medicine extraction and development of several drugs and chemotherapeutics from these plants as well as from traditionally used rural herbal remedies (Lawal*et al.,* 2015) have become a topic of global importance. Current estimates suggest that, in many developing countries, a large proportion of the population relies heavily

on traditional practitioners and medicinal plants to meet primary health care needs. Although modem medicine may be available in these countries, herbal medicines (phytomedicines) have often maintained popularity for historical and cultural reasons. Medicinal plants frequently used as raw materials for extraction of active ingredients which used in synthesis of different drugs. Like in case of laxatives, blood thinners, anti-biotics and anti-malarial, contain ingredients from plants. Moreover, the active ingredients of taxol, vincristine, and morphine isolated from foxglove, periwinkle, yew, and opium poppy, respective (Ogunwade *et al.,* 2012).

Medicine, in several developing countries, using local traditions and beliefs is still the mainstay of health ea.re. As defined by WHO, health is a state of complete, (Lot, mental, and social wellbeing and not merely the on the isolation and direct use of active medicinal constituents, or on the development of semi-synthetic drugs, or still again on the active screening of natural products to yield synthetic pharmacologically-active compounds (Toa and Zhou, 2014).

The world market for plant-derived chemicals -pharmaceuticals, fragrances, flavors and color ingredients, alone exceeds several billion dollars per year. Classic examples of phytochemicals in biology and medicine include taxol, vincristine, vinblastine, colchicine as well as the Chinese antimalarial - artemisinin, and the Indian ayurdevic absence of disease or infirmity. Medicinal plants are an integral component of research developments in the pharmaceutical industry with such research focuses on drug-forkolin. Trade in medicinal plants is growing in volume and in exports. It is estimated that the global trade in medicinal plants is US$800 million per year (Toa and Zhou, 2014).

The development and commercialization of medicinal plant: based bio industries in the developing countries is dependent upon the availability and information concerning upstream and downstream bio-processing, extraction, purification, and marketing of the industrial potential of medicine plants (Ogunwade *et al.,* 2012). Furthermore, the absence of modernized socio-economic and public healthcare systems reinforces reliance of rural and lower-income urban populations on the use of traditional medicinal herbs and plants as complementary aids to routine pharmaceutical market product, Recent estimates suggests the over 9,000 plants have known medicinal applications in various cultures and countries and this is without having conducted comprehensive research amongst several indigenous and other communities (Ogunwade *et al.,* 2010).

It has been estimated that in developed countries such as United States, plant dogs constitute as much as 25% or the total drugs, while in fast developing countries such as China and India, the contribution is as much as 80%. These countries provide two third of the plants used in modem system of medicine and the health care system of rural population depend on indigenous systems of medicine (Lawa *et al.,* 2015; Lawal and Adebayo, 2016).

Global estimates indicate that 80% of about 4 billion population cannot afford the products of the Western Pharmaceutical Industry and have to rely upon the use of traditional medicines which are mainly derived from plant material (Lawal and Adebayo, 2016). This fact is well documented in the inventory of medicinal plants, listing over 20,000 species, In spite of the overwhelming influences and our dependence on modern. Medicine and tremendous advances in synthetic drugs, a large segment of the World population still like drugs from plants. In many of the developing countries because modern life saving drugs arc beyond reach of three quarters 4 of the third world's population although many such countries spend 40-50% of their total wealth on drugs and healthcare (Ogunwade *et al.,* 2007). As a part of the strategy to reduce the financial burden on developing countries, it is obvious that an increased use of plant drugs will be followed in the future (Ogunwade *et al.,* 2007).

Phytotherapy is the use of plants or plant extracts for Medicinal purposes (especially plants that are not part of the normal diet) (Ogunwade *et al.,* 2004). Phytochemistry is the study of phytochemicals produced in plants, describing the isolation, purification, identification, and structure of the large number of secondary metabolic compounds found in plants (Encyclopedia of Ayurvedic medicinal plant (Ogunwade *et al.,* 2003).

3.0 MATERIALS AND EXPERIMENTAL PROCEDURE

3.1 Plant Collection

Fresh rhizomes of *Curcuma longa* (turmeric) and bulbs of *Allium saliva* (garlic) were collected from local market lyana-Iba Market Ojo, Lagos State of Nigeria on 12th of May 2020 and was identified by Yebunji 0.0 at the university of Lagos iierborium under herbarium number LUH 7631 and LUH 7633 respectively.

3.2 Apparatus , Reagent and Equipment

Beer- Lambert bottle, Weighing balance, round bottom flask and Hexane.

3.3 Isolation of Essential Oil

200g of the leaves sample were packed into the round bottom flask, and was adequately filled with distilled water. The extraction was carried out in the ETF research laboratory ofLagos State University. The grounded samples was then subjected to hydrodistillation, the oil was collected over hexane and kept in an airtighttube called beer Lambert tube, kept in a cool and dry place until analysis

3.4 GC Analysis

GC analysis was carried out on a Hewlett Packard HP 6820 Gas Chromatograph equipped with an FID detector and DB - 5 columns (60 m x 0.25 mm id) film thickness was 0.25 µm and the split ratio was 1:25. The oven temperature was programmed from 50°C (after 2 min) to 240 °C at 5°C/min and the final temperature was held for 10 min. Injection and detector temperatures were 200°C and 249 °C, respectively. Hydrogen was the carrier gas. An aliquot (0.5 µL of the diluted oil) was injected into the GC. Peaks were measured by electronic integration. A homologous series of n-alkanes were run under the same conditions for determination of retention indices.

3.5 Gas Chromatography – Mass Spectrometry

GC-MS analysis of the oil was performed on a Hewlett Packard Gas Chromatography HP 6890 interfaced with a Hewlett Packard 5973massspectrometer system equipped with a HP-5MS capillary column (30 m x 0.25 mm id, film thickness 0.25 µm). The oven temperature was programmed from 70-240°C at the rate of 5°C/min. The ion source was set at 240°C and electron ionization at 70eV. Helium was used as the carrier gas at a flow rate of 1mL/min. The scanning range was 35 to 425 amu. Diluted oil in n-hexane (1.0µL) was injected into the GC/MS.

4.0 RESULTS AND DISCUSSIONS

4.1 Chemical Constituents of Essential Oil of *Allium sativum* and *Curcuma longa*

Table 1: Chemical Constituents of Essential Oil of *Allium sativum*

Compounds [a]	Class of compounds	R1[b]	Percent composition
Dially sulphide	Sd	865	0.1
Methyl disulphide	Sd	919	0.1
Dimethyl trisulfide	Sd	974	0.1

Mycrene	Mh	993	0.1
Diallyl disulfide	Sd	1082	15.7
(z)-I-propenyalallyl disulphide	Sd	1098	0.4
(E)-I-propenyalallyl disluphide	Sd	1102	1.2
Methyl allyl trisulfide	Sd	1142	9.2
3-vinyl-1,2-dithiacyclohex-ene	Sd	1191	0.1
2-vinyl-1-4H-1,3-dithine	Sd	1207	0.3
Dimethyl tetra sulfide	Sd	1208	0.1
Nerol	Mo	1242	0.3
Geranial	Mo	1271	0.3
Diallyl trisulfide	Sd	1298	53.9
Allyl propenylallyltetra	Sd	1306	0.3
(z)-1-propenylallyltetra sulphide	Sd	1328	0.7
Diallyltetrasulfide	Sd	1539	11.7
Dodecanoic acid	Nd	1570	1.5
Monotepene hydrocarbon			0.1
Oxygenated monoterpene			0.6
Sulfur derivatives			94.1
Non-terpenes derivatives			1.5

[a] Elutionorder on HP-5MS column; [b] Retention indices on HP-5MS column; Mh, Monoterpene hydrocarbons; Mo, Oxygenated monoterpenes; Sd, Sulfur derivatives; Nd, Non- terpene derivatives.

Table 2: Chemical Constituents of Essential Oil of *Curcuma longa*

Compounds [a]	Class of compounds	R1[b]	Percent composition
α – pinene	Mh	941	0.3
Mycrene	Mh	993	0.2
α – phellandrene	Mh	1006	5.9

γ-3-carene	Mh	1013	0.1
α –tenerpine	Mh	1020	0.2
p-cymene	Mh	1028	1.9
Limonene	Mh	1032	0.6
1,8 cineole	Mo	1034	6.3
γ-terpineol	Mh	1063	0.3
Terpinolene	Mh	1090	1.9
4-terpineol	Mo	1179	0.2
α-terpineol	Mo	1191	0.4
Carvacrol	Mo	1301	0.2
4-hydroxyl-3-methylacetophenone	Nd	1322	0.1
β-caryophyllene	Sh	1419	0.5
(*Z*) -β-farnesene	Sh	1444	0.7
(*E*)-β-farnesene	Sh	1460	0.2
Alloaromadendrene	Sh	1461	0.1
γ-curcumene	Sh	1481	0.1
ar-curcumene	Sh	1483	2.3
α-zingiberene	Sh	1496	2.1
β-bisabolene	Sh	1508	0.5
β-curcumene	Sh	1513	0.1
β-sesiquphellandrene	Sh	1525	2.0
ar-tumerone	So	1666	28.6
β-atlatone	So	1667	21.9
Curlone	So	1701	18.8
Monoterpene hydrocarbons			11.4
Oxygenated monoterpenes			7.1
Sesquiterpenes hydrocarbons			8.6
Oxygenated sesiquterpenes			69.3
Non-terpene derivatives			0.1

[a] Elution order on HP-5MS columns; [b] Retention indices on HP-5MS column; Mh, Monoterpene hydrocarbons; Mo, Oxygenated montorpenes; Sh, Sesquiterpene hydrocarbons; So, Oxygenated sesquiterpenes; Nd, Non-terpene derivatives.

4.2 Yield and Colour of the Oil

Table 3: Percentage Yield of the Oils

	Curcuma long rhizomes	*Allium sativum* bulbs
Weight of sample g	300	250
Weightof bottle g	7.75	6.4
Weight of bottle + oil g	8.5	7.2
Weight of oil g	0.75	0.8
% yield of oil (w/w)	0.75	0.8

i. For *Curcuma longa* rhizomes
Weight of bottle = 7.75g
Weight of bottle + oil (g) = 8.5g
To get the actual yield of oil = 8.5g-7.75g=0.75g
% yield w/w = 0.75g/100 x 100/1 = 0.75%

ii. For *Allium sativum* bulbs
Weight of bottle = 6.4g
Weight of bottle + oil (g) =7.2g
To get the actual yield of oil =7.75-6.4g=0.8g
% yield w/w =0.8g/100 x 100/1 = -0.8%

4.2.1 Physical Properties of the Essential Oil

Table 4: Physical Properties of the Essential Oils

Phyiscal Properties	***Curcuma long***	***Allium sativum***
Colour	Pale yellow	Colourless
Odour	Aromatic smell	Pungent

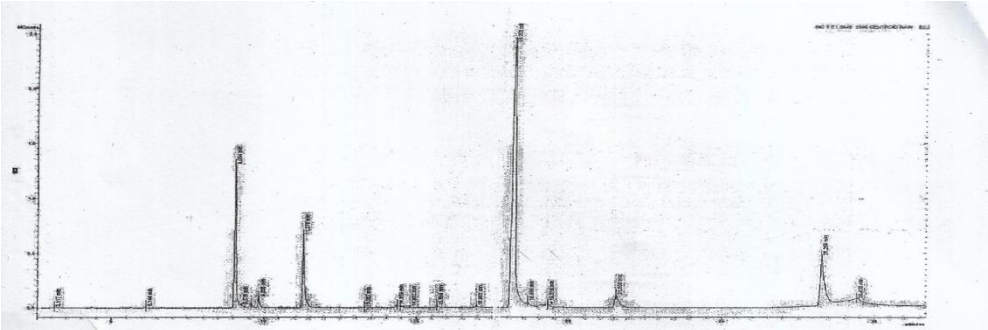

Fig 4.1: The chromatogram of essential oils from *Allium Sativum*

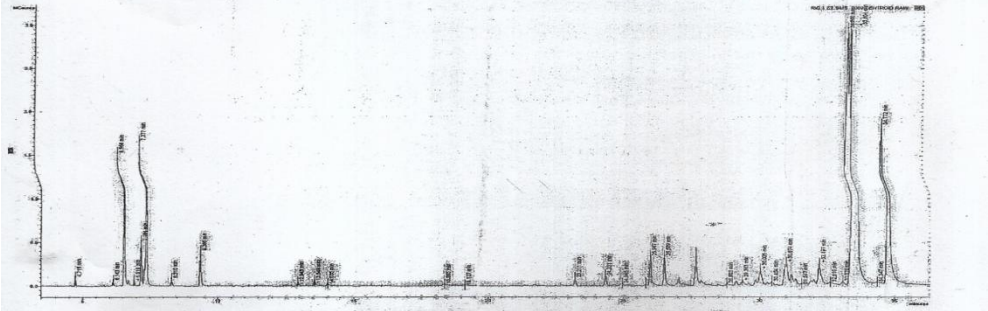

Fig: 4.2 The chromatogram of essential oils from *Curcuma longa*

4.2 DISCUSSION

The bulbs of *Allium sativum* has a colorless oil obtained in a yield of 0.75% (w/w) and rhizomes of *Curcuma longa* has a pale yellow oil obtained in a yield of 0.80% (w/w), calculated on a dry weight basis from hydro-distillation. The identity percentage of the chemical constituent and retention indices on Hp-5ms column could be seen in table 1 and 2.

Allium Sativum has eighteen compounds representing 96.3% of the oil content which were identified, the oils was dominated by a large amount of sulfur derivatives compounds. The main constituents of the oils were sulfur derivatives (94.1%), diallyltruslfide (53.9%), daillysldisulfide (15.7%), methylallyltrisulfude (9.2%) and diallytetrasulfide (11.7%). The least compound was montoterpenes hydrocarbon (0.1%) and non-terpenes derivatives (1.5%) *Curcuma longa* have twenty-seven compounds representing 96.5% of the oil content which were identified. Dominant classes of compounds were oxygenated sesquiterpenes (69.3%) and monoterpenes hydrocarbons (11.4%), the least compound was non-terpene derivatives (0.1). The major constituents in the oils were ar-tumerone (28.6%), β-atlantone (21.9%), curlone (18.8%), 18 were cineole (6.3%). Other compounds include a-phellandrene (5.9%), ar-curcumene (2.3%), a-zingiberene (2.1%), β-sesquilhellandrane (2.0%), p-cymene (1.9%) and terpinolene (1.9%).

A comparison of previous results on the essential oil of rhizomes of *Curcuma longa* which was obtained by methanolic extract in china as reported [40] revealed the most abundant constituents were ar-tumerone (25.5%) a-tuemrone (18.3%) and curlone (12.5%). The rhizome oil of C. longa from India [41] revealed that the major constituents were 31.7% of ar-turmerone, 12.9% of α-tumerone while the oil from the leaves contains α-phellantrene (9.1%) and terpineolene (8.8%). The essential oil from turmeric rhizomes from India [42] having components of ar-tumerone (31./1%), tumerone (10.0%), curlone (10.6%) and ar-curcumerne (6.3%). The chemical analysis of rhizomes of turmeric [44] revealed that the oil contained significant amounts of a-tumerone (45.3%) B-tumerone (13.5%), linalool (14.9%).

Generally, ar-tumerone was reported to be in turmeric volatile oil, which is mosquito repellent, used as drugs for the treatment of respiratory diseases, and a-tumerone appears to act as anticarcinogenic has been reported.

Furthermore, the insect repellent and anti inflammatory properties attributes to ar-tumerone and curlone, [44, 45].

These differences in percent composition of the constituents may be attributed to the differences in the part of the plant analyzed which was not stated or the climatic and ecological conditions between the *Curcuma longa* from Nigeria and *Curcuma longa* from other parts of the world such as China and Asia.

The oil compositions from this study show quantitative similarities and differences from previously published reports on garlic oil. Egyptian garlic essential oil extracted by hydrodistillation had diallyl disulfide (25.2%). Allyl methyl trisulfide (23.7%) and diallyltrisulfide (21.1%) as the major constituents [46]. The major components of Serbian garlic essential oil obtained by hydrodistillation were diallyltrisulfide (33.6%), diallyl disulfide (28.1%) and allyl methyl trisulfide (17.8%). The main components of Tunisian garlic essential oil obtained by hydrodistillation were diallyl disulfide (49.1%) and diallyltrisfulfide (30.4%) were the main components of Tunisian garlic essential oil obtained by hydrodistillation.

The profile identified in this study was also different from French garlic oil presented by Mnayer et al. in which the major components were diallyl disulfide (37.9%), diallyltrisulfide (28.1%), all methyl trisulfide (7.3%), daillaylslfide (6.6%) ddiallyltetrasulfide (4.1%) and allyl methyl disulfide (3.7%) [45,46,47,48.49.50.51.52.53,54,55]. *A. sativum*essential oil obtained by Clevenger hydrodistiilation was dominated by diallyltrisulfide (46.5%) followed by diallyl disulfide (16.0%), ally methyl trisulfide (10.9%) and diallyl disulfide (7.2%).

These investigators found diallyl disulfide, diallyltrisulfide and methyl allyltrisulfide to be the dominant components, in different compositions. These differences however attributed to the differences in the climatic and ecological conditions between the *Allium sativum*from Nigeria and *Allium sativum*from other parts of the world such as Asia and Europe.

The medicinal properties of garlic have been attributed to the abundance of sulfur containing compounds. These compounds have also shown antifungal, antibacterial, acaricidal, antiparastic, nematicidal, antiviral and insecticidal properties [56]. Diallyl disulfides and diallyltrisulfide which are allicin-derivative products have been shown to activate antixodiant enzymes and to possess antimicrobial activity [56, 63].

CONCLUSION

This research work shows that oil from turmeric and garlic comprises a total of 54 constituents and has 4 components in common.

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