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Research Article

GC-MS and Phytochemical Screening of Garlic (*Allium sativum*) Bulbs and Ginger (*Zingiber officinale*) Rhizome

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Abstract

Natural products (e.g. Garlic bulb and Ginger rhizome) has been used in food production and in traditional medicine. The objective of the study was to run the GC-MS and phytochemical screening tests for Garlic (*Allium sativum*) bulbs and Ginger ((*Zingiber officinale*)) rhizome. The samples of the Garlic and Ginger were purchased from the local market, Wad Medani City, Gezira State, Sudan. The qualitative phytochemical screening was run in University of Gezira, Sudan, following the standard methods, whereas, GC-MS analysis was carried out at Forensic Laboratories Directorate, Khartoum State, Sudan. The results showed that, the GC-MS database identified 7 different compounds from ginger rhizome, and only 4 different compounds from the garlic bulbs. The qualitative phytochemical screening of garlic bulb detected the presence of saponins, flavonoids, glycoside, sterols and tannins, whereas that of ginger rhizome contained the same classes in addition to alkaloids. This work recommends studying both garlic bulb and ginger rhizome as food supplemented raw materials as well as a natural materials for controlling microbes.

Introduction

Garlic (*Allium sativum*) is a species in the onion genus, *Allium*. Garlic is suggested to be originated in the regions of Central Asia and northeastern Iran. It has long been used worldwide [1], with a history of several

thousand years of human trading activities. It was known to most ancient civilizations, and has been used both in food processing and as a constituents in some traditional medicine preparations.

Garlic is usually used in foods because of its pungent flavor either raw or cooked. The garlic bulb is the only used part of the plant in most countries, and it is normally divided into fleshy sections (cloves). Garlic cloves have a characteristic flavor that considerably changed during cooking [2].

Ginger (*Zingiber officinale* L.) is a flowering plant belong to family Zingiberaceae. Ginger root or rhizome, is worldwide used in food processing as a spice and as a constituent in traditional medicine [3]. It is a herbaceous perennial plant, which grows untrue stems bearing the leaves. The inflorescences consisted of pale yellow and purple flowers that arises on separate shoots directly from the rhizome [4].

Ginger is native to Southeast Asia Islands and it was suggested to be domesticated at first by the Austronesians, and it was one of the oldest spices exported from Asia to ancient Greeks and Romans in Europe [5].

Ginger usually produces a hot taste and fragrant flavor [5]. Young fresh rhizomes are usually juicy and fleshy, but with mild taste. The volatile oils of ginger rhizome that compose 1-3% of the fresh weight, were responsible for the characteristic fragrance and flavor [6].

Gas chromatography-mass spectrometry (GS-MC) was used to analyze and compare the volatile components in the extracts. The chemical constituents revealed from the GC-MS analysis along with their retention time, base peak, molecular weight, molecular formula and compound names in addition to their figures were presented according to the library used to identify compounds [7].

Materials and Methods

Collection and Preparation of Plant Materials

The samples of Ginger (*Z. officinale*) rhizomes and garlic (*A. sativum*) bulbs were brought from the local market of Wad Medani city, Gezira State, Sudan.

The selected products were first cleaned manually and then let to dry at room temperature away from direct sunlight. The selected samples were then crushed to fine granules. Each powder was extracted with 99% chloroform for 48 hours using cooled extract (5g plant powder dissolved in 25ml chloroform). Each extract was filtered to separate solid parts from chloroform-soluble part (CSP) under reduced pressure. The extract (CSP) was stored in refrigerator to prevent evaporation until running the GC-MS analysis.

GC-MS Analysis

The apolar parts of Ginger (*Z. officinale*) rhizomes and garlic (*A. sativum*) bulbs were analyzed using GC-MS technique. GC-MS analysis was carried out at Forensic Laboratories Directorate, Khartoum State, Sudan. The chloroform-soluble part (CSP) was subjected to this test unlike the ethanol extracts.

In general, compound identifications depends on the database of National Institute Standard and Technology (NIST) interpreted on the GC-MS device. During fragmentation, and by using NIST library database, the unknown components were compared automatically with those stored in the database.

Phytochemical Screening Tests

Phytochemical screening for the presence of the main classes in the selected samples were done according to Yusha'u *et al.*, (2009) [8].

Test for the Presence of Alkaloids

In a test tube, to 3ml of each extract, 2 drops of Dragendoff's reagent was added. The precipitation of turbid orange red complex denoted the presence alkaloids.

Test for the Presence of Flavonoids and Flavonones

In a test tube, to about 4mg/ml of each extract a piece of magnesium ribbon was added then a drop of concentrated HCl was wisely added. The presence of flavonones was confirmed when the orange colour changed to red; while the presence of flavonoids was indicated by the red to crimson changes.

Test for the Presence of Glycosides

In a test tube, to about 1ml of the filtrate, 10ml of 50% H_2SO_4 was added. The mixtures was heated for 15 minutes then 10ml of Fehling's solution was added and boiled. The presence of glycosides was indicated by brick red precipitate.

Test for the Presence of Saponins

In a test-tube, to about 0.5g of each powdered plant materials, 5ml of distilled water was added and the test-tube was shaken vigorously for 2 minutes. The presence of saponins was indicated by the formation of froth that lasted for about 15 minutes.

Test for the Presence of Steroids

In a test tube, 2ml of each extracts were evaporated to dryness. The residues were dissolved in acetic anhydride then by addition of chloroform. Concentrated H_2SO_4 was gently added. The presence of steroids was confirmed by formation of brown ring at the mid-layer between the liquids and the violet supernatant.

Test for the Presence of Tannins

In a test tube, to 2ml of each extracts were diluted with distilled water, 3 drops of 5% ferric chloride ($FeCl_3$) solution was added. The appearance of green, black or blue colouration indicated the presence of tannins.

Results and Discussion

GC-MS Analysis

Concerning ginger rhizome, the GC-MS chromatogram draws 47 peaks, but database identified 7 different compounds from their chloroform extract: Benzoguanimine ($C_9H_9N_5$), Levomenthol ($C_{10}H_{20}O$), Anthracene ($C_{26}H_{48}$), Diethyltoluamide ($C_{12}H_{17}NO$), Versalide ($C_{18}H_{26}O$), Isopropyl myristate (C17H34O2), and Alpha Amyrenyl acetate ($C_{32}H_{52}O_2$) as was shown in Table (1).

Table 1: *Details of the identified compounds from chloroform-ginger rhizome*

No	Compound name	Molecular formula	Molec. weight	Retention time	Base peak
1	Benzoguanimine 1.3.5-Triazine-2,4-diamine,6-phenyl-s	$C_9H_9N_5$	187	8.275	187.00
2	Levomenthol 5-methyl-2-(1-methylethyl)-,[IR-(1-alpha,2. beta,5-alpha)]	$C_{10}H_{20}O$	156	4.917	81.00
3	Anthracene 9-dodecyltetradecahydro-	$C_{26}H_{48}$	360	9.558	191.00
4	Diethyltoluamide Benzamide,N,N-diethyl-3-methyl	$C_{12}H_{17}NO$	191	8.750	119.00
5	Versalide 7-Acetyl-6-ethyl-1-,1,4,4-tetramethyltetralin	$C_{18}H_{26}O$	258	11.508	243.00
6	Isopropyl myristate Tetradecanoic acid,1-methylethyl ester	$C_{17}H_{34}O_2$	270	10.858	43.00
7	Alpha Amyrenyl acetate Urs-12-en-3-ol,acetate,(3.beta)	$C_{32}H_{52}O_2$	468	15.808	218.00

In similar study, the results showed that 140 components were separated and about 74 of them were tentatively identified [9].

In other similar study, the principal constituent in ginger oil was Zinziberene, a kind of sesquiterpenes hydrocarbon its content was higher in Chinese than Guinean ginger. It was found that, the β-sesquiphellandrene was higher in Chinese ginger compared to Guinean ginger. The low boiling point monoterpenes a-pinene, Zinziberenol, Linalool, Terpineol, Borneol, Eucalyptol, 1, 8-Cineole, Cubenol, Cadinol, β-Eudesmol and Nerolidol were more abundant and present in various proportions and they imparted aromas characteristic to the products [10].

GC/MS analysis of methanol extract of *Zingiber officinale* rhizomes revealed the existence of Zingiberene, followed by AR-curcumene, α-Bergamotene, Gingerol, Zingerone, β-esquiphellandrene, (Z)-β-Farnesene, Caryophyllene and c-Elemene [11].

The GC-MS identified only 4 different compounds from the chloroform extract of garlic bulbs: 1,2-Benzenedicarboxylic acid,butyl,2-ethylhexy ester ($C_{20}H_{30}O_4$), Mononitromesitylene ($C_9H_{11}NO_2$), Bisoflex ($C_{24}H_{38}O_4$) and Lupenyl acetate ($C_{32}H_{52}O_2$) as was shown in Table (2). The GC-MS identified only 4 different compounds from the chloroform extract of garlic bulbs: 1,2-Benzenedicarboxylic acid,butyl,2-ethylhexy ester ($C_{20}H_{30}O_4$), Mononitromesitylene ($C_9H_{11}NO_2$), Bisoflex ($C_{24}H_{38}O_4$) and Lupenyl acetate ($C_{32}H_{52}O_2$) as was shown in Table (2).

Table 2: *Details of the identified compounds from chloroform- garlic bulbs*

No	Compound name	Molecular formula	Molecular weight	Retention time	Base peak
1	1,2-Benzenedicarboxylic acid,butyl,2-ethylhexy ester	$C_{20}H_{30}O_4$	334	12.383	149.0
2	Mononitromesitylene Benzene, 1,3,5-trimethyl-2-nitro	$C_9H_{11}NO_2$	165	11.233	148.0
3	Bisoflex Bis(2-ethylhexyl)phthalate	$C_{24}H_{38}O_4$	390	17.942	149.0
4	Lupenyl acetate Lup-20(29)-en-3-ol, acetate, (3-beta)	$C_{32}H_{52}O_2$	468	16.042	189.0

The active components of ethanol garlic extracts that compared through GC-MS analysis showed that, allyl trisulfide, 2-hydroxy-gamma-butyrolactone, 1 3-dihydroxyacetone dimer, propanoic acid, and 2-propone were detected in all extracts. These substances (Appendix, 1) are produced by the degradation of alline and have been reported to have beneficial effects, such as antioxidant and anticancer activities [7].

The qualitative phytochemical screening of Ginger rhizome and Garlic bulb were presented in Table (3). Ginger rhizome contained glycosides, flavonoids, saponins, sterols and alkaloids, as same as Garlic bulb (except in alkaloids which was not detected in garlic bulb). Tannins in both samples did not detected.

Table 3: *Phytochemical constituents*

Main class	Ginger rhizome	Garlic bulb
Saponins	+	+
Tannins	-	-
Glycosides	+	+
Sterols	+	+
Flavonoids	+	+
Alkaloids	+	-

Phytochemicals usually give plants its characteristic colour, odor and flavour, and consider part of its internal defense mechanism against pests, parasites and pathogens [12]. Ali and Ibrahim (2019) [13] detected the presence of alkaloids in Garlic bulbs. Deresse (2010) [14] found that garlic extract exhibited activity against both gram negative and gram positive due to presence of some phytochemicals such saponins and tannins.

Conclusion

Based on the results of the present study, the GC-MS database identified 7 different compounds from ginger rhizome chloroform extract, and only 4 different compounds from the garlic bulbs. phytochemical constituents, proximate and minerals components of garlic bulb were determined. The qualitative phytochemical screening of garlic bulb detected the presence of saponins, flavonoids, glycoside, sterols and tannins, whereas that of ginger rhizome contained the same classes in addition to alkaloids.

Recommendations

Based on the findings of the present study, both garlic bulb and ginger rhizome should be studied as food raw materials as well as a natural materials for controlling microbes.

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