



Comparative In vitro Antioxidant Studies and Phytochemical Analysis of Ginger (*Zingiber officinale*) and Garlic (*Allium sativum*)

Ilechukwu C. C.^{1*}, Ezenwelu C. O.², Ifemeje, J. C.¹, Ilechukwu J. N.³, Egbe, R. C.¹, Iheukwumere, I. H.⁴ and Nwaka, A. C.



¹Department of Biochemistry, Faculty of Natural Sciences, Chukwuemeka Odumegwu Ojukwu University, Anambra State Nigeria.

²Department of Applied Biochemistry, Faculty of Bio- Sciences, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria.

³Department of Community Health and Primary Care, Faculty of Medicine, University of Lagos, Akoka Lagos.

⁴Department of Microbiology, Faculty of Natural Sciences, Chukwuemeka Odumegwu Ojukwu University, Anambra State Nigeria.

*Corresponding author's email: chijokeilechukwu@gmail.com

Abstract	Article History
<p>Ginger (<i>Zingiber officinale</i>) and garlic (<i>Allium sativum</i>) are globally consumed spices known for their flavor, organoleptic properties, and health benefits. This study evaluates the comparative in-vitro antioxidant and phytochemical profiles of <i>Zingiber officinale</i> and <i>Allium sativum</i>. Fresh samples were washed, chopped, dried, pulverized, and extracted using standard procedures. Phytochemical composition and antioxidant parameters (hydrogen peroxide scavenging and ferric reducing antioxidant property, FRAP) of the methanol extracts were assessed. Phytochemical screening revealed the presence of flavonoids, glycosides, steroids, and carbohydrates in both extracts. Tannins were present in <i>Zingiber officinale</i> but absent in <i>Allium sativum</i>. Conversely, alkaloids and saponins were present in <i>Allium sativum</i> but absent in <i>Zingiber officinale</i>. In the hydrogen peroxide scavenging assay, both extracts showed dose-dependent activity. At 20 µg/ml, <i>Z. officinale</i> and <i>A. sativum</i> exhibited scavenging activities of $34.32 \pm 0.10\%$ and $30.16 \pm 0.14\%$, respectively. At 100 µg/ml, activities increased to $73.08 \pm 0.16\%$ for <i>Z. officinale</i> and $68.62 \pm 0.11\%$ for <i>A. sativum</i>. In the FRAP assay, reducing power also increased with concentration. At 10 µg/ml, <i>Z. officinale</i> and <i>A. sativum</i> recorded values of 36.33 ± 0.16 and 32.23 ± 0.14, respectively, while at 50 µg/ml, values rose to 74.09 ± 0.20 and 71.56 ± 0.20. These results indicate that both extracts possess in-vitro antioxidant activity, with <i>Z. officinale</i> showing slightly higher scavenging and reducing power than <i>A. sativum</i>. The antioxidant potential may be attributed to the phytochemicals present in the plants. Therefore, the methanol extracts of <i>Zingiber officinale</i> and <i>Allium sativum</i> demonstrate notable antioxidant activity against hydrogen peroxide and ferric ions, likely due to their phytochemical constituents.</p> <p>Keywords: <i>In vitro</i> antioxidants, ginger, garlic, phytochemicals, spices.</p>	<p>Received: 15 Jun 2025 Accepted: 28 Jun 2025 Published: 04 Jul 2025</p>  <p>Scan QR code to view*</p> <p>License: CC BY 4.0*</p>  <p>Open Access article.</p>
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1. Introduction

From time immemorial, medicinal plants are a rich source of bioactive phytochemicals or bio nutrients. Studies carried out during the past decades have shown that these phytochemicals have an important role in preventing chronic diseases like cancer, diabetes and coronary heart disease etc. Ginger and Garlic are commonly used spices important in medicine due to the presence of many important phytochemical constituents and nutrients which are biologically active substances. Some

chemical constituents of the medicinal plants have been reported in various literatures to contribute to the prevention and treatment of various diseases and ailments apart from the primary use as organoleptic enhancers in food preparation (Imo *et al.*, 2016). In literatures, some of the documented properties of ginger and garlic include antioxidant, anti-inflammatory, rheumatologic, blood circulation, anti-cramp, analgesic and immunity booster. Spices are a large group of natural ingredients. They include dried seeds, fruits, roots,

rhizomes, barks, leaves, flowers and any other vegetative substances used in a very small quantity as food additives for colour, flavor or to preserve food (Birt, 2006). Spices are any of vegetables substances either indigenous or exotic origin, aromatic, fragrant or with pleasant strong taste used to enhance tastes of foods and organoleptic properties of food (Harsha *et al.*, 2013). The bulk of the spices consist of carbohydrates such as cellulose, starch, pentoses and mucilage, and some amount of protein and minerals (Otunola *et al.*, 2010). Only very small fractions of dry matter of these spices such as the phytochemicals are responsible for the flavoring, coloring, preservative and health-promoting characteristics.

Several studies done in the past 2-3 decades have shown that these phytochemicals play an important role in preventing chronic diseases like cancer, diabetes, coronary heart disease, viral and bacterial diseases (Iheukwumere *et al.*, 2025a; Iheukwumere *et al.*, 2025b). Plants, herbs and spices contain phyto-nutrient or phytochemicals which possess antioxidant activity, antiviral activity and antibacterial activity (Anameze *et al.*, 2023; Iheukwumere *et al.*, 2025c; Iheukwumere *et al.*, 2025d, Iheukwumere *et al.*, 2025e). Plants, herbs and spices have been demonstrated to possess significant antioxidant properties in various studies suggesting its potential protective ability against oxidative stress and therefore play an important role in the chemo-prevention of diseases that have their etiology, progression and pathophysiology in reactive oxygen species (Ilechukwu *et al.*, 2014; Ilechukwu and Okafor, 2020; Ilechukwu, 2022; Ifemeje *et al.*, 2025; Ilechukwu *et al.*, 2025a; Ilechukwu *et al.*, 2025b).

The consumption of garlic for example has the potential of boosting immunity, reduction of arterial plaque and as an antioxidant agent against skin cancer. Garlic is also used as a digestive stimulant, diuretic and antispasmodic agent (Nwinuka *et al.*, 2005). The chemical constituent of garlic has also been used for the treatments of cardiovascular disease, cancer, diabetes, blood pressure, atherosclerosis and hyperlipidemia (Gebreselema and Mebrahtu, 2013). Ginger has been used as a spice and natural food additive for more than 2000 years. The plant has been identified as an herbal medicinal product with pharmacological effect, consumption of ginger led to reduction in blood cholesterol and also served as a potential anti-inflammatory and antithrombotic agent. Studies have shown that, the long term dietary intake of ginger has hypoglycaemic and hypolipidaemic effect. It suppresses prostaglandin synthesis through inhibition of cyclooxygenase-1 and cyclooxygenase-2. In traditional Chinese and Indian medicine, ginger has been used to treat a wide range of ailments including stomach aches, diarrhea, nausea, asthma and respiratory disorders (Grzanna *et al.*, 2005). In Ayurveda, ginger is reported to be useful in treating inflammation and rheumatism (Ghosh *et al.*, 2011). Ginger is used as flavor in locally prepared drinks especially in Northern Nigeria.

As the plants are widely used as spices and in the treatment of several ailments that threaten the existence of mankind, this research paper seeks to highlight the comparative invitro antioxidant and phytochemical analysis of Ginger (*Zingiber officinale*) and Garlic (*Allium sativum*).

2. Materials and Methods

Reagents and Chemicals

All chemicals and reagents used were pure and of analytical grade and products of British Drug house (BDH), England; May and Baker, England; Sigma Aldrich, USA.

Plant material

Fresh Ginger and Garlic were purchased from a local market in Awka Anambra state, South East Nigeria. The samples were identified by Prof. C. Ukpaka a botanist in the department of Biological sciences Chukwuemeka Odumegwu Ojukwu University Anambra State Nigeria.

Preparation of sample and material

Fresh ginger (*Zingiber officinale*) and garlic (*Allium sativum*) were washed, chopped into pieces. It was allowed to dry under room temperature for 3 weeks and then pulverized using a blender, till a fine dry powder was obtained. The powdered sample were stored in the polythene bags and placed at room temperature until they were used. The glass wares used were washed with detergents, rinsed in distilled water and dried.

Extraction

The methanol extract of the samples was obtained by soaking 20g each of powdered samples of garlic and ginger in 100 ml of methanol in different air-tight, properly labelled glass containers. These were left undisturbed at a temperature of $28 \pm 2^\circ\text{C}$ for 120 hours (5 days). Thereafter the extracted samples were filtered with a clean white sieving cloth into separate 100ml conical flasks. Further filtration was done for each sample using Whatman filter paper. The filtrates were then poured into separate 100ml beakers and were appropriately labelled. Afterwards, the extracts were concentrated to 15ml by placing in an oven set at 45°C . Each concentrated extract was poured into different 3ml glass bottles, labelled and the yield of each extract was then subjected to qualitative phytochemical screening.

Qualitative Phytochemical Screening

Detection of Flavonoids

Ten (10ml) of each extracts (separately) were treated with few drops of sodium hydroxide solution. Formation of intense yellow colour, which becomes colorless on addition of dilute acid, indicates the presence of flavonoids.

Detection of Tannins

One ml of the extract was added in a test tube followed by addition of tannic acid. The formation of white precipitate indicates the presence of tannins.

Test for Alkaloids (Wagner's Test)

Two ml of the extract were treated with 1ml of Wagner's reagent in test tube. The formation of reddish-brown precipitate indicates the presence of alkaloids in the extract.

Detection of Saponins (Foam Test)

One ml of the concentrated extract was diluted to 5ml with distilled water and shaken vigorously. The formation 1cm layer of foam that persisted indicates the presence of saponins.

Test for Steroids

One gram of plant extract was dissolved in a few drops of acetic acid and a drop of conc. H₂SO₄ was added. The green colour indicated the presence of steroids.

Test for carbohydrates

To 0.5 mL of plant extract, 1mL of water, and 5-8 drops of Fehling's solution were added and heated. The presence of reducing sugar was indicated by the appearance of brick red precipitation (Thusa & Mulmi, 2017).

Test for glycosides

To the extract, 5mL Molisch's reagent and concentrated H₂SO₄ were added. Violet color indicated glycosides (Alamzed *et al.*, 2013).

In Vitro Antioxidant Assays**Hydrogen Peroxide Scavenging Effects**

The ability of the samples to scavenge hydrogen peroxide was assessed by the method of Ruch *et al.*, (1989).

Reagents

1. Phosphate buffer (0.1M, pH 7.4)
2. H₂O₂ (40mM) in phosphate buffer

Procedure

A solution of H₂O₂ (40mM) was prepared in phosphate buffer. Samples at the concentration of 10mg/10µl were added to H₂O₂ solution (0.6ml) and the total volume was made up to 3ml. The absorbance of the reaction mixture was recorded at 230nm in a spectrophotometer (Genesys 10-S, USA). A blank solution containing phosphate buffer, without H₂O₂ was prepared. The extent of H₂O₂ scavenging of the sample was calculated as:

$$\% \text{ scavenging of hydrogen peroxide} = \frac{(A_0 - A_1) \times 100}{A_0}$$

A₀ - Absorbance of control

A₁ - Absorbance in the presence of sample

Ferric Reducing Antioxidant Property**Principle**

The principle of the assay is the quantification of ferric degradation product, by its condensation with the extract

Method

The reducing property of the extracts was determined as described by (Pulido *et al.*, 2000)

Procedure

Exactly 0.25 ml of the extracts was mixed with 0.25 ml of 200 Mm Sodium phosphate buffer pH 6.6 and 0.25 ml of 1% Potassium ferricyanide. The mixture was incubated at 50°C for 20 min, thereafter 0.25 ml of 10% trichloroacetic acid was added and centrifuged at 2000 rpm for 10 min, 1 ml of the supernatant was mixed with 1 ml of distilled water and 0.2 ml of ferric chloride and the absorbance was measured at 700 nm.

3. Results**Qualitative Phytochemical Screening**

The methanol extracts of *Zingiber officinale* and *Allium sativum* were subjected to qualitative phytochemical analysis to detect the presence of various bioactive compounds. The results, summarized in Table 1, indicate that both extracts contain flavonoids, steroids, glycosides, and carbohydrates. *Zingiber officinale* showed the presence of tannins and absence of alkaloids and saponins, whereas *Allium sativum* tested positive for alkaloids and saponins but negative for tannins.

Table 1: Qualitative phytochemical screening Result of methanol extract of *Zingiber officinale* and *Allium sativum*

Phytochemicals	<i>Zingiber officinale</i>	<i>Allium sativum</i>
Alkaloids	-	+
Tannins	+	-
Flavonoids	+	+
Steroids	+	+
Saponins	-	+
Glycosides	+	+
Carbohydrates	+	+

+ = Present

- = Not detected

Ferric Reducing Antioxidant Activity

The antioxidant activity of methanol extracts of *Allium sativum* and *Zingiber officinale* was evaluated using the ferric reducing antioxidant power (FRAP) assay. The results, presented in Table 2, show a concentration-dependent increase

in percentage inhibition for both extracts, with *Zingiber officinale* exhibiting slightly higher antioxidant activity than *Allium sativum* at all tested concentrations. The standard antioxidant, ascorbic acid, showed the highest percentage inhibition across all concentrations tested.

Table 2: Ferric reducing antioxidant property/ activity of methanol extract of *Allium sativum* and *Zingiber officinale*

Conc in µg/ml	% inhibition of <i>Allium sativum</i>	% inhibition of <i>Zingiber officinale</i>	% inhibition of standard (ascorbic acid)
10	32.23 ± 0.14	36.33 ± 0.16	41.28 ± 0.33
20	39.18 ± 0.25	42.24 ± 0.18	54.29 ± 0.46
30	46.32 ± 0.19	49.36 ± 0.28	65.59 ± 0.14
40	57.35 ± 0.12	60.36 ± 0.44	71.33 ± 0.06
50	71.56 ± 0.20	74.09 ± 0.20	81.28 ± 0.12

Values are expressed as mean ± SD (n=3).

Hydrogen Peroxide (H₂O₂) Scavenging Activity

The H₂O₂ scavenging potential of methanol extracts of *Allium sativum* and *Zingiber officinale* was assessed and compared with ascorbic acid as the standard antioxidant. As shown in Table 3, both extracts demonstrated a dose-dependent increase

in scavenging activity. *Zingiber officinale* exhibited higher scavenging activity than *Allium sativum* at all tested concentrations, with maximum activity observed at 100 µg/ml. However, the standard ascorbic acid showed the highest scavenging activity overall.

Table 3: H₂O₂ scavenging activity of *Allium sativum* and *Zingiber officinale*

Conc in µg/ ml	% scavenging activity of <i>Allium sativum</i>	% scavenging activity of <i>Zingiber officinale</i>	% scavenging activity of standard (ascorbic acid)
20	30.16 ± 0.14	34.32 ± 0.10	38.19 ± 0.28
40	38.36 ± 0.18	40.40 ± 0.19	46.14 ± 0.19
60	41.39 ± 0.23	47.23 ± 0.28	54.35 ± 0.11
80	57.42 ± 0.16	59.39 ± 0.13	67.21 ± 0.30
100	68.62 ± 0.11	73.08 ± 0.16	81.45 ± 0.17

Values are expressed as mean ± SD (n=3)

4. Discussion

Free radicals which are mainly reactive oxygen species and reactive nitrogen species are involved in the development of several diseases causing oxidative stress and oxidative damage. These free radicals have been implicated in the etiology and progression of many pathological diseases (Ilechukwu *et al.*, 2014; Ilechukwu and Okafor, 2020; Ilechukwu, 2022; Ifemeje *et al.*, 2025; Ilechukwu *et al.*, 2025a; Ilechukwu *et al.*, 2025b). Antioxidant eliminate these free radicals by mopping up or chelating it. These natural chemicals found in food and body tissue are said to have beneficial effects in terminating chain reactions of free radicals. Vitamin A, C and E are dietary antioxidant found richly in vegetables and fruits.

The qualitative Phytochemicals analysis were carried out on the Garlic (*Allium sativum*) and Ginger (*Zingiber officinale*) revealed the presence of flavonoids, steroids, glycosides and carbohydrates. Some of these phytochemicals have been established to be of high medicinal values (Oloyede, 2005). High concentrations of glycosides are useful as cardiac stimulant and diuretic. Flavonoids are important group of polyphenols widely distributed among the plant flora. Numerous reports support their use as antioxidants or free radical scavengers as well as quenchers of singlet oxygen formation (Ali and Neda, 2011). Steroids helps to increase muscle strength and power. And carbohydrates are the body's main source of energy, they help fuel the brain, kidneys, heart muscles, and central nervous system. Alkaloid and saponin were present in Garlic (*Allium sativum*) but absent in Ginger (*Zingiber officinale*) while Tanin was present for Ginger and absent in Garlic.

In this study, the comparative study on the in vitro antioxidant properties Garlic (*Allium sativum*) and Ginger (*Zingiber officinale*) were evaluated using ferric reducing antioxidant property and hydrogen peroxide scavenging activity. The reduction of ferricyanide (Fe³⁺) to the ferrous form (Fe²⁺) by the extracts serves as an indicator of its antioxidant capacity, this reduction is due to the presence of reductants in the solution. The higher reducing power, the greater the antioxidant activity (Pakade *et al.*, 2013). Hence *Zingiber officinale* shows stronger reducing activity than *Allium sativum* which showed weaker activity. Therefore, *Zingiber officinale* plant possesses greater in vitro antioxidant capacity than *Allium sativum*. The

study is in conformity with the works of Pulido *et al.* 2000, Ayoade *et al.*, 2022 and Akullo, *et al.*, 2023 which observed that *Zingiber officinale* has higher in vitro antioxidant property than *Allium sativum*.

In vitro antioxidant activities were also estimated based on hydrogen peroxide scavenging activity, the methanol extract of *Zingiber officinale* shows strong peroxide scavenging activity when added to H₂O₂ solution whereas *Allium sativum* shows poor peroxide scavenging activity. Therefore, *Zingiber officinale* is shown to have more antioxidant capacity. This conforms with the works of Akullo, *et al.*, 2023 which observed that *Zingiber officinale* has higher in vitro antioxidant property than *Allium sativum*.

The observed antioxidant activities of *Zingiber officinale* and *Allium sativum* support their therapeutic potential, aligning with findings by Ekesiobi *et al.* (2025) and Iheukwumere *et al.* (2025f), which highlight the pharmacological efficacy of these botanicals in combination therapies and antiviral strategies, respectively.

5. Conclusion

Results from this study shows that *Zingiber officinale* with higher level of in vitro antioxidant capacity could offer more protection against damage due to oxidation than *Allium sativum* it also reveals that the higher the concentration of the extract, the more antioxidant capacity they possess, the *Zingiber officinale* shows a stronger reducing activity whereas *Allium sativum* showed weaker activity. Therefore, *Zingiber officinale* possess greater in vitro antioxidant capacity than *Allium sativum* hydrogen peroxide scavenging activity.

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