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RESEARCH ARTICLE

COMPARATIVE NUTRACEUTICAL POTENTIALS OF *OCIMUM GRATISSIMUM* AND *OCIMUM BASILICUM*: ANTIOXIDANT, ANTI-DIABETIC, ANTI-INFLAMMATORY AND LIPASE INHIBITORY ACTIVITIES

Andrew Bamidele Falowo, Anthony Suyi Adaramola, Olugbenga David Oloruntola*, Akeem Ishola Azeez, Taiwo Oladamola Ganiyu, Boluwatife Olamioposi Omojola, Blessing Pius Rotimi, Johnson Segun Oluwadamilare, Oluwapelumi Precious Awosanma, Oluwafunmike Oluwabusola Ogunlade

Department of Animal Science, Adekunle Ajasin University, PMB 001, Akungba Akoko, Nigeria
Corresponding author: olugbenga.oloruntola@aaua.edu.ng; oloruntoladavid@gmail.com

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ABSTRACT

This study evaluated the nutraceutical potentials of *Ocimum gratissimum* and *Ocimum basilicum* leaves, focusing on proximate, phytochemical, antioxidant, enzyme inhibitory, and anti-inflammatory activities. Fresh leaves collected from Akure, Nigeria, were authenticated, shade-dried, powdered, and extracted with 70% ethanol. Standard methods were applied for proximate and phytochemical composition, while antioxidant capacity was assessed using 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging, 2,2′-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid) (ABTS) radical scavenging, ferric reducing antioxidant power (FRAP), and lipid peroxidation inhibition (LPI) assays. Enzyme inhibitory assays targeted α-amylase, α-glucosidase, lipase, and protease, while anti-inflammatory potential was determined via protein denaturation inhibition. All analyses were performed in triplicate. Significant compositional and functional differences were observed between the two species. *O. gratissimum* recorded higher moisture, crude fat, nitrogen-free extract, saponins (78.99 ± 1.33 mg/g), phenolics (18.12 ± 0.30 mg GAE/g), DPPH activity (60.65 ± 0.67%), α-glucosidase inhibition (43.37 ± 0.95%), protease inhibition (91.75 ± 0.14%), and albumin denaturation inhibition (10.48 ± 0.66%). In contrast, *O. basilicum* exhibited higher crude ash, fibre, tannins (10.04 ± 0.17 mg/g), alkaloids (4.23 ± 0.08%), flavonoids (1.01 ± 0.17 mg QE/g), vitamin C (1.04 ± 0.02 mg/g), LPI (53.88 ± 0.78%), α-amylase inhibition (20.10 ± 1.34%), and lipase inhibition (66.55 ± 0.61%). No significant differences were noted in crude protein, ABTS scavenging, or FRAP values. Overall, *O. gratissimum* appears more effective against oxidative stress and inflammation, while *O. basilicum* shows stronger potential for glycemic and lipid regulation. These findings highlight their complementary nutraceutical roles and suggest both species as promising candidates for functional food and nutraceutical development.

KEYWORDS

Ocimum species, Antioxidant activity, Enzyme inhibitors, Nutraceuticals

1. INTRODUCTION

The increasing global burden of chronic and metabolic diseases such as diabetes, obesity, cardiovascular disorders, and inflammatory conditions has prompted growing interest in the use of functional foods and nutraceuticals as safe and sustainable therapeutic strategies (Dama et al., 2024). Synthetic drugs, though effective, are often associated with undesirable side effects and limited long-term safety. Consequently, there is a paradigm shift toward bioactive-rich plants, which offer multiple mechanisms of action including antioxidant, anti-inflammatory, anti-diabetic, and lipid-regulatory effects, thereby providing an integrative approach to disease prevention and health promotion (Nasim et al., 2022).

The genus Ocimum (family: Lamiaceae), commonly known as basil, encompasses numerous species valued in ethnomedicine, culinary practices, and industrial applications (Kakurde et al., 2024). Among them, *Ocimum gratissimum* (African basil, clove basil) and *Ocimum basilicum* (sweet basil) stand out as widely utilized herbs across tropical and subtropical regions (Mulugeta et al., 2023). Both plants are traditionally employed in managing ailments such as fever, diarrhea, respiratory disorders, microbial infections, and metabolic imbalances (Ugbogu et al., 2021; Aminian et al., 2022). The therapeutic value of these species has been largely attributed to their diverse phytochemical profiles, which include phenolics, flavonoids, alkaloids, tannins, saponins, and essential oils (Dharsono et al., 2022). These compounds are reported to modulate oxidative stress, regulate inflammatory mediators, enhance glucose metabolism, and inhibit digestive enzymes linked with metabolic dysfunctions (Singh et al., 2022).

Oxidative stress plays a central role in the pathophysiology of chronic diseases by damaging cellular biomolecules and disrupting signaling pathways. Phytochemicals with strong antioxidant activity are therefore critical for restoring redox balance and protecting tissues against degenerative processes (Tan et al., 2018). Similarly, chronic low-grade inflammation is a hallmark of metabolic syndromes, where pro-inflammatory cytokines and mediators exacerbate insulin resistance, tissue injury, and dyslipidemia. Natural compounds capable of suppressing these inflammatory cascades are of immense nutraceutical interest (Arulselvan et al., 2016). Moreover, inhibition of key enzymes such as α-amylase and α-glucosidase (linked with postprandial hyperglycemia) and pancreatic lipase (involved in dietary fat absorption) offers important dietary strategies for combating diabetes and obesity (Benrahou et al., 2022; Oloruntola, 2022).

Although O. gratissimum and O. basilicum have been studied individually

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for diverse pharmacological effects, few studies have compared their nutraceutical potentials across multiple bioactivities. Such comparative evaluation of their composition, phytochemicals, and biological functions can validate traditional uses and support their application in functional foods and therapeutic interventions. This study therefore assessed the proximate composition, phytochemical constituents, antioxidant, anti-diabetic, anti-inflammatory, and lipase inhibitory activities of both species. The findings are expected to enhance understanding of their nutraceutical relevance and potential roles in the prevention and management of lifestyle-related diseases.

2. Materials And Methods

2.1 Plant materials and authentication

Fresh leaves of *Ocimum gratissimum* and *Ocimum basilicum* were collected from a vegetable garden in Akure, Ondo State; on March, 2025. Species identification was carried out at the Department of Plant Science and Biotechnology, Adekunle Ajasin University, Akungba Akoko, Nigeria. Leaves were washed with distilled water, shade-dried at ambient temperature (25–28 °C; RH < 50%) until constant weight, pulverized (0.5 mm mesh), and stored in airtight containers at 4 °C before use.

2.2 Extract preparation

Powdered leaves (50 g) were macerated in 500 mL of 70% ethanol (1:10 w/v) for 48 h at room temperature with occasional agitation. Extracts were filtered (Whatman No. 1), concentrated under reduced pressure at ≤40 °C, and freeze-dried with a rotary evaporator. Extract yields (%) were calculated and the dried extracts stored at –20 °C until analysis.

2.3 Proximate composition

Moisture, crude protein, crude fat, crude fibre, ash, and carbohydrate contents were determined in triplicate according to AOAC (2010) methods. Protein was estimated using the Kjeldahl method (N × 6.25), lipid by Soxhlet extraction with n-hexane, and fibre by sequential acid–alkali digestion.

2.4 Phytochemical quantification

Total phenolics were determined using Folin–Ciocalteu method (Otles and Yalcin, 2012). Extract (0.5 mL; 1 mg/mL) was mixed with 2.5 mL Folin–Ciocalteu (10% v/v) and 2 mL Na_2CO_3 (7.5% w/v). After 30 min (dark, 25 °C), absorbance was read at 765 nm. Results expressed as mg gallic acid equivalents per g dry extract (mg GAE/g).

For the determination of flavonoids; Aluminium chloride colorimetric method (Surana et al., 2016). Extract (0.5 mL; 1 mg/mL) was added to 0.1 mL 10% $AlCl_3$, 0.1 mL 1 M potassium acetate, and 4.3 mL methanol. After 30 min at room temperature, absorbance was read at 415 nm. Results expressed as mg quercetin equivalents per g (mg QE/g).

Tannins in leaf extracts were determined using the vanillin–o-toluidine assay (Zhao et al., 2018). Leaf samples were extracted with Tris buffer and acetonitrile, centrifuged (10,000 rpm, 10 min), defatted with n-hexane, re-centrifuged, filtered (0.22 µm), and stored at 4 °C until analysis. For the assay, 1 mL of extract or vanillin standard solution (1 pg/mL–500 µg/mL) was mixed with 200 µL o-toluidine (prepared in N,N-dimethylformamide, 1:3 v/v), shaken for 5 min at room temperature, followed by addition of 200 µL acetic acid. The mixture was heated in a boiling water bath at 100 °C for 15 min, cooled, and absorbance was measured at 500 nm using a UV spectrophotometer. Tannin concentration in the leaf extracts was quantified from the vanillin calibration curve and expressed as milligrams vanillin equivalents per gram of sample (mg VAE/g).

Saponins in the leaf extracts were determined using the Vanillin–H_2SO_4 method (He et al., 2014). Extract (1 mL; 1 mg/mL) was treated with 0.5 mL vanillin (8% w/v) and 5 mL 72% H_2SO_4. After 30 min at 60 °C, absorbance was measured at 544 nm with a UV/Vis spectrophotometer. Results expressed as mg diosgenin equivalents per g.

The detailed outlined for determining the alkaloids, and steroids has been reported by (Oloruntola and Ayodele 2022). Alkaloid content was quantified using the gravimetric method as described by (Adeniyi et al., 2009). Briefly, 5 g of sample was macerated in 50 mL of 10% (w/v) acetic acid in ethanol, agitated, and left to stand for 240 min before filtration. The filtrate was concentrated on a hot plate to approximately one-quarter of its original volume, after which concentrated ammonium hydroxide was added dropwise to precipitate the alkaloids. The precipitate was collected by filtration, washed with 1% ammonium hydroxide, oven-dried at 60 °C for 30 min, cooled in a desiccator, and weighed to a constant mass. Alkaloid content was expressed as a percentage of the sample weight.

Steroidal content was analyzed following the method of (Madhu et al., 2016). One milliliter of test extract was transferred into a 10 mL volumetric flask, followed by the sequential addition of 2 mL of 0.5% (w/v) $FeCl_3$, 2 mL of 4 N H_2SO_4, and 0.5 mL of 0.5% (w/v) potassium hexacyanoferrate (III). The mixture was heated in a water bath at 70 °C for 30 min with intermittent stirring, diluted to volume with distilled water, and the absorbance measured at 780 nm against a reagent blank.

The vitamin C content of the sample was determined according to the procedure of (Benderitter et al., 1998). Briefly, 500 µL of the extract mixture was prepared by combining 300 µL of appropriately diluted sample extract with 100 µL of 13.3% (v/v) trichloroacetic acid and water. To this mixture, 75 µL of DNPH reagent [composed of 2 g dinitrophenylhydrazine, 270 mg $CuSO_4 \cdot 5H_2O$, and 230 mg thiourea dissolved in 100 mL of 5 mL/L H_2SO_4] was added. The reaction mixture was incubated at 37 °C for 3 h, followed by the addition of 0.5 mL of 65% (v/v) H_2SO_4. Absorbance was then measured at 520 nm using a UV–visible spectrophotometer, and the vitamin C concentration of the sample was quantified using ascorbic acid as the standard.

The 2,2'-Azino-Bis-3-Ethylbenzothiazoline-6-Sulfonic Acid (ABTS) radical scavenging activity was evaluated following (Turkoğlu et al., 2010 and Özgen et al., 2006). The $ABTS^+$ radical cation was generated by reacting ABTS with potassium persulfate in 20 mM sodium acetate buffer (pH 4.5) to yield an absorbance of 0.700 ± 0.01 at 734 nm. A mixture of 1 mL $ABTS^+$ solution and 3 mL extract (100 µg/mL in ethanol) was incubated for 30 min at room temperature, after which absorbance was measured at 734 nm. Radical scavenging activity (%) was calculated as (Acontrol – Asample)/Acontrol×100, where Acontrol and Asampleare the absorbance of the control and test solution, respectively.

The ferric reducing antioxidant power (FRAP) assay was performed as described by Benzie and Strain (1996). The FRAP reagent was prepared by mixing 300 mM acetate buffer (pH 3.6), 10 mM TPTZ in 40 mM HCl, and 20 mM $FeCl_3 \cdot 6H_2O$ in a 10:1:1 ratio and prewarmed to 37 °C. For the assay, 3.995 mL of freshly prepared FRAP reagent was mixed with 5 µL of the appropriately diluted sample extract. After incubation at 37 °C for 30 min, the reduction of the Fe^{3+}–TPTZ complex to the Fe^{2+}–TPTZ form was monitored by measuring absorbance at 593 nm against a reagent blank (3.995 mL FRAP reagent + 5 µL distilled water). A calibration curve was constructed using $FeSO_4$, and results were expressed as mg Trolox equivalents per gram of sample.

The inhibition of lipid peroxidation was assessed according to the method of (Bajpai et al. 2015). The reaction mixture consisted of 1 mM $FeCl_3$, 50 µL bovine brain phospholipids (5 mg/L), and 1 mM ascorbic acid in 20 mM phosphate buffer (pH 7.4), incubated at 37 °C for 60 min in the presence or absence of sample extracts (50–250 µg/mL) or a reference compound. Lipid peroxidation was quantified by measuring malondialdehyde (MDA) formation using the thiobarbituric acid (TBA) reaction. The percentage inhibition of lipid peroxidation was calculated as:

$$\text{Inhibition} = \frac{A\ control - A\ test}{A\ control} x\ 100$$

Where A control is the absorbance of the control reaction, and A test is the absorbance of the test reaction.

2.6 Enzyme inhibitory and anti-inflammatory activities

2.6.1 Alpha-amylase inhibitory activity

The α-amylase inhibitory activity of the extract was evaluated using the 3,5-dinitrosalicylic acid (DNSA) method as described by (Wickramaratne et al., 2016). The extract, pre-dissolved in at least 10% dimethylsulfoxide (DMSO), was diluted with phosphate buffer (0.02 M Na_2HPO_4/NaH_2PO_4, pH 6.9, containing 0.006 M NaCl) to obtain concentrations ranging from 10 to 1000 µg/mL. A reaction mixture containing 200 µL of extract and 2 mL of α-amylase solution was incubated at 30 °C for 10 min, followed by the addition of 200 µL of 1% (w/v) soluble starch solution. After 3 min of incubation, the reaction was terminated by adding 200 µL of DNSA reagent (12 g sodium potassium tartrate tetrahydrate in 8 mL of 2 M NaOH and 20 mL of 96 mM DNSA solution), and the mixture was boiled in a water bath (85–90 °C) for 10 min. The samples were cooled to room temperature, diluted with 5 mL distilled water, and the absorbance was measured at 540 nm using a UV–Visible spectrophotometer. A control reaction containing buffer instead of extract represented 100% enzyme activity, while extract blanks without enzyme were included to correct for background absorbance. Acarbose (100–200 µg/mL) was used as a positive control. The percentage inhibition of α-amylase activity was calculated using the formula:

$$\%\ \alpha - \text{amylase inhibition} = 100\ x \frac{Abs\ 100\%\ Control - Abs\ Sample}{Abs\ 100\%\ Control}$$

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2.6.2 Alpha-glucosidase inhibitory activity

The α-glucosidase inhibitory activity of the extracts was determined according to the method with slight modifications. In a 96-well plate, 50 µL of 10 mM phosphate buffer (pH 7.0) containing 0.2 mg/mL sodium azide and 2 mg/mL bovine serum albumin was mixed with 1 U/mL of Saccharomyces cerevisiae α-glucosidase (Type I, lyophilized powder, Sigma, EC 3.2.1.20) and 50 µL of sample solution (8 mg/mL) (Dej-adisai and Pitakbut 2015). A 5% DMSO solution served as the negative control, while acarbose (8 mg/mL) was used as a positive control. After pre-incubation at 37 °C for 2 min, 50 µL of 4 mM p-nitrophenyl-D-glucopyranoside (pNPG) was added as substrate, and the reaction mixture was incubated for a further 5 min under the same conditions. The release of p-nitrophenol (pNP) was monitored at 405 nm using a microplate reader, with absorbance recorded every 30 s for 5 min. The reaction velocity (V) was calculated from the linear relationship between absorbance and time, and the percentage inhibition was determined using the formula:

$$\% \text{ Inhibition} = \frac{Vcontrol - V\ sample}{Vcontrol}\ x\ 100$$

where V control is the velocity of the control and V sample is the velocity of the test sample.

2.6.3 Lipase inhibition activity

The lipase inhibitory activity of the samples was evaluated according to the method of (Ambigaipalan et al., 2017), with modifications by (Fathi et al., 2021). Briefly, lipase (5 mg) was dissolved in 1 M Tris-HCl buffer (pH 8.5). Test samples (100 µL; 0.2–1 mg/mL) were mixed with an equal volume of lipase solution and 4 mL of Tris-HCl buffer, followed by incubation at 37 °C for 25 min. The reaction was initiated by adding 100 µL of the substrate (5 mM palmitate in dimethyl sulfoxide:ethanol, 1:1 v/v), and the mixture was further incubated at 37 °C for 25 min. Absorbance was measured at 412 nm using a microplate reader (BioTek, Winooski, Vermont, USA). Lipase inhibitory activity (%) was calculated using the formula:

$$\% \text{ Inhibition} = \frac{As - Asb}{Ac - Acb}\ x\ 100$$

Where As, Asb, Ac and Acb represent the absorbance of the sample, sample blank, control, and control blank, respectively. Control and blank reactions were prepared under the same conditions, excluding the enzyme or inhibitor as appropriate.

2.6.4 Anti-proteinase activity

Proteinase inhibitory activity was determined according to the method with slight modifications (Rajesh et al., 2019). The reaction mixture (2 mL) contained 1 mL of 20 mM Tris-HCl buffer (pH 7.4), 0.06 mg of trypsin, and 1 mL of the test sample at different concentrations (100–500 µg/mL). The mixture was incubated at 37 °C for 5 min, followed by the addition of 1 mL of 0.8% (w/v) casein as substrate. After a further incubation at 37 °C for 20 min, the reaction was terminated by adding 2 mL of 70% perchloric acid. The mixture was centrifuged, and the absorbance of the supernatant was measured at 210 nm against a buffer blank. All assays were performed in triplicate. The percentage inhibition of proteinase activity was calculated as:

$$\% \text{ Inhibition} = \frac{Acontrol - Asample}{Acontrol}\ x\ 100$$

Where Acontrol and Asample represent the absorbance of the control and test samples, respectively.

2.6.5 Protein Denaturation Inhibition Assay

The assay was carried out according to the procedure described by (Osman et al., 2016). Ibuprofen and diclofenac were used as positive standards and prepared at a concentration of 0.1% (1.0 mg/mL), along with the seed extracts. Each reaction mixture contained 1000 µL of the test extract, 1400 µL of phosphate-buffered saline (PBS), and 200 µL of egg albumin. Distilled water served as the negative control in place of the extract. The mixtures were incubated at 37 °C for 15 minutes, followed by heating at 70°C for 5 minutes. After cooling, absorbance was measured at 660 nm. The percentage inhibition of protein denaturation was calculated using the following equation:

$$\% \text{ Denaturation inhibition} = \left(1 - \frac{Absorbance\ of\ test\ sample}{Absorbance\ of\ negative\ control}\right)\ x\ 100$$

2.7 Statistical analysis

All assays were performed in triplicate, and the results were expressed as mean ± standard deviation (SD). Data were analyzed using one-way analysis of variance (ANOVA), followed by Duncan's multiple range test to determine significant differences among treatments. Differences were considered statistically significant at $p < 0.05$.

3. Results

3.1 The proximate composition

The proximate composition of *O. gratissimum* and *O. basilicum* leaves is presented in Figure 1. Significant ($p < 0.05$) differences were observed across most parameters. The moisture content of *O. gratissimum* (6.32 ± 0.11%) was markedly higher than that of *O. basilicum* (1.05 ± 0.01%). Crude fat was also higher in *O. gratissimum* (6.78 ± 0.12%) compared to *O. basilicum* (5.35 ± 0.09%). In contrast, crude ash was significantly higher in *O. basilicum* (16.89 ± 0.30%) than in *O. gratissimum* (8.44 ± 0.15%). A similar trend was observed for crude fibre, with O. basilicum recording 26.46 ± 0.46% compared to 17.30 ± 0.31% in *O. gratissimum*. Crude protein contents were comparable between the two species (4.39 ± 0.01% in *O. gratissimum* and 4.40 ± 0.01% in *O. basilicum*), with no significant difference ($p > 0.05$). However, the nitrogen-free extract (NFE) was significantly higher in *O. gratissimum* (56.74 ± 0.14%) relative to *O. basilicum* (45.82 ± 0.08%). Overall, *O. gratissimum* exhibited higher concentrations of moisture, crude fat, and nitrogen-free extract, while *O. basilicum* was richer in crude ash and crude fibre.

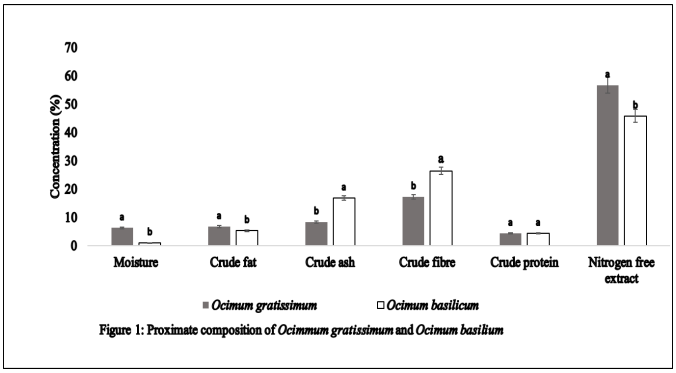

Figure 1: Proximate composition of *Ocimmum gratissimum* and *Ocimum basilium*

3.2 Phytochemical composition

The phytochemical composition of *Ocimum gratissimum* and *Ocimum basilicum* is presented in Figure 2. Significant ($p < 0.05$) differences were observed between the two species across several parameters. *O. basilicum* contained higher tannin (10.04±0.17 mg/g) and alkaloid (4.23±0.08 %) concentrations than *O. gratissimum* (8.41±0.14 mg/g and 2.11±0.04%, respectively). Conversely, *O. gratissimum* exhibited markedly higher saponin (78.99±1.33 mg/g) and phenol (18.12±0.30 mg GAE/g) contents compared with *O. basilicum* (60.48±1.02 mg/g and 13.97±0.23 mg GAE/g, respectively). Flavonoid levels of *O. basilicum* (1.01±0.17 mg QE/g) were significantly ($P<0.05$) higher than those of *Ocimum gratissimum* (0.89±0.02 mg QE/g). Steroid concentrations were higher in *O. basilicum* (0.87±0.01 mg/g) compare to 0.73±0.011 mg/g in *O. gratissimum*.

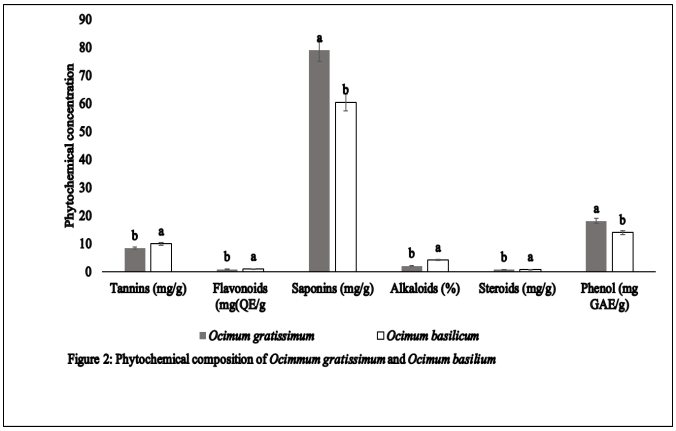

Figure 2: Phytochemical composition of *Ocimmum gratissimum* and *Ocimum basilium*

3.3 Vitamin C and antioxidant activities

The vitamin C composition and antioxidant activities of *Ocimum gratissimum* and *Ocimum basilicum* are shown in Figure 3. Significant ($p < 0.05$) differences were observed between the two species for some of the measured parameters. *O. basilicum* exhibited a slightly higher vitamin C content (1.04±0.02 mg/g) than *O. gratissimum* (0.68±0.0 mg/g). No significant difference ($p > 0.05$) was observed in ABTS radical scavenging

activity. For DPPH scavenging activity, *O. gratissimum* recorded a significantly higher activity (60.65±0.67 %) than *O. basilicum* (57.60±0.72%). The FRAP was generally low in both species, with no significant (P>0.05) difference. In contrast, lipid peroxidation inhibition (LPI) was significantly higher in *O. basilicum* (53.88±0.78%) compared with *O. gratissimum* (20.94±1.34%).

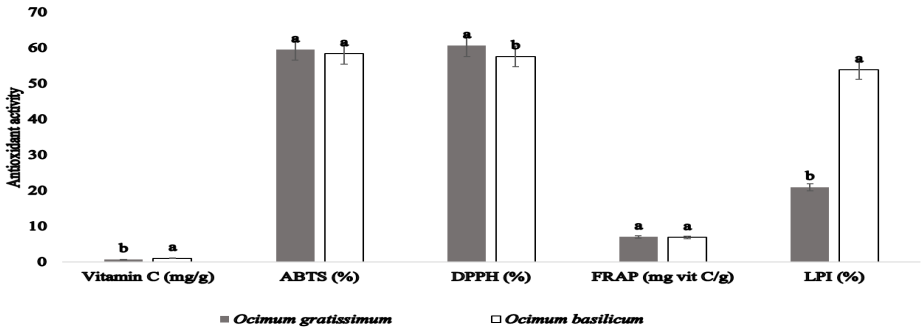

Figure 3: Vitamin c composition and antioxidant activities of *Ocimmum gratissimum* and *Ocimum basilium*
ABTS:2,2'-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid)
FRAP: Ferric reducing antioxidant power
LPOI: Lipid peroxidation inhibition

3.4 Enzyme inhibitory and anti-inflammatory activities

The enzyme inhibitory and anti-inflammatory activities of *Ocimum gratissimum* and *Ocimum basilicum* leaves are presented in Table 1. Significant ($p < 0.05$) variations were observed between the two species across all tested parameters. O. basilicum exhibited significantly higher α-amylase (20.10±1.34%) and lipase (66.55±0.61%) inhibitory activities compared with *O. gratissimum* (11.32±1.5% and 19.82±1.02%, respectively). In contrast, *O. gratissimum* demonstrated greater α-glucosidase (43.37±0.95%) and protease (91.75±0.14%) inhibitory activities relative to O. *basilicum* (39.98±1.01% and 79.66±0.34%, respectively). With respect to albumin denaturation inhibition, an indicator of anti-inflammatory potential, *O. gratissimum* showed a higher activity (10.48±0.66%) than *O. basilicum* (8.39±0.7%).

Table 1: Enzyme inhibitory and anti-inflammatory activities of *Ocimum gratissimum* and *Ocimum basilicum* leaf

Sample	α-Amylase inhibition	α-Glucosidase inhibition	*Lipase inhibition*	*Protease inhibition*	Albumin denaturation inhibition
Ocimum gratissimum leaf	11.32[b]	43.37[a]	19.82[b]	91.75[a]	10.42[a]
Ocimum basilium leaf	20.10[a]	39.98[b]	66.55[a]	79.66[b]	8.39[b]
SEM	2.03	0.83	10.45	2.71	0.53
P value	0.01	0.01	0.01	0.01	0.02

3.5 Enzyme Inhibitory and Anti-Inflammatory Activities

The enzyme inhibitory and anti-inflammatory activities of *Ocimum gratissimum* and *Ocimum basilicum* leaves are presented in Table 1. The α-amylase inhibitory activity was significantly higher ($p = 0.01$) in O. basilicum leaf (20.10±1.35%) compared with *O. gratissimum* leaf (11.32±1.5%). Conversely, α-glucosidase inhibition was greater ($p = 0.01$) in *O. gratissimum* leaf (43.37±0.95%) than in *O. basilicum* leaf (39.98±1.01%).

For lipase inhibition, *O. basilicum* leaf exhibited markedly higher activity (66.55±0.61%) than *O. gratissimum* leaf (19.82±1.01), with a significant difference ($p = 0.01$). In contrast, protease inhibition was significantly higher ($p = 0.01$) in *O. gratissimum* leaf (91.75±0.13%) relative to *O. basilicum* leaf (79.66±0.35). Regarding albumin denaturation inhibition, *O. gratissimum* leaf (10.48±0.66%) showed higher activity compared with *O. basilicum* leaf (8.40±0.7%), and this difference was statistically significant ($p = 0.02$). Overall, the results indicate that *O. basilicum* leaf exhibited stronger α-amylase and lipase inhibitory activities, while *O. gratissimum* leaf demonstrated superior α-glucosidase, protease, and albumin denaturation inhibitory activities.

3. Discussion

The higher moisture, crude fat, and nitrogen-free extract content observed in *O. gratissimum* suggests a greater energy value and lipid-soluble nutrient reservoir compared with *O. basilicum*. The relatively higher crude ash and crude fiber contents in *O. basilicum* are nutritionally relevant, as crude ash reflects the mineral density of plant materials (Giménez-Berenguer et al., 2025), while dietary fiber is linked to gastrointestinal health, glycemic regulation, and prevention of chronic metabolic disorders (Ayessou et al., 2020). The comparable crude protein levels in both species further support their value as complementary protein sources in human diets.

Phytochemicals serve as the bioactive constituents underlying many nutraceutical benefits (Oloruntola et al., 2022). The significantly higher tannin and alkaloid levels in *O. basilicum* may contribute to its astringent, antimicrobial, and anti-diabetic properties (Zhakipbekov et al., 2024). Conversely, the higher saponin and phenolic contents in O. gratissimum underscore its antioxidant, cholesterol-lowering, and immunomodulatory potential (Igbinosa et al., 2013; Timilsena etal., 2023). The higher flavonoid concentration in *O. basilicum* suggests additional antioxidant and anti-inflammatory benefits, as flavonoids are well-recognized free-radical scavengers and enzyme modulators (Zahra et al., 2024). The observed variation in steroid concentrations also points to possible roles in membrane stabilization and hormonal regulation (Janeczko, 2021).

Vitamin C, a potent water-soluble antioxidant, was slightly higher in *O. basilicum*, suggesting its superiority in ascorbic acid-linked health benefits, including collagen synthesis and immune modulation (Padayatty et al., 2021). However, both species demonstrated strong radical-scavenging properties. The higher DPPH scavenging activity in O. gratissimum reflects its efficiency in donating hydrogen atoms to neutralize free radicals, which is consistent with its high phenolic and saponin content (Moneme et al., 2025). In contrast, *O. basilicum* exhibited greater lipid peroxidation inhibition, an important marker of membrane protection against oxidative stress (Valgimigli, 2023). Since lipid peroxidation is implicated in aging, inflammation, and degenerative diseases, *O. basilicum* may offer more direct protection against lipid-derived radicals in biological systems (Yang et al., 2024).

The enzyme inhibitory assays highlight the differential potential of the two species in metabolic regulation (Ramsay et al., 2017). The stronger α-amylase and lipase inhibitory activities of *O. basilicum* suggest its utility in controlling postprandial hyperglycemia and hyperlipidemia, which are key therapeutic targets in diabetes and obesity management (Noor et al., 2019). On the other hand, the higher α-glucosidase and protease inhibitory activities of *O. gratissimum* emphasize its role in slowing carbohydrate digestion and in protein stabilization (Hossain et al., 2020). By delaying glucose absorption, *O. gratissimum* could contribute to improved glycemic control, while protease inhibition may have

implications in inflammatory regulation and digestive modulation (Vergnolle, 2016).

Protein denaturation is a validated marker of anti-inflammatory activity (Gonfa et al., 2023). The significantly higher albumin denaturation inhibition observed in *O. gratissimum* suggests superior anti-inflammatory potential compared with *O. basilicum*. This aligns with its higher phenolic and saponin content, as these compounds are known to modulate inflammatory signaling pathways and cytokine responses (Hernández-Ruiz et al., 2025). Such activity highlights the therapeutic relevance of *O. gratissimum* in managing inflammation-associated chronic diseases, including arthritis, metabolic syndrome, and cardiovascular disorders.

Taken together, *O. basilicum* appears more promising in the regulation of carbohydrate and lipid metabolism due to its high α-amylase and lipase inhibitory activities, along with strong lipid peroxidation inhibition. These properties position *O. basilicum* as a potential dietary adjunct for diabetes and obesity management. In contrast, *O. gratissimum* demonstrates superior antioxidant (via DPPH scavenging), α-glucosidase and protease inhibition, and anti-inflammatory activities, underscoring its broader potential in oxidative stress mitigation and inflammation control. Therefore, the distinct bioactive profiles of both species highlight their complementary nutraceutical values, suggesting that dietary incorporation of both may provide synergistic benefits for metabolic and inflammatory health.

4. Conclusion And Recommendation

Ocimum gratissimum and *Ocimum basilicum* exhibited distinct nutraceutical potentials. *O. gratissimum* showed higher antioxidant, α-glucosidase, protease, and anti-inflammatory activities, while *O. basilicum* demonstrated stronger α-amylase, lipase, and lipid peroxidation inhibition. These findings suggest that *O. gratissimum* may be more useful in managing oxidative stress and inflammation, whereas *O. basilicum* holds promise for glycemic and lipid regulation. Both species are recommended as potential nutraceutical ingredients, either individually or in combination, and further in vivo studies are needed to validate their health-promoting effects.

Data Availability

The data sets generated during and/or analysed during the current study are available from the corresponding author upon reasonable request.

Conflict Of Interest

The authors declare that they have no conflict of interest.

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