International Journal of Innovations & Research Analysis (IJIRA)
ISSN :2583-0295, Impact Factor: 6.238, Volume 04, No. 03(I), July - September, 2024, pp 41-51

PROXIMATE ANALYSIS OF CLOVE AND MORINGA SEEDS AND EVALUATION OF THEIR OILS FOR ANTIOXIDANT AND ANTIMICROBIAL ACTIVITY

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ABSTRACT

The current study shows proximate analysis of Syzgium aromaticum (clove) and Moringa oleifera (Moringa) seeds; wherein, carbohydrates, protein, lipids, ash and fibre in clove seeds was 471.38 mg/g.dw, 219.53 mg/g.dw, 217 mg/g.dw, 14.6 mg/g.dw and 21 mg/g.dw while in moringa seeds was 492.32 mg/g.dw, 214.06 mg/g.dw, 114 mg/g.dw, 48.8 mg/g.dw and 20 mg/g.dw respectively. Furthermore, GC-MS analysis of Moringa oleifera (moringa) oil revealed presence of 14 different essential fatty acids whereas Syzgium aromaticum (clove) oil revealed presence of 18 different phytocompounds. Furthermore, the findings demonstrate that clove and moringa oil have the same total phenolic and total flavonoid levels (TPC and TFC), with higher value of both TPC and TFC in clove oil (24.56 mg/g.dw GE and 6.55 mg/g.dw QE) in comparison to Moringa oil (9.13 mg/g.dw GE and 3.15 mg/g.dw QE). Furthermore, the potent antibacterial as well as antifungal efficacy of both clove oil and moringa oil against E. coli, S. aureus, A. nigerand P. chrysogenum, concluded that clove oil has a greater level of antibacterial and antifungal effectiveness.

Keywords: *Syzgium Aromaticum, Moringa Oleifera, TPC, TFC, Antioxidant, Antibacterial, Antifungal.*

Introduction

Plants are endowed with the capacity for photosynthetic reactions and provide much needed oxygen to different lifeforms on earth, thereby aiding in sustenance of several lifeforms and contributing to perpetuation of life on earth. In addition to this, plants also cater to the nutritional needs of other components of the ecosystem by providing essential nutrients as well as minerals. Based on these two traits, plant have rightly been termed as primary producers owing to their ability to fulfil the incessant nutritional as well as other demands of mankind (Vezzani *et al.,* 2018; Solbrig, 1994).

In order to evade the attack by obnoxious pathogens which aim to obliterate plant growth and development through their nefarious means, plants have evolved a complex defence system comprising of a perfectly orchestrated biomolecule. These bioactive secondary metabolites include phenolics, flavonoids, terpenes, coumarins, tannins and several other bioactive secondary metabolites. The complex yet effective signalling involving these bioactive molecules aids in strengthening of plant immune system and shields them from malicious phytopathogen attacks. However, these bioactive compounds' defense mechanism makes them efficient even against dangerous pathogens that pose a threat to human survival, such as pathogenic bacteria and fungi (Hussein *et al.,* 2019; Kaushik *et al.*, 2021; Bhatti *et al.,* 2022).

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Thus, a plethora of research has indicated the potential utility of plant extracts and essential oils in managing illness caused by detrimental bacterial and fungal germs. In light of the chaotic state of antibiotic resistance, the scientific and medical communities have experienced a profound sense of relief from the antibacterial action of essential oils and phytochemicals produced from plants, Because of this, we have practically run out of antimicrobials and must find newer therapeutic agents to contain strains of bacteria that are resistant to antibiotics. In addition to these, plant-based therapeutics are safer to use and environment friendly, which is an added benefit, considering the widespread concerns about environmental degradation of antibiotics (Yeshi *et al.,* 2022; Wink *et al.*, 2012; Sharma *et al*., 2012).

This is why the current study, which focuses on the pharmacological characteristics and health advantages of two significant seeds—*Syzgium aromaticum*, or clove, and *Moringa oleifera*, or moringa seeds—has been meticulously designed. The researchers have shown rich nutritional composition of both these seeds by performing their proximate analysis showing presence of carbohydrates, lipids, proteins, ash and fibre in the both the seeds. Additionally, GC-MS research reveals that the oil from both seeds has been shown to contain various additional phytocompounds that function as antibacterial, anti-inflammatory, hypolipidemic, and antioxidant molecules, in addition to a number of important fatty acids. In addition, both clove and moringa oil have been demonstrated to contain important bioactive secondary metabolites, phenolics and flavonoids, which contribute to antioxidant activity of oils. It was observed that clove oil has a higher level of phenolics and flavonoids, together with antioxidant potential. Additionally, it has been shown that both moringa and clove oil have strong antibacterial and antifungal properties against E. coli, S. aureus, A. niger, and P. chrysogenum. However, clove oil exhibits stronger antibacterial and antifungal properties.

Materials and Methods

Proximate Analysis

- **Lipid**

The total lipid was calculated using a slightly modified Folch *et al.,* (1957) method. Five grams of the ground material were suspended in 50 milliliters of a mixture of chloroform and methanol (2:1 v/v), well mixed, and left for three days. Filtering the solution and centrifuging it at 1000 g were done using a table centrifuge. Using a Pasteur pipette, the top layer of methanol was removed, and heating caused the chloroform to evaporate. The crude lipid was all that was left.

- **Protein**

A 5-gram ground sample was combined with 50 milliliters of 0.1 N NaOH and allowed to boil for 30 minutes. A DSC-200T tabletop centrifuge was used to centrifuge the solution at 1000 × g after it had cooled to ambient temperature. Using the method described by Lowry *et al.* (1951), the total protein content of the supernatant was ascertained.

- **Ash**

One-gram crucible containing the sample was carefully weighed. After heating the crucible on a low flame until all of the material was burned, it was placed on a clay pipe triangle and baked in a muffle furnace for five to six hours at 600 degrees Celsius. Weighing was done after allowing it to cool in a desiccator. In order to verify that the ashing was finished, the crucible was heated for an hour in the muffle furnace, cooled, and then weighed. The two subsequent weights were equal when this process was completed and the ash had almost turned white or grayish white in color (Raghuramulu*et al.,* 2003).

The total amount of ash was then determined using the following formula:

Ash content (g/100 g sample) = weight of ash × 100/weight of sample taken.

- **Fiber**

200 milliliters of boiling 0.255 N H2SO4 were added to a beaker that held ten grams of moisture- and fat-free material. Throughout the thirty minutes that the combination was heated to a boil, water was added frequently to keep the mixture's volume constant. Using hot water, the residue was cleansed until it was free of acid after the combination was run through a muslin cloth filter. After that, 200 milliliters of boiling 0.313 N NaOH were added to the material in the same beaker. When the mixture was filtered through a muslin cloth after 30 minutes of boiling (keeping the volume constant), the residue was cleaned with ether, alcohol, and hot water until all the alkali was removed.

After that, it was moved to a crucible, dried at 80–100 degrees Celsius for the entire night, and weighed (We) using an electric balance (Keyi: JY-2003; China). The crucible was cooled and weighed once again (Wa) following its six-hour heating to 600°C in a muffle furnace.

The weight of crude fiber is represented by the difference in weights (We-Wa).

Crude fiber (g/100 g sample) = [100 − (moisture + fat)] × (We-Wa)/Wt of sample (Raghuramulu et al., 2003).

- **Carbohydrate**

20 milliliters of 80% ethanol were macerated with a 50 mg sample of dried plant material in a mortar and pestle for a whole night.Each homogenate was centrifuged at 1200 rpm for 15 minutes, and the supernatants were gathered and concentrated on a water bath. Subsequently, 50 milliliters of water were added to each concentration before processing. To determine the total quantities of carbohydrates in each test sample, aliquots (1 ml) were employed along with the phenol-H2SO4 reagent and a regression curve constructed for standardization with glucose.

A glucose stock solution (1 mg/ml) was prepared, and 0.1 to 0.8 ml of the solution was pipetted into test tubes. Distil water was then used to increase the volume of each test tube to 1 ml. Each was put into an ice chest with 1 ml of 5% phenolic aqueous solution, and the mixture was gently shaken. Following that, 5ml of concentrated H_2SO_4 was added right away while being stirred slightly. The ODs of the yellow-orange colour so obtained at 490 nm were assessed in a spectrophotometer with 100 percent transmission against the blank after 20 minutes in a water bath at 30^0C (It was formed by replacing the sugar solution with pure water). Three replicates from each group's mean values were calculated. A regression curve between the relevant OD and the known concentration was made using Beer's Law.

The standard glucose regression curve was used to obtain the soluble sugar concentration values in test samples.

- **Flavonoids:** To find the total flavonoid concentration, the aluminum chloride colorimetric test was utilized. Four milliliters of distilled water and one milliliter of extract make up the reaction mixture in a ten milliliter volumetric flask. Following the addition of the beaker of 0.30 milliliters of 5% sodium nitrite and waiting five minutes, 10% aluminum chloride was mixed with 0.3 milliliters. After being exposed to 1M sodium hydroxide for 5 minutes, distilled water was used to dilute 2 ml of the solution to 10 ml. Following the previously mentioned procedure, an array of quercetin-containing reference standard solutions (20, 40, 60, 80, and 100 µg/ml) were created. Absorbance was measured at 510 nm in relation to the reagent blank for the test and standard solutions using a UV/Visible spectrophotometer.In milligrams of QE per gram of extract, the total flavonoid concentration was stated (Kaviarasan et al., 2007; Hanane et al., 2010).
- **Total phenols:** The spectrophotometric approach was used to determine the amount of phenolics present in plant extracts. Total phenol content was ascertained using the Folin-Ciocalteu test technique. 9 ml of distilled water and 1 ml of extract make up the reaction mixture in a volumetric flask (25 ml). Following its addition to the blend, one milliliter of Folin-Ciocalteu phenol reagent was thoroughly shaken. Five minutes later, the liquid was mixed with ten milliliters of a 7% sodium carbonate (Na2CO3) solution. There was a 25 ml increase in volume. As previously mentioned, a series of standard gallic acid solutions (20,40, 60, 80, and 100 µg/ml) were made. When the test and standard solutions were incubated for 90 minutes at room temperature, the absorbance of each at 550 nm in proportion to the reagent blank was measured using an ultraviolet (UV)/visible spectrophotometer. GAE/gm of extract was used to express the total phenol content (Ghasemzadeh et al., 2010; Rasool et al., 2011).
- **Phytosterols:** Plant materials were put in a thimble holder and then placed in a distillation flask during the Soxhlet extraction process. The desired solvent is put into the distillation flask. The solution in the thimble holder is inhaled and syphoned back into the distillation flask when the solvent reaches the overflow level. The extract was introduced into the main liquid via the solution. Extracted solutes are stored in the distillation flask, and the new solvent was returned to the plant material's thimble container. Up till the extraction was finished, this process was repeated. The Soxhlet extraction technique should be used to extract the desired chemicals, and a suitable solvent was selected. The yield was quantified.

Antioxidant Activity by DPPH Assay

For determination of DPPH radical scavenging potential of the extracted samples 1,1-diphenyl 2-picryl-hydrazil (DPPH) method proposed by Alothman*et al*., (2009) was applied. The mixing of 100 µl aliquot form samples was done in 3.9 ml taken from 0.1 mM DPPH (methanolic) solution. Then blend was subjected to vortex and left for incubation in the dark for 30 min. Its OD was calculated at 515 nm while methanol was used as blank.

Using the formula = ($Ab_{control}$ – Ab_{sample} / $Ab_{control}$) × 100, the radical scavenging activity was calculated.

Where the absorbance of the DPPH solution with sample is indicated by Ab_{sample}, and $Ab_{control}$ is displaying the absorbance of the DPPH solution.

Linear plot of concentration versus % inhibition was plotted and by this IC_{50} values were determined. The antioxidant potential of each extract was showed in form of IC_{50} (stated as the quantity of concentration necessary to prevent DPPH radical development by 50%), find out with the help of inhibition curve.

Antimicrobial Activity

- **Antibacterial Assay**

The well diffusion method was used to assess the extracted oils' antibacterial activity (Irobi*et al*., 1994). Bacterial strains were sub-cultured in Nutrient Agar and incubated at 37°C for 24 hours. A sterile cotton swab was then used to wipe the cultures onto petriplates containing nutritional agar. Poking holes onto the agar plates, each measuring 6 mm in diameter and 25-100 µl/ml of oil samples (diluted using DMSO) were loaded into wells. Each well's zone of inhibition was evaluated after the plates were incubated. To assess how well samples worked against the investigated microorganisms, streptomycin (30µg/ml) was employed as a control. By measuring the test sample's inhibition zone using an antibiotic medication, the activity index was computed.

- **Antifungal Assay**

The modified agar well diffusion method was used to test the antifungal potential (Bonjar*et al.,* 2005). The fungal strains, which were separately suspended in saline solution and seven days old, were inoculated into Petri plates with PDA media. For fifteen minutes, the plates were left to dry at room temperature. Using cork-borers, 6 mm-diameter wells were punched through the agar. A well-prepared distance control system was also in place. Dimethyl sulphoxide (DMSO) was used to dilute the various samples, and various quantities of each sample (ranging from 25 to 100 µl/ml) were also generated. The standard medication and all the other sample concentrations were sown into the wells of prearranged Petri plates. The seeded plates were incubated for 48 hours at 28°C. Next, the diameter of IZ (in mm) was determined to determine the antifungal activity. Every experiment was conducted three times, and the mean value was determined. The standard control for determining antifungal activity was ketokenazole (30µg/ml). In addition to the inhibitory zone, the activity index (AI) was computed.

Results

- **Proximate analysis of *Syzgium aromaticum* (clove) and *Moringa oleifera* (moringa) seeds**

The results in Table 1, its corresponding table and picture show proximate analysis of the clove and moringa seeds by analysing several parameters such as, carbohydrates, proteins, lipids, ash and fibre. The results show higher amount of proteins, lipids and fibre in clove seeds while moringa seeds were found to contain higher amount of carbohydrates and ash content. The content of carbohydrates, protein, lipids, ash and fibre in clove seeds was 471.38 mg/g.dw, 219.53 mg/g.dw, 217 mg/g.dw, 14.6 mg/g.dw and 21 mg/g.dw respectively. On the other hand, the content of carbohydrates, protein, lipids, ash and fibre in moringa seeds was 492.32 mg/g.dw, 214.06 mg/g.dw, 114 mg/g.dw, 48.8 mg/g.dw and 20 mg/g.dw respectively.

Table 1: proximate analysis of the selected seed samples.

Name of Plant Material	Carbs (mg/g.dw)	Protein (mg/g.dw)	Lipids (mg/g.dw)	Ash (mg/g.dw)	Fibers (mg/g.dw)
Clove seeds	471.38±6.08	219.53±7.34	217±29.42	14.6±4.20	21±6.85
Moringa seeds	492.32±18.85	214.06±10.81	114±14.47	48.8±4.73	20±2.87

- **GC-MS analysis of *Syzgium aromaticum* (clove) and *Moringa oleifera* (moringa) oil**

Oil was extracted from *Syzgium aromaticum* (clove) and *Moringa oleifera* (moringa) seeds and subjected to GC-MS analysis. GC-MS of *Moringa oleifera* (moringa) oil (Table 2) revealed presence of 14 different phytocompounds, namely, Myristic Acid, Palmitic Acid, Palmitoleic Acid, Stearic Acid, Oleic Acid, Linoleic Acid, Linolenic Acid, Arachidic Acid, Gandoleic Acid, Eicosandienoic Acid, Behenic Acid, Eruric Acid, Lignoceric Acid and Nervonic Acid. Eruric acid was found to be highest (49%) in comparison to other compounds (Figure 1).

Table 2: GCMS analysis of the extracted Moringa seed oil.

Name	RT	Area %
Myristic Acid	12.577	0.069
Palmitic Acid	14.398	2.592
Palmitoleic Acid	14.616	0.249
Stearic Acid	16.053	0.968
Oleic Acid	16.262	7.816
Linoleic Acid	16.729	14.566
Linolenic Acid	17.429	13.392
Arachidic Acid	18.128	0.803
Gandoleic Acid	18.428	5.348
Eicosandienoic Acid	19.110	0.893
Behenic Acid	21.230	1.225
Eruric Acid	21.776	49.396
Lignoceric Acid	26.207	0.646
Nervonic Acid	27.022	2.037

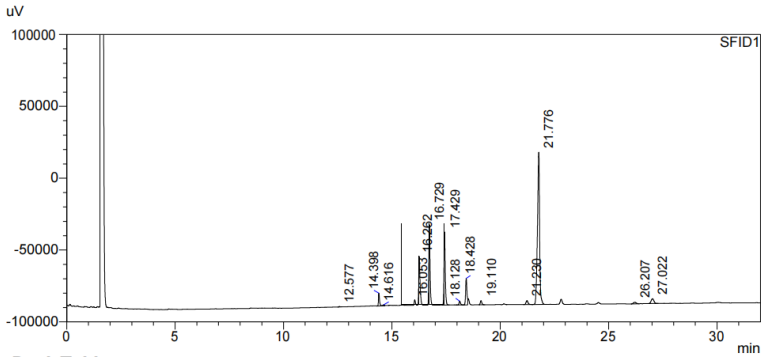


Figure 1: GCMS Spectra of Moringa Seed Oil

On the other hand, GC-MS of *Syzgium aromaticum* (clove) oil (Table 3) revealed presence of 18 different phytocompounds, namely, 2-heptanone, Alpha pinene, p-cymene, limonene+1,8 cineole, 2-heptyl acetate, Beta ocimene, 2-Nonanone, Linalool, Methyl salicylate, p-allyl phenol, eugenol, alpha-copaene, beta-caryophyllene, alpha-humulene, delta-cadinene, eugenyl acetate, caryophyllene oxide and 2 (12), 6, (13)-caryophyllen-dien-5-ol. Eugenol was found to be highest (87%) in comparison to other compounds (Figure 2).

Table 3: GC-MS Analysis of the Extracted Clove Oil

Compound	RT	% Area
Alpha pinene	0.63	0.05
p-cymene	2.35	0.15
Limonene	3.23	2.12
2-heptyl acetate	5.30	0.01
Beta ocimene	6.32	1.97
2-Nonanone	8.09	1.84
Linalool	10.12	3.14
Methyl salicylate	11.24	9.68
Myristic acid	12.44	10.91
Arachidic acid	18.16	13.71
Gandoleic acid	18.35	14.66
Eicosandienoic Acid	19.28	16.74
Behenic Acid	20.47	15.18
Eruric Acid	23.11	6.42
Lignoceric Acid	24.32	0.18
Nervonic Acid	27.31	1.12

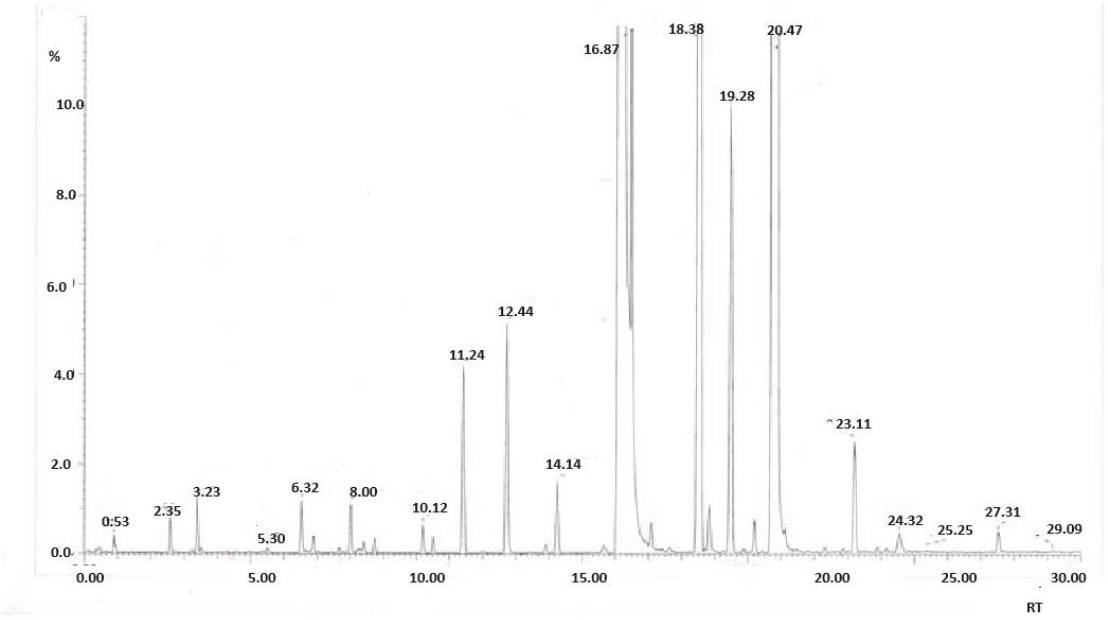


Figure 2: GC Spectra of Clove Oil

Assessment of Total phenolic content (TPC), Total flavonoid content (TFC), and antioxidant potential of *Syzgium aromaticum* (clove) and *Moringa oleifera* (moringa) oil

The results in table 4 and table 5 show Total phenolic content (TPC), Total flavonoid content (TFC) and antioxidant potential of *Syzgium aromaticum* (clove) and *Moringa oleifera* (moringa) oil . The results show in Table 4 shows higher TPC and TFC value in case of *Syzgium aromaticum* (clove) oil in comparison to *Moringa oleifera* (moringa) oil. Clove oil, Syzgium aromaticum, was discovered to have 24.56 mg/g.dw GE and 6.55 mg/g.dw GE of TPC and TFC, respectively. The TPC and TFC contents of Moringa oleifera (moringa) oil, on the other hand, were discovered to be 3.15 mg/g.dw GE and 9.13 mg/g.dw GE, respectively.

Table 4: TPC and TFC in the Selected Seed Samples

Name of plant material	TPC (mg/g.dwGE)	TFC (mg/g.dwQE)
Clove	24.561±4.0	6.55±1.58
Moringa seeds	9.13±0.36	3.15±0.30

Furthermore, antioxidant potential of *Syzgium aromaticum* (clove) and *Moringa oleifera* (moringa) oil was determined using DPPH free radical scavenging assay. The results in Table 5 of DPPH assay show higher DPPH free radical scavenging activity in case of *Syzgium aromaticum* (clove) oil at all the tested concentrations. At 50 ul, 100 ul, 150 ul, and 200 ul, respectively, the values of DPPH free radical scavenging activity for *Syzgium aromaticum* (clove) oil were determined to be 90.33%, 93.11%, 94.05%, and 95.06%. Furthermore, it was discovered that *Moringa oleifera* (moringa) oil had DPPH free radical scavenging activity values of 38.63%, 45.96%, 57.61%, and 69.57%, respectively.

Table 5 : DPPH Free Radical Scavenging Activity of the Extracted Oil

	% Free radical scavenging activity at given oil quantity			
	50 µl	100 µl	150 µl	200 µl
Clove oil	90.33±13.41	93.11±2.37	94.05±3.40	95.06±3.58
Moringa oil	38.63±2.78	45.96±4.62	57.61±7.61	69.57±7.16

Determination of antimicrobial activity of *Syzgium aromaticum* (clove) and *Moringa oleifera* (moringa) oil

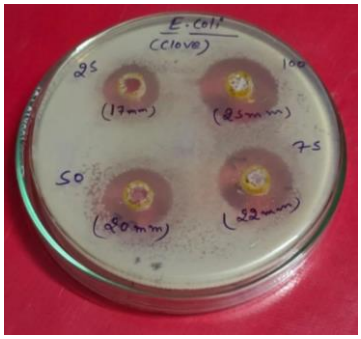
The antimicrobial efficacy of both *Syzgium aromaticum* (clove) and *Moringa oleifera* (moringa) oil was evaluated against two bacterial strains, namely*, E. coli* and *S. aureus*. The results show in table 6 that *Syzgium aromaticum* (clove) oil showed slightly high antibacterial activity against *E. coli;* with the

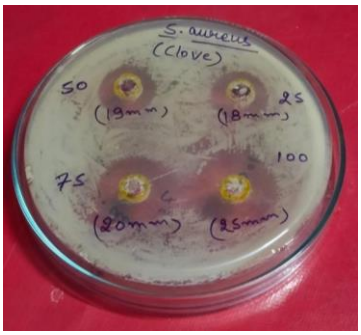
inhibition zone values of 17 mm, 20 mm, 22 mm and 25 mm at 25 ul, 50 ul, 75 ul and 100 ul concentrations respectively. However, the inhibition zone values against *E. coli* in case of *Moringa oleifera* (moringa) oil were found to be 18 mm, 19 mm, 20 mm and 22 mm at 25 ul, 50 ul, 75 ul and 100 ul concentrations respectively (Figure 3) . Similar results were obtained in case of *S. aureus,* where too, *Syzgium aromaticum* (clove) oil showed comparatively higher antibacterial activity, as evident from higher value of inhibition zones (18 mm, 19 mm, 20 mm and 25 mm) in contrast to lower values of inhibition zones in case of *Moringa oleifera* (moringa) oil (18 mm, 16 mm, 17 mm and 20 mm) at 25 ul, 50 ul, 75 ul and 100 ul concentrations respectively (Figure 3).

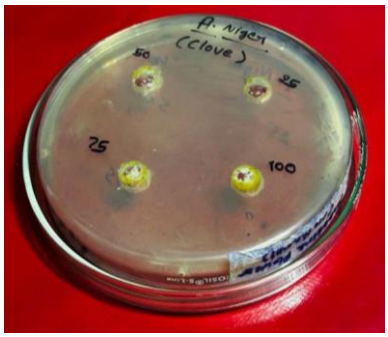
On a similar note, the antifungal efficacy of both *Syzgium aromaticum* (clove) and *Moringa oleifera* (moringa) oil was evaluated against two fungal strains, namely *Aspergillus niger*and *Penicillumchrysogenum.* The results in Table 6 and its corresponding graph as well as pictures show that *Syzgium aromaticum* (clove) oil completely inhibited the growth of both the fungal strains at all the concentrations tested. Furthermore, *Moringa oleifera* (moringa) oil showed meagre antifungal activity against both the fungal strains, as evident from small diameter of inhibition zones, lying in the range of 10 mm to 14 mm against both *Aspergillus niger*and *Penicillumchrysogenum* at the tested concentrations (Figure 3).

Table 6: Zone of Inhibition by the Extracted Oil

Quantity of the extracted oil	25 µl	50 µl	75 µl	100 µl
E. coli				
Clove oil	17	20	22	25
Moringa oil	18	19	20	22
S. aureus				
Clove oil	18 mm	19	20	25
Moringa oil	12	16	17	20
Aspergillus niger				
Clove oil	Growth was inhibited completely			
Moringa oil	10	11	12	13
Penicillumchrysogenum				
Clove oil	Growth was inhibited completely			
Moringa oil	10	11	12	14







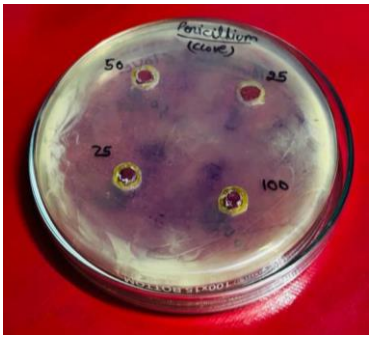


Figure 3: Antimicrobial Activity of Clove Oil and Moringa Oil

Discussion

The study shows high number of primary metabolites, including carbohydrates, lipids, proteins, ash and fibre in the both clove as well as moringa seeds. It is because of presence of these primary metabolites that both clove as well as moringa form an integral component of a healthy dietary regimen owing to their rich nutritional value. In addition to serving as crucial dietary source, all these primary metabolites serve important functions and contribute to plant growth and development. For instance, carbohydrates serve as energy source and act as structural components for plant cell wall biosynthesis. In addition, lipids serve as crucial components of plant cell walls while amino acids aid in nitrogen fixation and act as raw materials for nucleic acid and protein biosynthesis (Zaynab *et al.,* 2019; BOCSO*et al.,* 2022; Salam *et al.,* 2023).

Thereafter, the researchers showed presence of several important fatty acids, including, Myristic Acid, Palmitic Acid, Palmitoleic Acid, Stearic Acid, Oleic Acid, Linoleic Acid, Linolenic Acid, Arachidic Acid, Gandoleic Acid, Eicosandienoic Acid, Behenic Acid, Eruric Acid, Lignoceric Acid and Nervonic Acid in *Moringa oleifera* (moringa) oil. All these fatty acids fulfil several crucial functions in the plants such as:

- Myristic Acid aids in formation of lauric acid which exhibits potent antimicrobial properties and also aids in biosynthesis of myristoylated proteins, which aid in cell signalling (Legrand *et al.,* 2010).
- Palmitic Acid aids in biosynthesis of phospholipids and glycolipids (Carta *et al.*, 2017).
- Palmitoleic Acid, Stearic Acid, oleic acid, linoleic acid, linolenic acid and Arachidic acid act acts as important hypolipidemic, antioxidant and anti-inflammatory molecules (Watkins *et al.,* 2017).
- Also, as antioxidants and contributors to the formation of sphingolipids in the brain are Behenic Acid, Eruric Acid, Lignoceric Acid, and Nervonic Acid. (Namiecinska *et al.,* 2024).
- Furthermore, GC-MS of *Syzgium aromaticum* (clove) oil revealed presence of 16 different phytocompounds, namely, Alpha pinene, p-cymene, limonene, 2-heptyl acetate, Beta ocimene, 2-Nonanone, Linalool, Methyl salicylate, Myristic acid, Arachidic Acid, Gandoleic Acid, Eicosandienoic Acid, Behenic Acid, Eruric Acid, Lignoceric Acid and Nervonic Acid. A number of previous studies have reported several important functions of these biomolecules, which include:

- Alpha pinene, limonene, Beta ocimene, 2-Nonanone and Linalool exhibit insect-repellent, antibacterial, antifungal, analgesic, antioxidant and anti-inflammatory activity. In addition, most of the above-mentioned terpenes facilitate entry of other compounds across the biological membranes (Singh *et al.,* 2019).
- Owing to their antimicrobial property, the above-mentioned terpenes play a protective role in fortifying the plant defence system (Parveen *et al.,* 2024).

In the next section, for both *Syzgium aromaticum* (clove) oil and *Moringa oleifera* (moringa) oil, the researchers measured the total phenolic content (TPC) and total flavonoid content (TFC). The results show higher TPC and TFC value in case of *Syzgium aromaticum* (clove) oil in comparison to *Moringa oleifera* (moringa) oil, where it was discovered that, in contrast to moringa oil, clove oil had a TPC content that was 2.69 times greater and a TFC content that was 2.07 times higher. Both phenolics and flavonoids play crucial role in plants by acting as antioxidants, aiding in plant defense, providing structural support, UV protection, plant microbe interaction and defense signalling as well as allelopathy (Kumar *et al.,* 2020; Tuladhar *et al.,* 2021). Comparing clove oil to moringa oil, the researchers found that clove oil has greater DPPH radical scavenging activity, which may be attributed to higher TPC and TFC content in clove oil. There are phenolics and flavonoids in both clove oil and moringa oil, according to several previous studies, and these components are linked to the oils' antioxidant properties(Adaramola*et al.,* 2016; Sultana *et al.,* 2014).

In the next section, researchers showed potent antibacterial activity of both clove oil as well as Moringa oil against both *E. coli* and *S.aureus*, wherein, higher antibacterial efficacy against both the bacterial pathogens was observed in case of clove oil. The antibacterial activity of clove oil maybe attributed to presence of several important compounds in the clove oil, that include Alpha pinene, limonene, Beta ocimene, 2-Nonanone and Linalool, all of which are known to exhibit potent antibacterial activity (Zygadlo *et al.,* 2017; Valdivieso-Ugarte *et al.,* 2019). Furthermore, clove oil is also reported to contain several other compounds like eugenol, eugenyl acetate and β-Caryophyllene, which act as potent bactericidal agents by initiating disruption of bacterial cell membrane and impede both quorum sensing and bacterial enzymes (Chaieb *et al.,* 2007). Clove oil has antimicrobial properties, according to a number of previous research (Bai *et al.,* 2023; Fu *et al.,* 2009). In addition to being a potent antibacterial agent, clove oil demonstrated a remarkable antifungal activity as evident from complete neutralization of the fungal colonies of *Aspergillus niger*and*Penicillumchrysogenum*on exposure to clove oilat all the tested concentrations. Eugenol, which disrupts the fungal cell wall and membrane and inhibits the formation of ergosterol and other essential fungal enzymes, is responsible for clove oil's significant antifungal properties. Inhibiting fungal growth, germination, and fungal biofilm formation have also been documented effects of clove oil. Furthermore, clove oil also inhibits fungal secretion of hydrolytic enzymes and hence is suitable for use as a potent antifungal agent in controlling notorious fungal outbursts (Pinto *et al.*, 2009; Hiwandika*et al,* 2021).

Briefly summarizing the study's findings, the researchers have highlighted the immense range of primary metabolites, including, carbohydrates, lipids, proteins, ash and fibre in the both clove as well as moringa seeds. Presence of these primary metabolites shows the need for supplementation of a healthy diet regimen with both these seeds. Furthermore, Numerous important fatty acids have reportedly been found in the oil from both moringa and clove such as, Myristic Acid, Palmitic Acid, Palmitoleic Acid, Stearic Acid, Oleic Acid, Linoleic Acid, Linolenic Acid, Arachidic Acid, Gandoleic Acid, Eicosandienoic Acid, Behenic Acid, Eruric Acid, Lignoceric Acid and Nervonic Acid. All these acids act as hypolipidemic, antioxidant and anti-inflammatory molecules. Clove oil has also reportedly been found to contain the following acids: Alpha pinene, limonene, Beta ocimene, 2-Nonanone and Linalool, all of which are known to exhibit potent antimicrobial efficacy. Following that, it was discovered that both clove and moringa oils were high in phenolics and flavonoids, with clove oil having a higher concentration of both. Both flavonoids and phenolics contribute to higher antioxidant activity of clove oil. Thereafter, the researchers haven shown potent antibacterial as well as antifungal efficacy of both clove and moringa oil, wherein, clove oil demonstrated higher antibacterial as well as antifungal efficacy, which maybe attributed to presence of anti-microbial compounds like eugenol, eugenyl acetate and β-Caryophyllene, which act as potent antimicrobial agents. Therefore, the study unveils potential benefits of both clove as well as moringa seeds as well as their oil, in supplementing the nutritional needs as well as serving crucial functions in pharmaceutical as well as healthcare industry owing to their several health benefits and potential antimicrobial activity.

Conclusion

From the results of the present study, it may be said that both oils has compounds which showed good antioxidant and antimicrobial activities. So, these can be utilized for formulation of herbal based medications to treat infectious diseases and for scavenging free radicals.

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