# Comparative study of Antioxidant Compositions of *Ocimum gratissimum* (African Basil), *Ocimum africanum* (Lemon Basil), *Zingiber officinale* (Ginger) and *Curcuma longa* (Turmeric)

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***ABSTRACT***

***Background:*** *Natural antioxidants are abundant in many herbs and spices in Nigeria. Knowledge of their antioxidant contents will promote decision to make these herbs and spices part of one's daily diet which is vital for optimal health.*

***Objectives:*** *Comparative analysis of antioxidants (phospholipids, phenolic compounds, ascorbic acid and carotenoids) contents of some common herbs and spices (African basil, lemon basil, ginger and turmeric) in Nigeria was carried out.*

***Methods:*** *Triplicate determinations of the value of each of the antioxidants in the samples were done using standard methods. The results were analyzed using the Statistical Package for Service Solution (SPSS) version 22. Means and standard deviations were analyzed. Duncan's new multiple range test was used to separate the means, and analysis of variance was used to compare the means. Significance was judged at $p<0.05$. Pearson's correlation coefficient was used to determine correlation between antioxidant contents of the herbs and spices*

***Results:*** *African basil had the highest phenolic compound content (156 mg/100 g), while ginger had the lowest content (17 mg/100g). The carotenoids content was highest (23.91 mg/100g) in African basil and lowest (1.56 mg/100g) in ginger. The ascorbic acid values of the samples ranged from 2.13mg/100g in African basil to 337 mg/100g in ginger. The phospholipid values of the samples ranged from 2.37 mg/100g in ginger to 11.13 mg/100g in turmeric.*

***Conclusion:*** *African basil is a better source of phenolic compounds and carotenoids; ginger is a richer source of ascorbic acid, and turmeric is a richer source of phospholipids. Incorporating these herbs and spices in diets is vital for optimal health; hence, creation of awareness on their health benefits through nutrition education is recommended.*

**Keyword:** *Antioxidants, African basil, lemon basil, ginger and turmeric*

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## INTRODUCTION:

Free radical s reactive oxygen species are generated by our body by various endogenous systems and exposure to different physiochemical conditions (1). Free radicals have been linked to a variety of diseases including heart disease and certain cancers. Antioxidants are compounds in

foods that scavenge and neutralize these free radicals, thereby significantly preventing the oxidation they cause which are responsible for degradation (1,2). Antioxidants counteract negative effects of oxidative stress in human body and also protect food from the harmful effects of oxidation, and preserve lipid constituents of food from quality degradation (3). They are also associated with colour and acceptability of foods (4).

Herbs and spices have been used for centuries as flavouring and preservation agents in food. They have also been utilized in medical treatments from ancient times due to their recognized health benefits. Herbs and spices are shown to possess antioxidant, antimicrobial, and anti-inflammatory properties which are beneficial to health, and offer protection against cardiovascular disease, neurodegradation, type-2 diabetes, and cancer (5). Herbs and spices are widely recognized as good sources of natural antioxidants. It is shown that antioxidant activities of herbs and spices are ten times higher than that of fruits and vegetables (6).

*Ocimum gratissimum* (African basil) popularly known to Nigerians as scent leaf is a common plant with a very strong aroma and is used as a natural flavouring, fragrance, seasoning, or vegetable in food preparation. Fresh or dried African basil leaves give a unique taste to a variety of dishes, including tomato stews, salads, pepper soups, and meat. African basil is also used locally as a remedy for colds, cough, malaria, asthma, stomach acidity and influenza (7).

*Ocimum africanum* (lemon basil) leaves popularly known as curry leaves, are known and used in foods for its refreshing and subtly sweet citrus fragrance. Lemon basil is also known for its therapeutic qualities and is used as a natural home remedy for a variety of health problems such as wet coughs and chest congestion (8). It is a common plant and can be cultivated in home gardens.

*Zingiber officinale* (ginger) is cultivated for its edible rhizome that is commonly used as a spice. Ginger possesses both culinary and medicinal qualities. It is popularly used as a flavouring ingredient in drinks and numerous culinary dishes. It also provides relief from indigestion, flatulence, diarrhoea, and stomach cramps. Ginger is a global spice, and it is used in a variety of forms in food preparation including fresh, dried, in oil form, as a paste, and as an emulsion (9).

*Curcuma longa* (turmeric) is a rhizomatous herbaceous perennial plant that contains essential oils which contribute to its spicy and fragrant smell. These oils are commonly utilized in medicinal and cosmetic products. Another key components of turmeric which gives it its dull-orange colour are curcuminoids which has been shown to have anti-cancer, anti-inflammatory, antioxidative and anti-alzheimer properties in clinical research (10). Curcumin also possesses hepatoprotective, neuroprotective, cardioprotective, hypoglycemic, antirheumatic, and antidiabetic properties (10). Both curcuminoids and essential oils constitute the foundation for the beneficial effects of turmeric (10).

The possible health risks associated with the consumption of synthetic antioxidants has led to increasing necessity for the utilization and consumption of natural antioxidants not just because of their safety, but also as a result of increased consumer interest and knowledge on the health benefits of natural products. Making herbs and spices part of daily diet would ensure intake of natural antioxidants and optimal health. Comparative analysis of antioxidants (phospholipids, phenolic compounds, ascorbic acid and carotenoids) contents of *Ocimum gratissimum* (African basil), *Ocimum africanum* (lemon basil), *Zingiber officinale* (ginger) and *Curcuma longa* (turmeric) which are commonly consumed herbs and spices in Nigeria was therefore, carried out to enhance this.

## MATERIALS AND METHODS

### Procurement of Materials

Fresh leaves of *Ocimum gratissimum* (African basil), *Ocimum africanum* (lemon basil) and *Zingiber officinale* (ginger) and *Curcuma longa* (turmeric) rhizomes were purchased from Ogige main Market in Nsukka Local Government Area of Enugu State, Nigeria.

### Methods of Sample Preparation

The fresh samples were sorted to remove unhealthy ones, after which they were washed with water to remove dirt. The moisture remaining on the

samples after washing was left to drain, and subsequently the samples were ground into pastes using corona manual grinder. Thereafter, they were stored in four separate plastic containers with covers labelled. They were stored in a refrigerator at $4^0$C to prevent spoilage, and brought out in turns.

**Determination of Antioxidant Contents**

The phenolic compound, carotenoid, ascorbic acid and phospholipid contents of the samples were determined in triplicates.

***Phenolic Compound Determination***

The Folin-Ciocalteu assay as described by Lamuela-Raventos (11) was used in the determination of phenolic compounds of the samples. Folin-Ciocalteu reagent was diluted with distilled water (1:10) and poured into the test tubes containing the extracts. Half millilitre (0.5ml) of the diluted reagent containing the tested compound was extracted with a syringe and mixed with 0.5 ml 6% $Na_2CO_3$. This was left to incubate for 90 minutes at 22C before absorption was measured at 505nm. The phenolic compound content was calculated as follows:

$$\text{Phenolic compounds (mg/100g)} = \frac{\text{Absorbance of sample} \times 0.45\%}{0.356 \times \text{sample size}}$$

***Carotenoid Determination***

The carotenoid contents were determined by spectrophotometric method of AOAC (12). Eighty percent (80%) acetone was added to the solution in the test tubes to give a volume of 10ml. Absorbance was measured on a spectrophotometer at a wavelength of 470 nm. The carotenoid content was calculated as follows:

$$\text{Carotenoid value (mg/100g)} = \frac{\text{Absorbance of sample} \times 4\text{mg}}{0.4 \times \text{sample size}}$$

***Ascorbic Acid Determination***

The AOAC method (12) was used in the determination of vitamin C. Five grams of each macerated sample was weighed into a 250ml Erlenmeyer flask. Then, 60ml TCA/Acetic acid solution (3% TCA; 8% Acetate) was added to the flask. Upon intermittent shaking, the mixture in the flask was filtered after 60mins. The filtrate was made up to 100ml and 10ml aliquot taken for the titration with 0.05% 2,6 Dichlorophenol indophenol(DCIP) to a pink end point. The vitamin C content was calculated as follows:

$$K = \frac{Y \times Z \times DF}{\text{Weight of sample}}$$

Where

Y is the titre of the sample,

Z is the figure got when 50mg of standard Vitamin C is divided by its titre value

DF is the dilution factor

To get vitamin C in mg/100g equivalent, K is then multiplied by a factor of 20.

***Phospholipid Determination***

This was carried out using ammonium ferrothiocyanate method as described by Stewart (13). One gram of each macerated sample was weighed into a 30ml test tube and subsequently extracted with chloroform and methanol (2:1) according to the Al Brinks procedure. On separation, 1ml chloroform extract was removed with a syringe and evaporated to dryness in a stream of air at 50°C. The dried extract of phospholipids was dissolved further in 5ml chloroform after which 2ml of ammonium ferrothiocyanate solution was added. The mixture was sent to a rota mixer. Following phase separation, the lower chloroform layer was removed with a Pasteur pipette and the absorbance read at 488nm in a Jenway 6305 spectrophotometer. Phospholipid concentration was extrapolated from the phospholipid standard curve prepared the same way as the sample.

**Statistical analysis**

The results were analyzed using the Statistical Package for Service Solution (SPSS) version 22 for windows. Data were expressed as means and standard deviations. Duncan's new multiple range test was used to separate the means, and analysis of variance was used to compare the means. Differences were considered significant at $p<0.05$. Pearson's correlation coefficient was used to determine correlation between antioxidant contents of the herbs and spices, and significance

was judged at $p<0.01$ and 0.05 (2-tailed).

## RESULTS

Table 1 presents the antioxidant contents of the herbs and spices. The table shows that African basil had the highest values of phenolic compounds and carotenoids (156.70 mg/100g and 23.91 mg/100g, respectively) significantly higher than others ($p<0.05$), while ginger had significantly the lowest contents (17.6 mg/100g and 1.56 mg/100g, respectively). The values for turmeric and lemon basil were not significantly different ($p<0.05$). It was also shown that ginger had the highest ascorbic acid content (337 mg/100g) significantly higher than others, while African basil had significantly lowest content (213 mg/100g). Turmeric had significantly highest phospholipid content (11.13 mg/100g), while ginger had significantly lowest value (2.37 mg/100g). The values for turmeric and lemon basil were similar ($p<0.05$).

The Pearson's correlation coefficients of the antioxidant contents of the herbs and spices are presented in Table 2. Their carotenoid content significantly correlated positively with their phospholipid ($p<0.05$) and phenolic compound ($p<0.01$) contents, but negatively correlated with ascorbate contents ($p<0.01$). It was also shown that ascorbate had significant negative correlation with phenolic compounds $p<0.01$).

## DISCUSSION

The significantly highest carotenoid values found in turmeric and African basil were similar to those found in a study (14) on turmeric, scent leaves, sage, rosemary, thyme and sweet basil. The carotenoid content of ginger (1.56 mg/100g) though lowest among the samples studied, was higher than the value (0.81 mg/100g) from a study (15) of the nutritional composition of ginger powder prepared using various drying methods. Carotenoids protect the skin from photo oxidative damage and studies have shown that increased dietary intake of carotenoids is linked to a lower risk of cancers, as they possess anti-carcinogenic properties (16).

The phenolic compound content of ginger (17.6 mg/100g), though lowest among the samples analysed, was higher than the value (10.53 mg/100g) reported in a study (17) on phytochemicals, antioxidant and anti-inflammatory properties of ginger extracts. Phenolic compounds have the ability to scavenge free radicals, donate hydrogen atoms or electrons, or bind metal cations. Phenolic compounds also play significant roles in the reduction of lipid oxidation in both plant and animal tissues (18).

The highest ascorbic acid value (337 mg/100g) found in ginger was extremely higher than the value (3.8 mg/100g) reported in the study on the nutritional composition of ginger powder prepared using various drying methods (15). This difference in value could be attributed to differences in climate, soil content and analytical methods used in both studies, especially the processing of the ginger into powder by drying methods used in the earlier study (15). Again, phytochemical contents of foods can significantly differ depending on the varieties (19,20), genotype (21) and cultivation practices (22).

The lowest value (213.29 mg/100g) of ascorbic acid found in African basil was lower than the value (197.35 mg/100g) reported in a study (23) on nutritional and anti-nutritional values of *uziza* (*Piper guineense*) leaf and scent leaf. Ascorbic acid has been shown to not only scavenge free radicals; it also interacts with small-molecule antioxidants including tocopherol, glutathione and thioredoxin. It can also stimulate biosynthesis and activation of antioxidant enzymes such as superoxide dismutase and glutathione peroxidase. It also supports action of other exogenous antioxidants, mainly polyphenols (24).

Turmeric had the highest phospholipid content with a value of 11.1 mg/100g. This was higher than the value (6.86 mg/100g) reported in a study (25) on biochemical composition of ginger and turmeric. Ginger had the lowest phospholipid content with a value of 2 mg/100g. This was lower than the value (7 mg/100g) reported in a study (25) of biochemical composition of ginger and turmeric. Dietary phospholipids are shown to suppress lipid peroxidation and also thought to be efficient in providing fatty acid residues for cell membrane incorporation (26).

The negative correlation between ascorbate and phenolic compounds contents of the samples was in contrast with an earlier report (27) of linear positive correlation between ascorbate and polyphenol contents of frozen vegetable soups. The negative correlation however, agreed with results from a study (28) in which there was negative correlation between ascorbate and total polyphenol contents of some Nigerian indigenous spices.

**Table 1:** Antioxidant contents of the herbs and spices

| Sample | Phenolic compounds (mg/100g) | Carotenoids (mg/100g) | Ascorbate (mg/100g) | Phospholipids (mg/100g) |
|---|---|---|---|---|
| Ginger | 17.60±0.000$^{a}$ | 1.56± 0.41$^{a}$ | 337±29.18$^{b}$ | 2.37±0.29$^{a}$ |
| Turmeric | 87.20±10.74$^{b}$ | 23.03±0.000$^{b}$ | 264.88±24.32$^{ab}$ | 11.13±1.29$^{b}$ |
| Lemon basil | 106.80±27.71$^{b}$ | 18.62± 4.98$^{b}$ | 254.56±29.18$^{ab}$ | 5.63±1.44$^{ab}$ |
| African basil | 156.70±14.28$^{c}$ | 23.91±0.00$^{b}$ | 213±29.18$^{a}$ | 6.49±3.92$^{ab}$ |

Values are means ±standard deviations of three determinations. Mean values with different superscripts in a column are significantly different ($p<0.05$)

**Table 2:** Correlation between antioxidant contents of the herbs and spices

| Sample | | Phospholipids | Carotenoids | Ascorbate | Phenolic compounds |
|---|---|---|---|---|---|
| **Phospholipids** | *r*-value | 1 | 0.725* | -0.497 | 0.417 |
| | *p*-value | | 0.042 | 0.211 | 0.303 |
| | N | 8 | 8 | 8 | 8 |
| **Carotenoids** | *r*-value | | 1 | -0.871** | 0.884** |
| | *p*-value | | | 0.005 | 0.004 |
| | N | | 8 | 8 | 8 |
| **Ascorbate** | *r*-value | | | 1 | -0.960** |
| | *p*-value | | | | 0.000 |
| | N | | | 8 | 8 |
| **Phenolic compounds** | *r*-value | | | | 1 |
| | *p*-value | | | | |
| | N | | | | 8 |

**Correlation is significant at the 0.01 level (2-tailed)

*Correlation is significant at the 0.05 level (2-tailed)

## CONCLUSION

The phenolic compounds were highest in African basil and lowest in ginger. Carotenoids were found to be higher in African basil and turmeric, while they were lower in lemon basil and ginger. Ascorbic acids were found to be higher in ginger and turmeric, while they were lower in African basil and lemon basil. Phospholipids were found to be higher in turmeric and African basil, while they were lower in lemon basil and ginger. Therefore, among the four herbs and spices studied, African basil could be said to be the richest source of phenolic compounds and carotenoids; ginger as the richest source of ascorbic acid, and turmeric as the richest source of phospholipids.

Incorporating these herbs and spices in one's daily diet is thus, vital for optimal health, and for protection from harmful effects of environmental pollutants and contaminants in foods. People should be encouraged to incorporate them as integral parts of healthy nutritious diets as these functional ingredients helps to reduce incidence of non-communicable diseases.

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