NIGERIAN AGRICULTURAL JOURNAL
*ISSN: 0300-368X*
Volume 55, Number 3, December 2024, Page 135-141
Available online at: http://www.ajol.info/index.php/naj
https://www.naj.asn.org.ng
*Creative Commons User License CC:BY*

# Evaluation of the Effect of Drying Methods on the Chemical Compositions and Antimicrobial Properties of Selected Leafy Spices

**[1]Nwanagba, N.L., [1]Ukom, A. N., [2]Pipi, G. O., [3]Jacob, Y., [4]Okoli, J. N., [1]Keke, J. U. and [5]Ezehmalu, J. A.**

[1]Department of Food Science and Technology; [2]Department of Microbiology, Michael Okpara University of Agriculture, Umudike
[3]Department of Human Nutrition and Dietetics, College of Health Technology, Michikka Adamawa,
[4]Department of Human Nutrition, Nnamdi Azikiwe University, Awka
[5]Department of Food Science and Technology, Federal University of Technology, Akure
Corresponding author's email: nwanagban@yahoo.com

**Abstract**
This study assessed the effect of sun drying and kiln drying methods on chemical, composition and antimicrobial properties of selected indigenous leafy spices Uziza leaf *(Piper guineense*), Curry leaf (*Murraya koenigii*), and Scent leaf (*Ocimum gratissimum*). The three leafy spices were divided into 500 g each. The fresh sample of each leafy spices served as control. Two portions of 500 g each of leafy spices were separately washed and subjected to two drying methods (sun drying and kiln drying) for 2 days for sundried samples while kiln dried sample was done at 100 $^0$C for 4 days. The leaves were ground and stored in an airtight container prior to analysis. The mineral, phytochemical, and antimicrobial properties were analyzed based on standard methods. Data generated were subjected to analysis of variance of a completely randomized design while mean separation was done with Duncan multiple range tests at 95% confidence level. Results showed that drying did not affect the phytochemical components of the leafy spices. The mineral contents of the leafy spices varied from 21.07 to 34.00 mg/100g Sodium, 0.32 to 0.60 mg/100g, Zinc, 1.37 to 11.25 mg/100g, Iron, 107.60 to 297.30 mg/100g, Calcium, and 184.80 to 698.90 mg/100g Potassium respectively. The antimicrobial results showed that extracts of sun-dried and kiln-dried *O. gratissimum* leaves gave maximum inhibitory zone diameters (IZD) of 16.0 mm against *Staphylococcus aureus* and *Candida albicans* at 4000 µg/ml which was less compared to the control, extracts from kiln dried and sun dried leaves of *P. guineense* were effective against *E. coli* and *S. aureus* with maximum IZD range of 15mm at 4000 µg/ml while sun dried and kiln dried leaf extracts of *Murraya koenigii* showed strong growth inhibition against *S. aureus* and *C. albicans* with IZD range of 17 mm and 16 mm at 4000 µg/ml which is also less compared to the control.
***Keywords: Leafy spices, Sun drying, kiln drying, phytochemical, antimicrobial properties***

## Introduction

Leafy spices are considerably more than just flavour enhancers. They are formidable nutritional forces. In addition to being rich in minerals like Potassium, manganese, iron, and magnesium, leafy spices also contain concentrated phytonutrients with anti-inflammatory, antioxidant, and even anti-cancer properties

(Lewis, 2001). Interest in many dietary and medicinal plants, as well as their antioxidant potential, has grown. On the other hand, the majority of common leafy spices are members of the Apiaceae and Lamiaceae families. Fresh green spices are typically eaten with meals or, depending on how they are dried, can be preserved.

By reducing the growth of germs and stopping specific metabolic reactions that could change the product's properties, drying is a useful technique that extends the shelf life of the finished good. The process of drying may have an impact on antioxidant capacity, nutritional and physical quality of the herbs (Annamalai *et al*., 2011).

African basil, also known as scent leaf (Ocimum gratissimum), is widely grown for culinary and therapeutic purposes. According to Mann (2012), phytochemical elements include alkaloids, tannins, terpenoids, flavonoids, and saponins. According to reports, it possesses antioxidant, anti-inflammatory, antibacterial, antifungal, and anti-carcinogenic qualities (Mann, 2012).

Pepper guineense, or uzazi, is used for almost all soups and other dishes, particularly in Eastern Nigeria. This blooming vine is utilised for its leaves, which provide soups, stews, sauces, vegetable dishes, salads, and other meals a unique flavour and scent. Terpenoids, alkaloids, flavonoids, and essential oils are examples of phytochemical components (Pal, 2013).

The Curry leaf plant (Murrayakoenigii) is prized for both its therapeutic properties and distinctive fragrance. This plant has yielded several components of essential oil for the leaves, as well as alkaloids such as carbazole, murrayacine, and koenigii (Saini and Reddy, 2013).

The phytochemicals and antioxidants found in leafy spices are plentiful. They suppress the formation of some types of cancer by helping to detoxify carcinogens, guard against the damage caused by free radicals, and change the way tumour cells divide. Furthermore, using various drying techniques that will preserve the antioxidant qualities of these leafy spices and make them available year-round will help broaden how leafy vegetables are used. The objective of this research was to assess the impact of various drying methods on the chemical compositions, microbial, and antimicrobial properties of some selected leafy spices.

## Materials and Methods

### *Sample Collection*

Fresh leaves of cultivated scent leaf (*Ocimum gratissimum*), uziza leaf (*Piper guineense*), and curry leaf *(Murraya koenigii*) with its stalks were obtained from Abubakar Rimi Market, Fagge Local Government Area, Kano State, Nigeria.

### *Sample Preparation and Dilution*

The leaves were carefully cleaned manually to remove dirt and damaged ones, ground using a pestle and mortar into powdered form, sieved, and stored in a plastic container. The powdered leaves were used for both phytochemical and elemental analysis. Each leafy spice was divided into two batches. One was immediately set aside for the control. The other batch (500 grams each) of the plant leaves was used for the drying process.

### *Sample Dilution*

Exactly 2g of the samples was weighed and transferred into the digestive tubes. Ten (10) ml of nitric acid was added, and 5 ml of HCL was added to the samples. The samples were then mixed. The temperature set for digestion was at 250 degrees, and a fumed brown color was observed.

The samples were digested at 250 degrees Celsius for 1 hour until a clear fume was observed and the samples were completely digested. The digested samples were allowed to cool, and 10 ml of distilled water was added (Ladipo *et al*., 2010).

### *Drying Process*

Sun drying and kiln drying were the drying processes used, where each sample was evenly spread on a tray, respectively. Ten grams (10 g) each of raw leaves was used. A sample for sun drying was placed on a tray directly exposed to direct sunlight for 4 days until a constant weight was achieved, while the kiln-drying sample was. Placed on a tray exposed to an electric bulb as a source of kinetic energy for 7 days until a constant weight was achieved too before being used for analysis.

**Analysis of Dried Leafy Spices**

***Determination of Minerals***

This experiment was determined using the procedure described in the AOAC (2003) method. The mineral content includes: sodium (Na), potassium (K), Iron (Fe), calcium (Ca), and Zinc (Zn) were estimated by using an atomic absorption spectrophotometer.

***Phytochemical analysis***

Phytochemical screening was carried out using standard procedures to identify the constituents as described by Ladipo (2010).

**Antimicrobial Analysis**

Agar well diffusion method was used to screen the antibacterial and antifungal activities of polar solvent extracts (Daoud *et al*., 2015). About 1 ml of fresh bacterial or fungal culture was pipetted in the center of a sterile Petri dish. Molten cooled Muller Hi (PDA) for fungi was then poured into the Petri dish containing the inoculum and mixed well. Upon solidification, wells were made using a sterile cork borer (6 mm in diameter) into agar plates containing inoculums. Then, 100 µl of each extract (20% w/v) was added to respective wells. The concentration of extracts (20% w/v) has been selected based on our pre-experiments and previous literature. The plates were placed in the refrigerator for 30 minutes to let the extracts diffuse well into the agar. Then, the plates were incubated at 37$^{o}$C for 18 hours. Antimicrobial activity was detected by measuring the zone of inhibition (including the well's diameter) that appeared after the incubation period. DMSO at a concentration of 10% was employed as a negative control.

**Statistical Analysis**

All analyses of the indigenous spicy leaves were carried out in duplicate. The data obtained were analyzed using the analysis of variance (ANOVA) and expressed as mean value and standard deviation. Duncan test was conducted to examine significant differences at a 95 % confidence level.

***Experimental Design***

A Completely Randomized Design (CRD) was used in carrying out the research work.

**Results and Discussion**

***Mineral Composition of Dried Leafy Spices***

The results showed that the leaves have nutritional and therapeutic benefits since they included vital components like potassium (K), zinc (Zn), iron (Fe), sodium (Na), and calcium (Ca) (Table 1). The dried Curry leaf samples varied significantly in terms of calcium, iron, potassium, sodium, and zinc concentrations. Based on the results, the potassium concentration in Uziza leaf was 698.90 mg/100 g, which was significantly higher than the potassium concentration in the other samples, which included Curry leaf at 605.30 mg/100 g and Scent leaf at 447.00 mg/100 g, which was the lowest.

Sodium is essential for the upkeep of the water balance in cells and the proper operation of muscles and nerve impulses (Seldin and Giebisch, 1990). The plant's salt concentration falls between 70.048 and 0.56 mg/kg suggested by the World Health Organisation in 1995. A substantial portion of human blood and extracellular fluids, as well as the development and maintenance of healthy bones and teeth, depend on calcium. Based on the findings of (Bahl and Bahl, 2006), the presence of iron indicates that the plant is necessary for the body's ability to produce red blood cells and carry oxygen. According to reports from Bahl and Bahl (2006), the presence of zinc (Zn) in the plant indicates that it is essential for immune function, protein synthesis, blood clotting, hormones, haemoglobin formation, secretion, and potentiating insulin action. The concentration of Zn in the dried leaves ranged from 0.52 mg/100g for Curry leaf (CL), 0.60 mg/100g for Scent leaf (SL), and 0.39 mg/100g.or Uziza leaf (UL) respectively.

***Effect of Drying Methods on the Phytochemical Components of Some Selected Leafy Spices***

According to Cheng *et al*. (2002), phytochemicals are naturally occurring, non-nutritive compounds found in plants that can prevent disease. The impact of sun and kiln drying on the phytochemical components of a few chosen leafy spices is displayed in Table 2. As was seen with the fresh leaf spices, tannin was present in both the sun-dried and kiln-dried samples. Tannin-containing plants are used as diuretics to treat stomach and

duodenal tumours and as astringents to treat diarrhoea (Saxena *et al*., 2013). Alkaloids were found in all three samples of Uziza leaf (UL), sun-dried and kiln-dried samples of Curry leaf (CL), and both types of Scent leaf (SL).

The results of Oyeleke *et al*. (2008), who also reported the presence of alkaloids in leafy spices, are supported by the presence of alkaloids in leaf samples. Alkaloids have been shown to exhibit a range of pharmacological properties, such as anticancer, antihypertensive, and antiarrhythmic actions (Saxena *et al*., 2013). In medicine, pure isolated alkaloids and their synthetic derivatives have been employed as antibacterial, antispasmodic, and analgesics (Okwu, 2004).

Glycoside was found in every sample that was examined. All of the samples that were examined contained flavonoids as well. Plants include flavonoids, which have anti-inflammatory and antioxidant properties (Saxena *et al*., 2012). According to Okwu (2004) and Okwu and Josiah (2006), they possess the capacity to scavenge hydroxyl radicals, superoxide anions, and lipid peroxy radicals.

Saponin content was present in fresh samples and dried samples of Scent leaf (SL), present in fresh and sun-dried samples of Uziza leaf (UL), but absent in Curry leaf (CL). They could be beneficial in modulating blood lipids, lowering cancer risks, and improving blood glucose response as well as possessing antioxidant activity (Igidi and Edene, 2014).

Fresh and dried samples of Scent leaf (SL), fresh and sun-dried samples of Uziza leaf (UL) contained saponin, but were absent from Curry leaf (CL). In addition to having antioxidant activity, these leafy spices may help regulate blood cholesterol levels, reduce the risk of cancer, and enhance the blood glucose response (Igidi and Edene, 2014).

***Antimicrobial Activities on Leafy Spices***

The antibacterial properties of plant extracts (fresh, sun-dried, and kiln-dried fragrance leaf, uziza, and curry leaf samples) are displayed in Figure 1. Maximum inhibitory zone diameters (IZD) of 16.0 mm were obtained from extracts of sun- and kiln-dried *Ocimum gratissimum* leaves against *Staphylococcus aureus* and *Candida albicans* at 4000 µg/ml, which is lower than the control. IZD values ranging from 0.0 mm to 18.0 mm against *S. aureus*, 0.05 mm to 20.0 mm against *Escherichia coli,* and 7.0 mm to 17.0 mm against C. albicans were found in all of the *O. gratissimum* extracts used in this study. These results correlate with reports from Melo *et al*. (2019), who found that the essential oil of *O. gratissimum* extract had moderate growth inhibition against *S. aureus* and E. coli, with a range of 12 mm- 20 mm.

*O. gratissimum's* antibacterial properties have been documented in earlier research (Intorasoot *et al.,* 2017). Furthermore*, Ocimum* species extracts were found to be bioactive against isolates of both Gram-positive and Gram-negative bacteria, including *S. aureus* and *E. coli*, by Dharsono *et al*. (2022). This might be explained by variations in the phytochemicals' targets and modes of action between the extracts. Based on its bioactive components that interact with cellular membranes, demonstrating their permeability and producing distortion of intracellular contents that ultimately leads to bacterial mortality, *O. gratissimum* leaf extracts have bactericidal properties (Taufiq *et al*., 2019).

According to Mgbe-Ahuruike *et al*. (2018), methanol, hexane, chloroform, and ethanol extracts of P. guineense leaves showed an IZD range of 14.7-17.5mm against S. aureus isolates. These results are consistent with the findings that fresh, kiln, and sun-dried leaf extracts of Piper guineense inhibited the growth of S. aureus with an IZD range of 7.20mm. The maximum IZD range of 15 mm at 4000 µg/ml was observed in extracts from sun-dried and kiln-dried P. guineense leaves when tested against E. coli and S. aureus. These results are consistent with research by Mgbe-Ahuruike *et al*. (2018) that showed P. guineense leaf extracts were strong inhibitors of E. coli. This implies that a variety of natural compounds with antibacterial properties may be present in these extracts, which need to be assayed (Besong *et al*.2016). The growth inhibitory activities of P. guineense extracts have been reported previously

and are concentration dependent (Ebana *et al*., 2016). The antibacterial properties of P. guineense leaf extracts are linked to different kinds and concentrations of piperamide alkaloids and other non-polar chemicals (Mgbe Ahuruike *et al*., 2017).

Murraya koenigii leaf extracts that had been sun-dried and kiln-dried showed significant growth inhibition against S. aureus and C. albicans, with IZD ranges of 17 mm and 16 mm at 4000 µg/ml, less than the control. The leaves of M. koenigii have been used to extract various classes of secondary metabolites and alkaloids, including koenimbine, murrayafoline, mahamine, mahanimbine, isomahamine, and mukoline, which have been found to contain cytotoxic and pharmacological properties (Balakrishnan *et al*., 2020).

**Conclusion**

This study demonstrated how the elemental makeup of a few particular native spices can be impacted by drying techniques. The nutritional and mineral contents of the dry leafy spices under analysis varied considerably. The minerals (Ca, K, Na, Fe, and Zn) content of the scent leaf (SL) and uzaiza leaf (UL) samples was found to be significantly higher than the Recommended Dietary Allowances (RDA) values for each mineral. Given that the leaves of the plant are traditionally used to treat a variety of infectious ailments; plant extracts may also be a source for new medicine formulations. The regular use of these leafy spices in our daily diet should be recommended to further enhance the nutritional adequacy. This could enable the derivation of a full dose of the required vitamins, minerals, and phytochemical compositions, and better therapeutic effects could also be obtained. Further investigations on other drying methods that will be suitable for the preservation of these leafy spices should be done.

**References**


AOAC (2003). Official Methods of Analysis of the Association of Official Analytical Chemists. 17th Edition, AOAC, Gaithersburg.

Annamalai, N., Thavasi, P., Vijayalakshmi, S. and Balasubramanian, T. (2011). Extraction, purification, and characterization of thermostable, alkaline-tolerant α-amylase from Bacillus cereus. *Indian Journal of Microbiology*, 51:424-429.

Balakrishnan, R., Vijayraja, D., Jo, S. H., Ganesan, P., Su-Kim, I. and Choi, D. K. (2020). Medicinal profile, phytochemistry, and pharmacological activities of *Murraya koenigii* and its primary bioactive compounds. *Antioxidants*, 9: 101.

Besong, E.E., Balogun, M.E., Djobissie, S. F., Mbamalu, O. S. and Obimma, J. N. (2016). A review of *Piper guineense* (African Black Pepper). *International. Journal of. Pharmaceutical Research*, 6: 368–384.

Daoud, A. (2015). Assessment of polyphenol composition, antioxidant and antimicrobial properties of various extracts of Date Palm Pollen (DPP) from two Tunisian cultivars. *Arabian Journal of Chemistry.* http://dx.doi.org/10.1016/j.arabjc.2015.07.014.

Dharsono, H.D.A., Putri, S.A., Kurnia, D., Dudi, D. and Satari, M.H. (2022).*Ocimum* Species: A Review on Chemical Constituents and Antibacterial Activity. *Molecules*, 27: 6350.

Ebana, R., Edet, U., Ekanemesang, U., Ikon, G., Etok, C. and Edet, A. (2016). Antimicrobial activity, phytochemical screening, and nutrient analysis of *Tetrapleuratetraptera* and *Piper guineense*. *Asian Journal of Medical Health*, 1: 1–8.

Igidi, O.J. and Edene, C.E. (2014). Proximate and phytochemical compositions of Napoleona vogelii Hook fruit. *The International Journal of Engineering and Science*, 3(6): 46-51.

Intorasoot, A., Chornchoem, P., Sookkhee, S. and Intorasoot, S. (2017). Bactericidal activity of herbal volatile oil extracts against multidrug-resistant *Acinetobacter baumannii*. *Journal Ethnopharmacolology,* 6: 218–222.

Ladipo, M.K., Doherty, V.F. and Kanife, U.C. (2010). Phytochemical Screening and Antibacterial Investigation of the Extract of Ocimum gratissimum (Scent Leaf) on Selected Enterobacteriaceae, Production Agriculture and Technology. *African Journal of Agriculture*, 6: 75-76.

Lewis, A. J. and Southern, L. L. (2001). *Swine nutrition*. 2nd edition - CRC Press.

Mann, A. (2012). Phytochemical constituents and antimicrobial and grain protectant activities of

clove basil (*Ocimum gratissimum L.)* grown in Nigeria. *International Journal of Plant Research*, 2(1): 51-58.

Mgbe Ahuruike, E. E., PiaFyhrquist, H., Vuorela., R. Julkunen-Tiitto and Yvonne, H. (2018). Alkaloid-Rich Crude Extracts, Fractions and Piperamide Alkaloids of Piper guineense Possess Promising Antibacterial Effects. *Antibiotics*,7: 98.

Mgbe-Ahuruike, E.E., Yrjönen, T., Vuorela, H. and Holm, Y. (2017). Bioactive compounds from medicinal plants: Focus on *Piper* species*. African. Journal of Biotechnology,* 112: 54–69.

Okwu, D. E. (2004). Phytochemical and vitamin content of indigenous spices of South Eastern Nigeria. *Journal of Sustainable Agriculture and Environment*, 6:30-37.

Okwu, D.E, and Josiah, C. (2006). Evaluation of the chemical composition of two Nigerian medicinal plants, *African Journal of Biotechnology*, 4: 357-361.

Oyeleke, S.B., Dauda, B.E.N. and Boye, O.A. (2008). Antibacterial activity of Ficus capensis. *African Journal of Biotechnology*, 7(10):1414-1417.

Saini, S.C. and D.G. Reddy. (2013). *Murraya Koenigii*. IOSR *J. Pharma. Biol. Sc*i. 7: 15- 18.

Saxena, M., Saxena, J. and Pradhan, A. (2012). Flavonoids and Phenolic acids as antioxidants in plants and human health. *International Journal of Pharmaceutical Sciences. Review and Research,* 16(2): 130-134.

Saxena, M., Saxena, J., Nema, R., Singh, D. and Gupta, A. (2013). Phytochemistry of Medicinal Plants. *Journal of Pharmacognosy and Phytochemistry Center for Microbiology and Biotechnology Research and Training, Bhopal, India*. 8192 (1): 168-182.

Taufiq, M. and Darah, I. (2019). Antibacterial activity of an endophytic fungus *Lasiodiplodia pseudotheobromae* IBRL OS-64 residing in leaves of a medicinal herb, *Ocimum sanctum Linn*. *Journal of Appl. Biol. Biotechnol*., 7: 35–41.

WHO (1995). World Health Organization, Inorganic Lead. Environmental Health Criteria Number 165, Geneva.

**Table 1: Mineral composition (mg/100g) of the dried leafy spices**

| Sample code | Sodium (Na) | Zinc (Zn) | Iron (Fe) | Calcium (Ca) | Potassium (K) |
|---|---|---|---|---|---|
| **CLKD** | $34.00^{a}$ ±1.41 | $0.52^{a}$±0.14 | $3.67^{b}$±1.41 | $297.30^{a}$±1.41 | $433.00^{c}$±1.41 |
| **CLSD** | $32.08^{a}$±1.41 | $0.52^{a}$±0.14 | $3.61^{b}$±1.41 | $278.70^{b}$±1.41 | $521.40^{b}$±1.41 |
| **A1** | $24.15^{b}$±1.41 | $0.39^{b}$±0.14 | $11.25^{a}$±1.41 | $230.90^{c}$±1.41 | $605.30^{a}$±1.41 |
| **SLKD** | $21.25^{b}$±1.41 | $0.60^{a}$±0.14 | $2.96^{a}$±1.41 | $352.10^{a}$±1.41 | $400.80^{b}$±2.12 |
| **SLSD** | $21.07^{b}$±1.41 | $0.60^{a}$±0.14 | $4.66^{a}$±1.41 | $287.90^{b}$±1.41 | $447.00^{a}$±1.41 |
| **A2** | $31.76^{a}$±1.41 | $0.15^{b}$±0.00 | $1.37^{a}$±1.41 | $107.60^{c}$±1.41 | $269.60^{c}$±1.41 |
| **ULKD** | $24.15^{a}$±1.41 | $0.39^{a}$±0.00 | $11.25^{a}$±1.41 | $230.90^{c}$±1.41 | $605.30^{b}$±1.41 |
| **ULSD** | $24.80^{a}$±1.41 | $0.39^{a}$±0.00 | $10.91^{a}$±1.41 | $267.60^{a}$±1.41 | $698.90^{a}$±1.41 |
| **A3** | $22.97^{a}$±1.41 | $0.32^{b}$±0.00 | $4.47^{b}$±1.41 | $250.50^{b}$±1.41 | $184.80^{c}$±1.41 |

***A-c: values are means ± standard deviation of duplicate determination. Mean values in the same column with different superscripts are significantly different.***

***Key:***

***A(1-3): Control, *KD :Kiln drying, SD:Sun drying***

***Sample CL: Curry leaf***

***Sample SL: Scent leaf***

***Sample UL: Uziza leaf***

**Table2: Phytochemical Screening of Extracts from Leafy Spices**

| Plant extracts | Flavonoids | Alkaloids | Glycosides | Saponins | Tannins | Steroids |
|---|---|---|---|---|---|---|
| SL(sun dried) | + | + | + | + | + | + |
| SL (kiln dried) | + | + | + | + | + | + |
| SL (control) | + | + | + | + | + | + |
| CL (sun dried) | + | + | + | – | + | + |
| CL (kiln dried) | + | + | + | – | + | + |
| CL (control) | + | + | + | – | + | + |
| UL (sun dried) | + | + | + | + | + | + |
| UL (kiln dried) | + | + | + | + | + | + |
| UL (control) | + | + | + | + | + | + |

***Key: (+) = Presence, (–) = Absence.***
***SL Scent leaf,***
***UL Uziza leaf,***
***CL Curry leaf.***

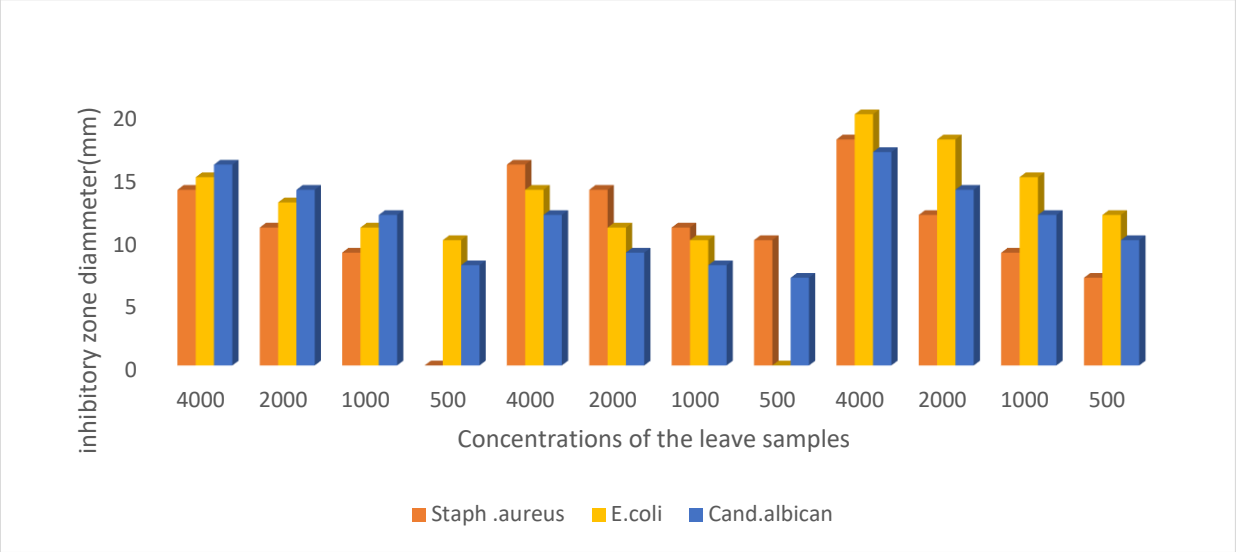



***Fig-1: Concentrations of leafy spicy extracts and antibiotics used as control (µg/ml)***