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Elemental Assessment of Four Popular African Immunity Boosting Medicinal Plants Marketed in Ede Local Market, Nigeria

Abibu, M.A.; Taleat, A.A.T.; Olaoluwa, D.T.; Muraina, T.A.; Adenipekun, O.D. and Adeniyi, B.O.
The Federal Polytechnic, School of Science and Technology
P.M.B. 231, Ede, Nigeria.

Abstract :- Essential elements occur naturally in medicinal plants and plant extracts to support immunomodulation therapy and other biochemical and physiological functions in the body. In this study, the quantitative determination of zinc, calcium, potassium, sodium and magnesium in four different African immune booster medicinal plants were assessed using atomic absorption spectrophotometry (AAS). The four popular immune boosting medicinal plant samples truly include cinnamon (Cinnamomum verum), clove buds (Syzygium aromaticum), and ginger root (Zingiber officinale) and Lemmon grass (cymbopogon citratus) dried powdered were subjected to proximate and essential elements analysis using official methods of analysis. The results obtained from the mean analysis of plant samples have proximate values on dried basis as 5.57 - 10.34 % (moisture content), 0.66 - 2.46 % (ash content). The result showed that the samples are also a rich source of nutritive elements containing calcium 60.39±0.0 – 142.23±0.01mg/kg, potassium 39.25±0.00 – 435.09±0.01 mg/kg, sodium 24.11±0.00 – 97.58±0.01 mg/kg, magnesium 20.91±0.00 – 82.41±0.00 mg/kg and zinc 0.84±0.00 – 31.11±0.00 mg/kg dry weight. However, of all plants analyzed cinnamon had highest amount of Ca (142.23±0.01mg/kg), while lemon grass was the best source of K (435.09±0.01 mg/kg). Clove had highest levels of Na (97.58±0.01 mg/kg), and was the best source of Mg (82.41±0.00 mg/kg). Clove also provided the highest level of Zn (31.11±0.00 mg/kg). These discoveries may benefit individuals with weakened immune systems, as well as vulnerable groups like children and the elderly. Such groups of people are encouraged to incorporate any of these medicinal plants in their diets as food supplements for their daily healthcare need.

Keywords:- *Essential Elements, Medicinal Plants, Immunotherapy, Atomic Absorption Spectrophotometer.*

I. INTRODUCTION

African nations including Nigeria were blessed with wide variety of plants which are both of nutritional, medicinal and economic important for the benefit of African communities (Ahn, 2017; Smith-Hall *et al.,* 2012). Medicinal plants are a valuable source of macro and micro elements. Essential elements are a group of inorganic nutrient essentially required in either large or tiny concentration by the body to maintain normal cellular and metabolic functions of human and animal life. The inorganic elements such as iron, zinc, calcium, magnesium, potassium, sodium are nutritional elements of modern man. Indeed essential element therapy helps the human to maintain a good healthy diet. These minerals are significantly essential for activities like oxygen transport in the red blood cells, muscle muscle contraction, nerve transmission, immune functioning, and antioxidant defense (Dutta and Layton, 2023; Blaine *et al.,* 2014). The body cannot produce essential minerals, so they must be obtained through diet and/or supplements. Deficiency of essential elements causes a wide range of abnormalities and metabolic disorders (Preet *et al.,* 2017). Medicinal plants are power house of bioactive compounds and essential elements that support health wellbeing and thus, help the body to stabilized and withstand infection. Oliveira & Neto (2012) reported that, the demand for alternative sources of unconventional treatment for individual health care systems as well as immune booster has being on today in both rural and urban areas (Street and Pinsloo, 2013).

Many plants, particularly medicinal plant are the cheapest source of affordable essential elements which act mainly as coenzymes for various metabolic processes (Francisconi *et al.,* 2013). Some of the medicinal plants extract contain many bioactive compounds in addition to the identified traditional nutrients such as proteins, lipids, certain hormone precursors, vitamins and specific essential elements necessary for the well-functioning of living things (Baloch , 2021; Adnans *et al.,* 2010). Globally, there is increasing attention on natural products and traditional spices as alternatives to synthetic options for fighting infections, especially among indigenous communities. Furthermore,

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certain plants extract and plant products provide alternative forms of quality nutrient that can empower body cell immunity because of their richness in natural substances and enzymatic systems that protect against oxidation and free radical attack during metabolism (Meccariello and D'Angelo, 2021; Chauke *et al.*, 2015; Huang *et al.*,2010). The earliest historical records of several medicinal plants, herbs and spices extracts, in particular, have been used for centuries for anti-ageing, food flavoring, preservatives and supplements purposes and may be one of the most potent dietary tools for boosting immunity. For example, cinnamon, turmeric, cloves, chamomile herbs and some other tradition vegetables extract were reported to have insulin potentiating activity hence beneficial for diabetic individuals (Kooti *et al.*, 2016; Choudhry *et al.*, 2004). In addition, Olayiwola and co-authors (2017) reported that ginger has been commonly used as cooking spice due to its refreshing pleasant aroma and carminative property makes it an indispensable constituent in food processing.

Analysis of essential elements in medicinal plant-food spices have not been given a lot of emphasis by most researcher, hence the need to determine selected essential elements in four popular African immunity boosting medicinal plants Despite the importance of essential elements, the rise in the use of inorganic dietary supplements from natural sources has highlighted the need for detailed dietary composition data to support epidemiological and intervention studies involving humans.

The aim of this study is to explore and to compare the proximate composition and selected essential elements (Ca, K, Na, Mg and Zn) contents of four popular African medicinal plant species prescribed traditionally for immunity boosting material. The medicinal plants chosen include true cinnamon (Cinnamomum verum), clove (Syzygium aromaticum), ginger (Zingiber officinale), and lemongrass (Cymbopogon citratus). These plants are becoming increasingly popular in modern scientific communities as natural alternatives to chemicals compounds that are useful for the maintenance of human and animal health. The antibacterial and antioxidant properties of garlic, along with the immune-boosting qualities of cloves, ginger and cinnamon can help combat viruses in the body. These traditional medicinal spices are widely consumed in the world because apart from their medicinal value, they have potential applications in functional food development, aquatic products and food packaging. The importance of these analyses is supported by the need to recommend medicinal plants as dietary sources of these minerals, while also ensuring they adhere to established intake limits where applicable. Like many herbs and spices, many studies have been conducted related to the pharmacological composition and nutritional values of these selected medicinal plants differ and contribution of each to human's diet also differs.

Fig 1 Immunity Boosting Medicinal Plants

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II. METHODOLOGY

A. Materials and Materials Preparations

Market survey of four samples of medicinal plant spices analyzed in this study was obtained from informal market at total filling station area, *Oke-Gada*, Ede North Local Government. Apparently healthy plants samples were collected, sorted and the dust removed. The samples were washed and dried at 105 ℃ to constant weight for 3 hours and grounded using a mechanical blender for each sample. The blender was thoroughly cleaned and dried after each grinding to avoid cross contamination.

➢ *Identification of Sample*

The plant samples were identified by Dr. Isreal Ogunsumi a Botanist in the Department of Biological Science, Federal Polytechnic Ede, Nigeria. The four specimens used were identified as; clove locally known as Kanafuru, ginger locally known as Ata-Ile, Cinnamon locally known as Pattai or Oriira and Lemon grass locally known as Koko-Oba or Ewe tea.

B. Proximate Analysis

➢ *Determination of Moisture Content*

The moisture content was measured using the air oven drying technique. The procedure outlined by the Association of Official Analytical Chemists (AOAC, 2000) was followed. Two crucibles were thoroughly cleaned and dried in an air oven at 110 °C for 10 minutes until they reached a stable weight. After cooling in a desiccators for 30 minutes, the crucibles were labeled A and B and weighed (W_1). Each crucible was then filled with precisely 2.0 g of sample and reweighed (W_2). The crucibles with the samples were placed in an oven set at 105 °C and left overnight. They were subsequently weighed, reheated, and cooled repeatedly in 30-minute intervals until a constant weight was achieved.

$$\%\ Moisture\ content = \frac{Weight\ Loss}{Initial\ Sample\ Weight}\ x\ 100$$

➢ *Determination of Ash Content for Sample Preparation for Analysis in Atomic Absorption Spectroscopy*

Ash refers to the residue left after the combustion of an oven-dried sample, which reflects the mineral content of the sample (AOAC, 2000). The ash determination method described by Sarma and Goswami (2017) was used. In this procedure, approximately 5.00 g of each powdered sample was weighed and charred in a crucible on a hot plate to prepare for ashing. The charred samples were then placed in a muffle furnace set at 550 °C for 3 hours in a well-ventilated room. Heating continued until a grayish ash formed. Once completed, the crucibles were removed, cooled in a desiccators for 20 minutes, and the final weights were recorded.

$$\%\ Ash\ content = \frac{weight\ of\ Crucible + ash) - (weight\ of\ empt\ crucible)}{Weight\ of\ Sample\ Used}\ x\ 100$$

The classical sample preparation method for metal analysis often includes several steps. Each ash sample was transferred into a small separate Kedjal flask of 100 mL capacity for digestion. A mixture of nitric acid (HNO_3), hydrochloric acid (HCl), and sulfuric acid (H_2SO_4) in 1:2:4 ratios were gradually added to the ash sample derived from the plant material. This mixture was digested in a fume hood on an electric hot plate, till the digestion has been completed which was indicated by white fumes coming out from the flask. The resulting pasty, colorless residue was then dissolved in about 12 mL of a 1:1 mixture of concentrated HCl and water. The resulting mixture was allowed to sit overnight and then filtered into a 100 mL volumetric flask using *Whatmann 40* filter paper to eliminate any remaining colorless insoluble solids. The volume was then adjusted to the 100 mL mark. The prepared solution was subsequently analyzed using Atomic Absorption Spectroscopy (AAS).

➢ *Atomic Absorption Spectrometry*

The diluted filtrate solutions of the digested samples were analyzed for the elements of interest using Atomic Absorption Spectroscopy (AAS). The analysis was conducted with a Perkin Elmer Analyst 400 model, as shown in Figure 1. In Atomic Absorption Spectroscopy (AAS), radiation is generated from a hollow cathode lamp containing a cathode composed of the element being analyzed. This modulated radiation is directed through a flame where the sample solution is atomized. Portion of solution were used to analyses for essential elements on AAS at Central Science Laboratory, O.A.U., Ile-Ife see Figure 1. The concentrations of various elements were determined using the relative method with analytical reagent (A.R.) grade solutions of the specific elements of interest.

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Fig 1: Overview of Atomic Absorption Spectrometer (AAS).

Today, Atomic Absorption Spectroscopy (AAS) has been employed as a powerful and widely used analytical technique for the quantification of low level essential element in biological, environmental and food matrices under mild conditions. As such, AAS is the method of choice, because it is sensitive, rapid, convenient, and gives low detection level when compared with ion selective electrode or redox titration method. To analyze some essential elements from traditional medicinal spices or natural products, an analytical AAS method was used as described in the literature Mohammed, (2021), using reference standard material and the specific hollow cathode for the element of interest at ambient temperature. The standard conditions for atomic absorption measurements are outlined in Table 1 below.

Table 1: Standard Conditions for Atomic Absorption Measurement.

Elements /	Wavelength (λ_{max})	Current I(A)	Energy	Slit width	Detection Limit (mg/l)
Ca	422.67	10	61	2.7/0.6	0.001
K	766.5	10	98	1.8//0.6	0.001
`Na	589.0	8	84	1.8/0.6	0.001
Mg	285.2	15	92	2.7/0.6	0.002
Zn	213.86	15	47	2.7/1.8	0.002

C. Statistical Analysis

The data collected were presented as mean ± standard deviation and analyzed using Student's t-test. A p-value of ≤ 0.05 was regarded as significant.

III. RESULTS AND DISCUSSIONS

The proximate composition and quantification of essential elements in Cinnamon (*Cinnamomum verum*), clove (*Syzygium aromaticum*), ginger (*Zingiber officinale*), and lemongrass (*Cymbopogon citratus*) were examined. The findings from the proximate analysis of the samples, expressed on a dry weight basis, are presented in Table 2, while the mineral analysis results for these samples are displayed in Table 3.

Table 2: *Proximate Composition of Medicinal Plant Samples.*

Traditional spice sample	Moisture content (%)	Ash content (%)
A = **Cinnamon**	5.57	2.38
B = **Ginger**	10.34	0.69
C = **Clove**	5.97	0.66
D = **lemon grass**	9.86	2.46

Moisture, and ash, contents (%) of medicinal spice samples are expressed as mean of three replications per sample (n = 3)

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The moisture content of plant spices is a critical quality parameter as it can influence the flavor, preservation, and palatability, as well as contribute to the development of fermenting microorganisms (Ajani, 2009). In general, the moisture content of the samples varied between 5.57% and 10.34%, with ginger exhibiting the highest moisture level at 10.34%. In contrast, cinnamon had the lowest moisture content at 5.57%. This value is significantly lower than that of other medicinal plant samples examined in previous studies (Njoka *et al.*, 2010).

Determination of ash content is useful for predicting mineral and trace element contents (Bradbear, 2009). High ash content indicates high mineral and trace element content of the honey, and vice versa (Bradbear, 2009). The results indicated that the ash content of all samples ranged from 0.66% to 2.46%. Consequently, among the medicinal plant samples, lemongrass, which exhibited the highest ash content, was anticipated to have the greatest mineral concentration. However, a significant variation in element content was noticed amongst the tested medicinal plant spices. In this study, the AAS method was successfully performed for the estimation of essential elements Ca, K, Na, Mg and Zn in Cinnamon, Ginger, Clove and Lemmon grass. The essential elements of the tested samples are shown in Table 3. They are abundant in calcium (Ca), potassium (K), sodium (Na), magnesium (Mg), and zinc (Zn).

Thus, the elements and their values are varied in samples studied as follows: Ca (60.39±0.00 – 142.25±0.01) K (39.52± - 435.55±0.01), Na (24.11±0.00 - 97.58±0.01), Mg (20.91±0.00 - 82.41±0.00), Zn (0.84±0.00 - 31.11±0.00) all are in mg/kg. Among the elements that are vital for bodily functions, certain characteristics can be highlighted. For instance, the essential mineral calcium is crucial for strengthening bones and teeth, as well as playing a role in blood coagulation and in certain enzyme metabolic process was found in highest concentration (142.25± 0.01 mg/kg) in Cinnamon (*Cinnamomum verum*), while the lowest concentration (60.39± 0.00 mg/kg) was found in ginger (*Zingiber officinale*) samples. Potassium is essential for metabolism and is plentiful in the diet. Its abundance can be beneficial, and excess levels are generally not a concern, as the human body efficiently excretes it. The kidneys are the primary means of potassium excretion, but the body can also eliminate potassium through the gut and sweat. Potassium was found in highest concentration (435.55±0.01mg/kg) in Lemmon grass (*Cymbopogon citratus*) but lowest concentration (39.52±0.00) was found in Ginger (*Zingiber officinale*) samples. It was reported that the only cause of diabetes mellitus is the lack of potassium in the body. Hassan *et al.*, (2004) reported that, plant based food supplements are usually high in potassium. Lemongrass is appreciated for its high potassium content, which is essential for maintaining healthy blood pressure levels. Potassium helps relax the walls of blood vessels and counteracts the effects of sodium in the body. Generally, all the tested samples are all excellent source of essential elements, (Table 3). The importance of these studied elements cannot be overemphasized because they are required by many enzymes as co-factors and are indispensable in numerous biochemical pathways as reported by (Saod *et al.*, 2019; Soetan *et al.*, 2010; Ozcan, 2004).

Table 3: The Result of Some Elemental Content (mg/kg) in Traditional Medicinal Spices

Element (mg/kg)	Cinnamon	Ginger	Clove	Lemon Grass	RDA (US) mg, 2017
Ca	142.25± 0.01	60.39± 0.00	130.50±2.89	100.55±0.00	1200
K	93.04± 0.00	39.52±0.00	262.03±0.00	435.55±0.01	4700
Na	24.11±0.00	60.25±0.001	97.58±0.01	58.28±0.25	1500
Mg	20.91±0.00	62.12±0.00	82.41±0.00	29.16±0.00	420
Zn	2.71±0.00	1.21±0.00	31.11±0.00	0.84±0.00	11

Results are mean ± standard deviation of triplicate determination (n = 3): RDA = Recommended Dietary Allowance without appreciable health effects

IV. CONCLUSIONS

This study offers comparative biochemical insights into the essential elements and proximate composition of true cinnamon (*Cinnamomum verum*), clove (*Syzygium aromaticum*), ginger (*Zingiber officinale*), and lemongrass (*Cymbopogon citratus*) and lemmon grass (*Cymbopogon citratus*) and the results of the observations were summarized in Tables 2 and 3 respectively. From Table 2, the moisture content of clove (*Syzygium aromaticum*) (5.97%) was found lower compared to those of ginger, lemon grass and cinnamon. In the literature, moisture content is commonly regarded as an indicator of stability and vulnerability to microbial contamination.

Furthermore, in Table 3 all tested traditional immunity boosting medicinal plants are all rich source of chemical elements such as (Ca, K, Na, Mg, and Zn) by using atomic absorption spectroscopy (AAS). Therefore, the nutritive analysis results of traditional medicinal spices give an indication that the tested samples are a rich source of necessary nutrients and can adequate incorporate any of these medicinal plants in the diets as food supplements for the daily healthcare need of human being.

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Conflict of Interest

The authors have no conflict of interest.

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