Nutritional Evaluation and Microbial Enumeration of Herbal Teas Made from *Vernonia amygdalina, Hibiscus sabdariffa,* and *Jatropha tanjorensis* Leaves Blended with of Lemon Zest and Ginger Rhizomes

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ABSTRACT

This study investigated the proximate, mineral, phytochemical composition and microbial enumeration of herbal teas made from leaves of *Vernonia amygdalina, Hibiscus sabdariffa,* and *Jatropha tanjorensis,* blended with ginger rhizomes and lemon zest. Fresh vegetable samples were obtained from markets around makurdi, Benue State Nigeria. They were washed dried and processed into herbal tea and standard methods were used for the analysis. Triplicate values were obtained in each case and expressed on dry weight basis. All data obtained were analyzed statistically using SPSS version 17.0 package. Means and standard deviation were calculated at significant level of $p < 0.05$. Proximate composition of *Vernonia amygdalina, Hibiscus sabdariffa,* and *Jatropha tanjorensis* herbal teas respectively were; moisture content (8.30, 5.70 6.01); crude fibre (18.20, 13.00, 16.80); ash (13.20, 9.80, 16.60); crude fat (4.80, 3.80, 2.89); crude protein (23.40, 18.99, 17.27); and carbohydrate (28.73, 46.71, 43.84); Phytochemical composition of herbal teas included; oxalate (2.59, 9.81, 5.18); phenolic acid (3.42, 9.09, 1.98); tannin (4.90, 3.33, 2.00); alkaloid (3.41) and flavonoid (42.70, 21.08, 20.08). Herbal teas respectively contained, Cu (1.94, 0.84); P (11.88, 12.76, 13.76); Fe (13.35, 13.77, 17.35); Zn (0.01,); Ca (10.31, 10.08, 13.67); and Pb was not detected in that order as well. Microbial enumeration of herbal teas investigated had Total Viable count(TVC) x 10^3 cfu/g (1.2 , 3.6 , 7.2), Total Fungi Count (TFC) x 10^3cfu/g of (2.1) was found only in *Hibiscus sabdariffa* herbal tea and Total Coliform Count(TCC) x 10^2 cfu/g was not detected in any of the samples. These findings suggest that herbal teas made from these leaves may have potential health benefits and could be used as natural sources of important nutrients and phytochemicals. Further research should be carried out on the shelf life, other means and methods of drying these leaves and mechanism of action of extracts of these leaves thereafter confidently project this leaves for therapeutic uses in the treatment of diseases.

Key words: *Jatropha tanjorensis, Hibiscus sabdariffa, Vernonia amygdalina, ginger rhizomes, lemon zest and herbal tea.*

INTRODUCTION

In Nigeria, a high proportion of the rural and urban population resort to natural food ingredients, particularly because of their availability. Both epidemiological and clinical studies have proven that phytochemicals present in cereals, fruits and vegetables are mainly responsible for reduced incidence of chronic and degenerative diseases among populations whose diets are high in these foods [1].

Plants contain other non-nutritive dietary components that are beneficial to health. These components are called phytochemicals. “Phyto” because they are only found in plant based foods [2].

This study concentrated on nutrient and phytochemical levels of three cultivated vegetables. Vegetables are generally herbaceous (non-woody) plants that are cultivated in farms, collected from forest trees, market and home gardens as well as kitchen gardens for home use. Usually, all the botanical parts of the plants (leaves, buds or flowers, calyxes, fruits, stalk, roots are consumed [2].

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This study laid emphasis on controlling post harvest losses in vegetables by producing herbal teas from three green leafy vegetables with blend of ginger rhizomes and lemon zest. During the raining season there is a lot of wastage due to abundance of vegetable produce, these vegetables can be harvested during its season of abundance and processed into herbal teas and during hamattan/dry season the weather is usually cold therefore producing a herbal tea can help control flu and also keep warm when taken hot and it is also cost effective.

Tea is, by definition, a beverage prepared by infusion of young leaves, leaf buds and internodes of varieties of the tea plant *Camellia sinensis* or *Camellia assamica* [3].

In recent times infusions of dry plant parts of other higher plant species have been given the same generic name 'tea' [4]. A more appropriate term for these infusions of other plants is 'herb tea'. A herb tea is defined as an 'infusion of leaves, fruits, stems, roots, etc. made from plant parts other than *Camellia sp*. [3]. The use of herbal remedies especially in the form of teas for management of various diseases is gaining increasing popularity, making them the main stay of health care system, especially among the rural populace in the developing countries [5].

The main objective of the study is to explore the alternative use of *Jatropha tanjorensis, Hibiscus sabdariffa,* and *Vernonia amygdalina* by blending these vegetables with ginger rhizomes and lemon zest as additives to produce herbal teas and ascertain their nutritional contents.

MATERIALS AND METHODS

Sample Collection

The plant samples of *Vernonia amygdalina*, *Hibiscus sabdariffa* , *Jatropha tanjorensis*, ginger rhizomes and lemon were collected from markets around Makurdi Benue State. These plants were authenticated by a plant taxonomist in Department of Botany, University of Agriculture Makurdi.

Preparation of Samples

The flowchart for production of herbal tea from the various vegetable leaves is presented in Fig. 1.

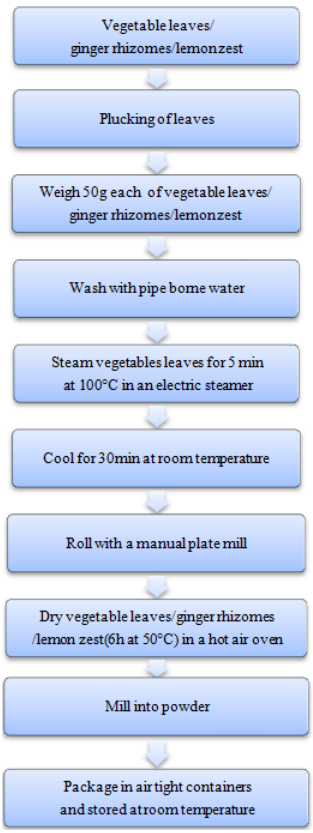

Fig. 1: Flow chart for the production process of herbal teas.

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Preparation of formulation

The dried and blended vegetable leaves were mixed in varying proportions with ginger and lemon. Twenty percent (20%) of lemon zest and ten percent (10%) of dried and powdered ginger rhizomes were added to seventy percent (70%) of each sample; the samples were packaged in a zip lock bag, labeled and stored to await further analysis.

Proximate Analysis

Two grammes (2 g) each of the powdered samples were processed for proximate analysis of various parameters which include (moisture, ash, protein, carbohydrate and lipid content) was determined using standard method of AOAC [6]. Moisture content was determined by drying the sample to a constant weight in the oven at 105^{o}C. Crude protein content was determined by estimating the nitrogen content using the Kjeldahl method of analysis. Ash content was determined by incineration of the sample at 550^{o}C in a furnace. The determination of crude fat was carried out using the Soxhlet extraction method, crude fibre was determined by acid and alkali digestion. Carbohydrate content was calculated by differential method:

% Carbohydrate = 100 – (% Protein + % Moisture + % Fat + % Fibre + % Ash)

Phytochemicals screening

Determination of flavonoid: Flavonoid was determined using spectrophotometer (Aluminum chloride method) as described by [7]. Nine milliliter of the sample was weighed and treated with ethyl acetate and mixed with 1 mL of Aluminum chloride ($AlCl_3$) and methanolic solution (2% w/v) incubated at a room temperature for 15 minutes, the absorbance was read at 430 nm. The amount of the TFC (total flavonoid contents) was estimated from the standard calibration curve of 10 – 100 ?g/ mL – 1 quercetin.

Determination of alkaloids: Two and half gram (2.5g) of each sample was weighed and dispensed into 200mL of 20% acetic acid solution in ethanol. The mixture was well shaken and allowed to stand for 4hrs. This was then filtered and the extract was concentrated using a water bath to evaporate about a quarter of the original volume. Concentrated NH_4OH was added drop-wise to the extract until precipitation was complete. The filter paper was weighed (W_2) and the precipitate was scrapped off and washed with 1% NH_4OH solution. This was weighed with filter paper (W_3); the precipitate was dried on a filter paper in the oven at 60°c for 30 minutes and reweighed (W_4). The weight of the alkaloid was determined and expressed as a percentage of sample weight analyzed, given by the formula [8].

Calculation;

% Alkaloid = $(W_1\text{-}W_2\times100)/ (W_3\times W_4)$

Where

W_1 = Weight of sample

W_2 = Weight of empty filter paper

W_3 = Weight of filter paper+ precipitate before drying.

W_4 = weight of filter paper+ precipitate after drying

Determination of tannins: Five gram (5g) of each of the ground sample were weighed into conical flask in triplicates and 100mL 2M HCl was added. The mixture was boiled in a water bath for 30 minutes. The extract was cooled and filtered using Whatman No. 1 filter paper. The filtrate was taken up twice in 40mL

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each of diethyl ether. The ether extract was heated to dryness and weighed. The tannins content was calculated using a standard curve of extract [7].

Determination of oxalate: Oxalate determination was carried out using methods described by [7]. Two grams of each sample were boiled in 40 mL distilled water for 30 minutes in a reflux condenser. A total of 10 mL of 20% Na_2CO_3 was added and boiled for another 30 minutes. The resulting mixture was filtered and the residue was washed repeatedly with hot water until neutral pH is achieved. The filtrates were concentrated to a small volume and cooled with constant stirring. Hydrochloric acid (HCl) was added, (1:1) drop wise until the final acid concentration after neutralization was 1%. The precipitate was allowed to flocculate and the extract carefully filtered into a 250 mL flask and made-up to mark. It was kept overnight and supernatant liquid was filtered through a dry filter paper in a dry beaker. 50mL portion of this filtrate was taken into a 400 mL beaker, diluted with water to 200 mL. In the cold medium, 10 mL of 10% calcium chloride solution was added and stirred well to precipitate calcium oxalate; it was allowed to stay overnight. The clear supernatant liquid was decanted off through whatman No. 42 and the precipitate was dissolved in HCl acid (1:1). Oxalic acid was re-precipitated by adjusting the pH with ammonia hydroxide solution. Content was boiled and allowed to settle overnight. Oxalic acid was determined by titrating against 0.05N $KMnO_4$, solution.

Calculation;

1 ml of 0.05N KMn04 = 0.00225 g anhydrous oxalic acid.

Oxalic acid = titre value × 0.000225 ⁄ 2

= titre value × 0.1125

Determination of total phenolics: The extraction and determination of total polyphenolics followed the method of [7]. This was performed in two stages: preparation of standard solution (using tannic acid) to produce a calibration curve; and preparation of polyphenol-containing water extract from the samples. The amounts of polyphenols in the samples were subsequently calculated as tannic acid equivalent from the tannic acid curve.

Minerals analysis

The atomic absorption spectrophotometer was used for the analyses of the following metals: Zinc, Iron, Copper, Calcium, Lead and phosphorus was determined using the vanadomolybdate colorimetric method by using an advanced UV/Visible Spectrophotometer (Shimadzu, IR Affinity 1, Japan). Using AAS, the ash solutions of the plant samples were prepared by weighing 5g of each of the powdered plant samples, these were ashed at 550°C in muffle furnace for 5 hrs, and the residues dissolved in 100 ml of deionized water. Suitable salts of the metals were used to make their standards, lamps were fixed. The standard minerals solutions were injected to calibrate the AAS using acetylene gas. An aliquot of ash solutions were injected and the concentrations obtained from the AAS. Using the flame photometer, the diluents of sample was aspirated into the jenway digital flame photometer using the filter corresponding to each mineral element. All of these were carried out using the method described by [9].

RESULTS AND DISCUSSION

The result in Table 1.1 reveals the amount of moisture (8.30± 0.22, 5.70± 0.09, 6.01± 0.18), crude fibre (18.20± 0.01, 13.00± 0.05, 16.80± 0.02), ash (13.20± 0.09, 9.80± 0.15, 16.60± 0.05), crude fat (4.80± 0.10, 3.80± 0.04, 2.89± 0.01), crude protein (23.40± 0.02, 18.99± 0.01 , 17.27± 0.00), and carbohydrate (28.73± , 46.71± 0.06, 43.84± 0.08) content present in *Vernonia amygdalina*, *Hibiscus sabdariffa* , and *Jatropha tanjorensis* herbal teas respectively.

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Table 1.1: Proximate composition of *Vernonia amygdalina, Hibiscus sabdariffa , Jatropha tanjorensis* herbal tea on (%) dry basis

Parameters	*Vernonia amygdalina*	*Jatropha tanjorensis*	*Hibiscus sabdariffa*
Moisture	8.30 ± 0.22^{a}	5.70 ± 0.09^{b}	6.01 ± 0.18^{b}
Crude fibres	18.20 ± 0.01^{a}	13.00 ± 0.05^{c}	16.80 ± 0.02^{d}
Ash	13.20 ± 0.09^{b}	9.80 ± 0.15^{a}	16.60 ± 0.05^{c}
Fats	4.80 ± 0.10^{a}	3.80 ± 0.04^{a}	2.89 ± 0.01^{b}
Protein	23.40 ± 0.02^{b}	18.99 ± 0.01^{c}	17.27 ± 0.00^{e}
Carbohydrates	28.73 ± 0.04^{a}	46.71 ± 0.06^{c}	43.84 ± 0.08^{c}

Values represent means of triplicate values ± s∂ (standard deviation)
Sample means with the same superscripts in a row are not significantly different p<0.05

Table 2.1 represents the phytochemical contents of *Vernonia amygdalina, Hibiscus sabdariffa , Jatropha tanjorensis* herbal tea; oxalate (2.59± 0.05 , 9.81± 0.05 , 5.18± 0.00), Phenolic acid (3.42± 0.25 , 9.09± 0.40 , 1.98± 0.35), Tannin (4.90± 0.01 , 3.33± 0.01 , 2.00± 0.01), alkaloid (3.41± 0.05,9.65± 0.05,5.09± 0.10) and flavonoid was (42.70±0.15, 21.08±0.15, 20.08± 0.15).

Table 2.1:

Table 2.1: Phytochemical composition of *Vernonia amygdalina, Hibiscus sabdariffa, Jatropha tanjorensis* herbal tea mg/100g

Parameters	*Vernonia amygdalina*	*Jatropha tanjorensis*	*Hibiscus sabdariffa*
Oxalates	2.59 ± 0.05^{a}	9.81 ± 0.05^{d}	5.18 ± 0.00^{b}
Phenols	3.42 ± 0.25^{e}	9.09 ± 0.40^{a}	1.98 ± 0.35^{d}
Tannins	4.90 ± 0.01^{a}	3.33 ± 0.01^{c}	2.00 ± 0.01^{e}
Alkaloids	3.41 ± 0.05^{b}	9.65 ± 0.05^{e}	5.09 ± 0.10^{a}
Flavonoids	42.70 ± 0.15^{a}	21.08 ± 0.15^{c}	20.08 ± 0.15^{b}

Values represent means of triplicate values ± s∂ (standard deviation)
Sample means with the same superscripts in a row are not significantly different p<0.05

Table 3.1 shows that *Vernonia amygdalina, Hibiscus sabdariffa and Jatropha tanjorensis* herbal teas respectively contained, Copper(1.94±0.01, 0.84±0.05,2.40±0.08), Phosphorus(11.88±0.05 , 12.76±0.02 , 13.76±0.00a), Ferrous(13.35±0.15 , 13.77±0.04 , 17.35±0.04), Zinc(0.01±0.01,0.01±0.01,0.02 ±0.01), Calcium (10.31±0.05, 10.08±0.02 , 13.67±0.00), and Lead was not detected in that order as well.

Table 3.1: Mineral composition of *Vernonia amygdalina, Hibiscus sabdariffa, Jatropha tanjorensis* herbal

Parameters	*Vernonia amygdalina*	*Jatropha tanjorensis*	*Hibiscus sabdariffa*
Copper(Cu)	1.94 ± 0.01^{a}	0.84 ± 0.05^{c}	2.40 ± 0.08^{e}
Phosphorus(P)	11.88 ± 0.05^{e}	12.76 ± 0.02^{f}	13.76 ± 0.00^{a}
Ferrous(Fe)	13.35 ± 0.15^{a}	13.77 ± 0.04^{a}	17.35 ± 0.04^{d}
Zinc(Zn)	0.01 ± 0.01^{a}	0.01 ± 0.01^{a}	0.02 ± 0.01^{a}
Calcium(Ca)	10.31 ± 0.05^{a}	10.08 ± 0.02^{c}	13.67 ± 0.00^{e}
Lead(Pb)	ND	ND	ND

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Values represent means of triplicate values ± s∂ (standard deviation)
Sample means with the same superscripts in a row are not significantly different p<0.05

Table 4.1 shows the microbial enumeration of *Vernonia amygdalina, Hibiscus sabdariffa, Jatropha tanjorensis* herbal teas respectively Total Viable count (TVC)x103cfu/g (1.24± 0.02 , 3.61± 0.05 , 7.25± 0.45), Total Fungi Count (TFC)x103cfu/g of 2.17± 0.14 in *Hibiscus sabdariffa* herbal tea and Total Coliform Count (TCC)x102 cfu/g was not detected in any of the samples.

Table 4.1: Microbial Enumeration of *Vernonia amygdalina, Hibiscus sabdariffa and Jatropha tanjorensis* herbal teas

Samples	*Vernonia amygdalina*	*Jatropha tanjorensis*	*Hibiscus sabdariffa*
Total Viable count (TVC)x10^3cfu/g	1.24 ± 0.02^{d}	3.61 ± 0.05^{e}	7.25 ± 0.45^{a}
Total Coliform Count (TCC)x10^2 cfu/g	-	-	-
Total Fungi Count (TFC)x10^3cfu/g	-	-	2.17 ± 0.14

ICMSF guidelines:stipulated values of < 10^5 for bacteria and 10^3- 10^4 for fungi < 10^5Cfu/g = Satisfactory, 10^5 to <10^6Cfu/g = Borderline, ≥10^6Cfu/g = Unsatisfactory. Cfu/g: colony forming units per gram

Discussion

Proximate analysis

The results from this study in Table 1.1 shows that the highest moisture content was recorded in *Vernonia amygdalina,* 8.30± 0.22 and lowest in *Jatropha tanjorensis* with 5.70± 0.09 %. Herbal teas studied generally have low moisture which is an index of extended shelf life. Tea in excess of 11% moisture is liable to mould infestation and musty infusion [10]. Low moisture content after dehydration provides concentrated nutrients while high moisture enhances water activities that can increase spoilage therefore; the low moisture content of the herbs studied can encourage the keeping quality through prevention of the growth of microorganisms, and conservation of nutrients that can prevent/ reverse nutritional related diseases [10]. Crude ash content for herbal teas, shows *Jatropha tanjorensis* was found to have the lowest ash content (9.80± 0.15) while *Vernonia amygdalina* and *Hibiscus sabdarrifa* had the highest ash content of (13.20± 0.09 , 16.60± 0.05). The ash content obtained from the samples compare favorably with the values reported for *Vernonia amygdalina* (16.65%) [11] and *Moringa oleifera* (15.09%) [12], this is also in line with [13] who proposed that Samples with high percentages of ash contents are expected to have high concentrations of various mineral elements, which are expected to speed up metabolic processes and improve growth and development. The crude fibre values for *Hibiscus sabdariffa* (16.80± 0.02) and *Vernonia amygdalina* (18.20± 0.01) were higher than that of *Jatropha tanjorensis* (13.00± 0.05). The results of crude fibre contents of the samples is in agreement with the crude fibre content reports from [10] which showed that powdered Moringa leaves has crude fibre content (18.64%), also (18.82%) reported for Srilanka tea [14], Findings from other researchers [15] also showed evidence that a high intake of dietary fibre is associated with enhanced insulin sensitivity and therefore may have a role in the prevention and control of Type 2 diabetes. Fibre cleanses the digestive tract by removing potential carcinogens from the body and prevents the absorption of excess cholesterol. Fibre also adds bulk to the diet and prevents the intake of excess starchy food [16] and may therefore guard against metabolic conditions such as hypercholesterolemia and diabetes mellitus [17]. In tea, however, crude fibre improves the sensory appeal of the beverage by providing a filter system to prevent the leaching of plant material from the tea bag into the infusion. Fat

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content value obtained in this present study for *Vernonia amygdalina, Hibiscus sabdariffa and Jatropha tanjorensis* herbal teas were 4.80± 0.10, 2.89± 0.01 , 3.80± 0.04, which conforms to the range of 1.60% to 6.5% indicated by [18] for nutritional composition of some leafy vegetables consumed in Imo State. The low values obtained is in agreement with the general observation that leafy vegetables are low lipid containing foods that play significant role in avoiding obesity [17]. A diet providing 1 – 2% of its caloric of energy as fat is said to be sufficient for human being as excess fat consumption is implicated in certain cardio-vascular disorders [19]. Protein contents revealed the highest protein content in the following order *Vernonia amygdalina* (23.40± 0.02) > *Jatropha tanjorensis* (18.99± 0.01) > *Hibiscus sabdariffa* (17.27± 0.00) Reports by [20] showed a crude protein content of (28.27%) for O. grattissimum, also [21] presented a higher value of 61.7% in *Telfaria occidentalis*. These disparities in the protein contents may be attributed to the differences and types of manure applied to enrich the nitrogen content of the soil where these vegetables are harvested [22]. Proteins are the building blocks of life and every cell in the human body contains protein which helps to repair and replace worn out tissues. [23].

Phytochemical screening

The results of the phytochemical screening of herbal teas are shown in table 2.1. From these results it reveals that flavonoids content was the highest in *Vernonia amygdalina* herbal tea (16.62± 0.01) while *Hibiscus sabdariffa* had the least flavonoid content of (8.28 ± 0.05). Flavonoids are potent water-soluble super antioxidants and free radical scavengers however, moderate intake of flavonoid is essential for normal heart beat, neuromuscular and metabolic activities [24]. The high content of flavonoids in these leaves may account for its use in treatment of diseases. The total alkaloid content present in the samples was found to be highest in *Jatropha tanjorensis* (9.65± 0.05), *Hibiscus sabdariffa* leaves (5.09 ± 0.10) and *Vernonia amygdalina* (3.41 ± 0.05%) had the least alkaloid content. Reports by [25] shows that alkanoids are powerful pain relievers, have an antipyretic action, a stimulating effect and can act as tropical anesthetic in ophthalmology. The presence of tannins in the leaves also agreed with [26] and the previous works of [27] that discovered traces of tannins in some leafy vegetables grown and consumed around Nigeria. Tannins are known to have antiviral, antibacterial and anti-tumor properties. Tannins can also be effective in curbing hemorrhages as well as restrict bare swellings [16]. The tannin content of the samples were within the range of (4.20 ±0.01- 1.21 ±0.01) According to [28], tannin level in foods below 5mg/100g are safe for human consumption. The herbal tea samples all had tannin content below 5mg/100g which implied that they are within safe levels for consumption and its antioxidant effects will help in cancer prevention [28]. The oxalate content of the herbal teas were within the range of (4.31± 0.09 to 1.14± 0.05) these results compares well with those of rubber seed which ranged from (3.36 to 13.26 mg/100 g) [29] but fell below those of [30] reported for (boiled) soybeans (52 mg/100 g). Research by [30] considered foods containing >10 mg oxalate as high-oxalate food. Oxalates bind to minerals like Ca, Fe, and Mg to form insoluble compounds, which brings some concerns given that calcium oxalate has been implicated in kidney stones, and render it unavailable for absorption [31]. The oxalate content of these herbal leaves was found to be below the recommended daily intake range for human consumption (maximum tolerated level of 50 mg/100 g) [32]. In the present study, drinking herbal teas is probably safe because of their low oxalate. Results obtained from this study showed phenolic content for *Vernonia amygdalina, Hibiscus sabdariffa and Jatropha tanjorensis* herbal teas were 0.17± 0.05 , 0.29± 0.05 and 0.23± 0.05. Phenols are strong antioxidants and play a role in the prevention and management of chronic diseases such as cancer and cardiovascular disease. Reports obtained by [33] stated that plant phenols may interfere with all stages of the cancer resulting to reduction of cancer risk.

These results showed the phytochemicals present in these samples can influence various body processes. They work together with nutrients and dietary fibre to protect the body against diseases, slow the aging process and reduce the risk of many diseases such as cancer, heart disease, stroke, high blood pressure etc [34].

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Mineral Analysis

The mineral constituents of *Vernonia amygdalina, Hibiscus sabdariffa and Jatropha tanjorensis* herbal teas are displayed in Table 3.1 and from these results, it was shown that the samples have high contents of ; P (11.88±0.05, 13.76±0.00, 12.76±0.02); Fe (13.35±0.15, 17.35±0.04, 13.77±0.04) respectively and this result compares favorably with RDI for men (8 mg/day) and women (18 mg/day) [35]. The iron content found in this work is significantly lower than the Fe content reported for the leaves of Figl and Girgir (57.2 mg/100 g) and (67.0mg/100g) respectively [32]. Ca(10.31±0.05, 13.67±0.00 , 10.08±0.02). Calcium plays an important role in building strong as well as in the keeping of healthy bones and teeth at both early and later life [35]; Cu (1.94±0.01, 2.40±0.08, 0.84±0.05) and Zn(0.01±0.01, 0.012±0.01, 0.01±0.01) the values obtained for Zn in these samples is within the maximum acceptable limit of 0.025 mg/g [36].

Microbial Analysis

Results from microbial enumeration of herbal teas made from *Vernonia amydalina, Hibiscus Sabdariffa and Jatropha tanjorensis* showed the absence of Total coliform count (TCC) in *Hibiscus Sabdariffa, Jatropha tanjorensis and Vernonia amydalina*, also Total fungi count (TFC) was not detected in *Jatropha tanjorensis* and *Vernonia amydalina*. This could be as a result of the blend of ginger rhizomes to the herbal teas which is also in agreement with [37] who investigated those Ginger-inhibited foodborne pathogens such as S. aureus, E. coli, and Enterococcus species. Ginger is rich in naturally occurring bioactive compounds and essential oils that suppress the growth of a variety of food spoilage microorganisms. The total fungal count was found in *Hibiscus Sabdariffa* herbal tea (2.17±0.14). This result is within the satisfactory levels of (?105Cfu/g) by [38]. It is obvious from our results the effect of the presence of ginger and lemon zest on the microbial analysis of the herbal tea blend. From the results of microbial analysis obtained herbal teas produced from leaves of *Vernonia amydalina, Hibiscus sabdariffa and Jatropha tanjorensis* are within the satisfactory levels of (?105Cfu/g) by [38] and are safe for human consumption.

CONCLUSION

The results of these study provides empirical basis for production of high quality herbal teas from leaves of Vernonia amygdalina, Hibiscus sabdariffa, and Jatropha tanjorensis. The moisture analysis conducted, clearly demonstrated that all herbal teas had low moisture content, which will enhance the shelf stability of the products, if properly packaged. Herbal teas had high levels of protein and carbohydrate contents. The herbal teas had an appreciable amount of ash content, thus indicating them as a good source of minerals which was clearly shown from investigated results of mineral analysis. The investigated herbal teas had significant amounts of phytochemicals present in them these phytochemicals work together with nutrients and dietary fibre to protect the body against diseases, slow the aging process and reduce the risk of many diseases such as cancer, heart disease, stroke, high blood pressure etc. the microbial analysis results shows that the microbial count of herbal teas produced are within the satisfactory levels of (?10^5Cfu/g) by [38] and therefore are deemed safe for human consumption.

REFERENCES

1. Shahidi, F., Zhong, Y., & Chandrasekara, G. A. (2012). Antioxidants and human health. In L. Yu, R. Tsao, & F. Shahidi (Eds.), Cereals and pulses: Nutraceutical properties and health benefits (1st ed., pp. 273–308). Chichester, UK: John Wiley & Sons, Inc
2. Okeke, E.C., Ene-Obong, H.N., Uzuegbunam, A.O., Ozioko, A.O., & Kuhnlein, H. (2008). Igbo Traditional Food Systems: Documentation, Uses and Research Needs. Pakistan Journal of Nutrition, 7(2). 365-376.
3. Bender, D.A. (2003) Benders' Dictionary of Nutrition and Food Technology, 7th Edition, CRC Press.
4. Owusu, E. and Odamtten, G.T. (1999) Quality of Ghana herbal tea: microflora and control measures. Journal of the Ghana Science Association 1 (3): 84-99.

5. Ogbonna, S.O., G.O. Mbaka, E.N. Anyika, J.E. Emordi and N. Nwakakwa, (2011). An evaluation of acute and subchronic toxicities of a Nigerian polyherbal tea remedy. Pak. Journal of Nutrition, 10: 1022-1028.
6. AOAC (2000). Association of Official Analytical Chemists, Washington D.C. Official method of Analysis, 16th edition
7. Opega J. Ladi., Orishagbebmi C. Ojo., Yusufu P, A., and Ishaka N. A., (2016). Proximate Composition, Mineral and Phytochemical Contents of Some Leafy Vegetables Native to Igala Kingdom Kogi State Nigeria. International Journal of Biochemistry Research & Review 15(4): 1-11, 2016; Article no.IJBCRR.30011
8. Okwu D.E, Emenike I.N. (2006). Evaluation of phytonutrients and vitamin contents of citrus fruits. International Journal of Molecular Medicine and Advance Science 2006;2 (1):1-6.
9. Chinma, C. E. and Igyor , M. A. (2007). Micronutrients and anti – nutritional contents of selected tropical vegetables grown in Southeast, Nigerian Food Journal, 25(1): 111 – 116, 2007.
10. Gabriel, I. O and Nkemakonam, M. O. (2015). Production and Quality Evaluation of Green and Black Herbal Teas from Moringa oleifera Leaf Department of Food Science and Technology, University of Nigeria, Nsukka, Enugu State, Nigeria Journal of Food Resource Science, 2015
11. Usunobun, U., Egharevba, E**.** (2015) Phytochemical Analysis, Proximate and Mineral Composition Mineral Composition and In Vitro Antioxidant Activities in Telfairia Occidentalis Aqueous Leaf Extract BIU Journal of Basic and Applied Sciences Vol. 1 no. 1 (2015)
12. Ugwu OPC, Nwodo OFC, Joshua PE, Bawa A, Ossai EC & Odo CE.(2013). Phytochemical and Acute Toxicity Studies of Moringa oleifera Ethanol Leaf Extract. International Journal of Life Sciences Biotechnology and Pharma Research 2(2), 66-71.
13. Bello, B.C., Izergina, N., Cavssinus, E. and Reicjert, H. (2008). Amplification of neutral stem cell. Proliferative By Intermediate Progenitor Cells in Drosophila Brain Development. Neural Dev. 19(3):5.
14. Mohammed, M.I. and Sulaiman, M.A. (2009). Proximate, caffeine and tannin analyses in some brands of tea consumed in Kano Metropolis, Nigeria. Bayero Journal of Pure and Applied Science., 2: 19-21.
15. Ylonen K, Saloranta C, Kronberg C, Leif G, Antti A, Suvi M, &Virtanean M. (2003). Associations of Dietary Fiber with Glucose Metabolism in Non-diabetic relatives of subjects with Type 2 Dia-betes. Diabetes care 26, 19791985.http://dx.doi.org/10.2337/diacare.26.7.1979.
16. Mensah JK, Okoli RI, Ohaju-Obodo JO and Eifediyi K. (2008).Phytochemical, nutritional and medical properties of some leafy vegetables consumed by Edo people of Nigeria. African Journal of Biotechnology 7, 2304-2309.
17. Henry S. (2004). Fiber: An all natural medicine for type 2 diabetes? Consumer health interative http://www.ahealthyme.com
18. Iheanacho, K. M. and Udebuani, A. C. (2009). Nutritional Composition of Some Leafy Vegetables Consumed in Imo State, Nigeria. Journal of Applied Science and Environmental. Management. 13(3) 35 – 38.
19. Antia BS, Akpan EJ, Okon PA &Umoren IU.(2006). Nutritive and Anti-Nutritive Evaluation of Sweet Potatoes (Ipomoea batatas) Leaves. Pakistan Journal of Nutrition 5,166-168http://dx.doi.org/10.3923/pjn.2006.166.168.
20. Emmanuel O, Ugbogu A. E., Odungide A. A., and Atani C. S.,(2017). "Proximate, Antinutritional and Mineral Estimation of Some Selected Consumed Green Vegetables in Afaha Eket, Akwa-Ibom State, Nigeria." American Journal of Food Science and Technology,vol.5, no. 5(2017): 182-191.doi: 10.12691/ajfst-5-5-3.
21. Asaolu, S. S., Adefemi, O. S., Oyakilome, I. G., Ajibulu, K. E. and Asaolu, M. F. (2012). Proximate and mineral composition of Nigerian leafy vegetables. Journal of Food Research, 1: 214-218, 2012
22. Saidu, A. N. and Jideobi, N. G. (2009). The proximate and elemental analysis of some leafy vegetables grown in Minna and environs. Journal of Applied Science and Environmental Management,13: 21-22, 2009
23. Kerstetter, J. E., Brien, K. O., Caseria, D. M., Wall, D. E. and Insogna, K. L. (2005). "The impact of dietary protein on Calcium absorption and kinetic measures of bone turnover in women". Journal of

Clinical Endocrinology and Metabolism, 90: 26-31, 2005.
24. Onimawo I.A. and Akubor P.l. (2012). Food chemistry (Integrated Approach with biochemical background). 2nd Edition, Joytal Printing Press, Agbowo, Ibadan Nigeria.
25. Edeoga, P.K. and Enata, D.O. (2011). Alkanoids, Tannins and Saponin content of the medicinal plants. J. Med. Amn. Plant Sci., 23: 344-349.
26. Abdurahman, F.I; Tijani, M.A. and Osuyi, U.O. (2012). Proximate content and chemical composition of Ocimum viridis leaf and Ocimum gratissium leaf. International Research Journal of Pharmacy, 2(3): 347- 354.
27. Oyeyemi, S. D., Arowosegbe, S., Adebiyi, A. (2014) Phytochemical and Proximate Evaluation of Myrianthus Arboreus (P.Beau.) And Spargonophorus Sporgonophora (Linn.) Leaves O IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS) e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 7, Issue 9 Ver. I (Sep. 2014), PP 01-05 Department of Plant Science, Ekiti State University, Ado-Ekiti, Nigeria
28. WHO (World Health Organization). (2002). The world health report 2002 – Reducing risks, promoting healthy life. Geneva, WHO.
29. Agbai, C. M., Olawuni, I.A., Ofoedu, C. E., Ibeabuchi, C.J., Okpala, C.O., Shorstkii I, Korzeniowska M. (2021). Changes in anti-nutrient, phytochemical, and micronutrient contents of different processed rubber (Hevea brasiliensis) seed meals. PeerJ 9:e11327 DOI 10.7717/peerj.11327
30. Mark, (2020). Understanding pulse anti-nutrients. American Oil Chemist Society. Available at https://www.aocs.org/stay-informed/inform-magazine/featured-articles/understanding-pulseanti-nutrientsjanuary-2020?sso=True (accessed 5 May 2020).
31. Spritzler, F. (2017). Oxalate (oxalic acid): good or bad? Healthline. Available at https://www.healthline.com/nutrition/oxalate-good-or-bad (accessed 5 May 2020).
32. Ebisa, O. K,. Yetenayet, B. Tola,. B,. Sirawdink, F. F,. (2020). Proximate, mineral, and anti-nutrient compositions of underutilized plants of Ethiopia: Figl (Raphanus sativus L.), Girgir (Eruca sativa L) and Karkade (Hibiscus sabdariffa): Implications for in-vitro mineral bioavailability. Food Research International 137 (2020) 109724
33. Holland, P.C. (2001). Evidence for health benefits of plant phenols: Local or systemic effects? Journal of Science Food and Agriculture, 81, 842-852.
34. Adelakun K. M, Kehinde A. S, Amali R. P, Ogundiwin D. I, Omotayo O. L (2016). Nutritional and Phytochemical Quality of Some Tropical Aquatic Plants. Journal of Poultry, Fisheries and Wildlife Sciences 4: 164.
35. Usunobun, U., Okolie, P. (2016). Phytochemical analysis and proximate composition of Vernonia Amygdalina. International Journal of Scientific World, 4(1) (2016)11-14
36. 2012b. Guideline: sodium intake for adults and children. Geneva, Switzerland: WHO Press, 10–16
37. Lui, Q.,Meng X., LI, Y., Zhao, C. N., Tang, G.Y. (2017). Antibacterial and antifungal activities of spices. International Journal of Molecular Sciences, Guangzhour, v.18, n.6, p.2-62,2017.
38. ICMSF, International Commission on Microbiological Specifications for Foods (2002) Microorganisms in foods, Microbiological testing in food safety management. Kluwer Academic/Plenum Publishers, New York.