

Full Length Research Paper

Qualitative and quantitative evaluation of some herbal teas commonly consumed in Nigeria

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Herbal tea can be used for therapeutic or nutritional purposes, depending on the chemical constituents present. This study aims at evaluating phytochemical, physicochemical parameters and elemental contents of herbal teas commonly consumed in Nigeria. Level of essential and toxic metals in medicinal plants is a matter of great concern all over the world. Six different brands of herbal teas were analysed in this study. Phytochemical screening results showed the presence of tannins, steroids, terpenoids, saponins, cardiac glycosides, flavonoids, alkaloids and phlobatannins, while the physicochemical parameters which includes moisture content, ash, water extractive and alcohol extractive matter values ranges from 7.55 to 21.20, 5.52 to 9.28, 8.86 to 14.80 and 4.22 to 7.05%, respectively. Atomic absorption spectroscopy (AAS) was used for the elemental analysis of different teas in which the content ranges from 0.83 to 2.63, 3.28 to 5.96, 7.45 to 86.67, 0.53 to 2.85 and 1.11 to 9.73 µg/g for chromium (Cr), iron (Fe), manganese (Mn), Lead (Pb) and zinc (Zn), respectively. The outcome of this study serves as an important contribution to knowledge in establishing quality parameters for the standardization of herbal tea in Nigeria.

Key words: Phytochemical, physicochemical, elemental analysis, herbal tea.

INTRODUCTION

Herbs have been used for centuries to treat a variety of medical illnesses. Both wild and cultivated ones have found wide acceptance in the past and present for the preparation of refreshing drinks, such as teas. Teas can be prepared from either fresh or dried herbs by infusion in hot water. Herbal tea can be used for therapeutic or nutritional purposes, depending on the chemical constituents present. Botanical evidence indicated that, today, tea is the most widely consumed beverage in the world, second only to water. Studies suggest that green tea (*Camellia sinensis*) in particular has many health benefits among which are: prevention of cancer, use as stimulant, diuretic (to promote the excretion of urine), astringent (to control bleeding and help heal wounds) and to improve heart health; treating flatulence (gas), regulating body

temperature and blood sugar, promoting digestion, and improving mental processes.

There are three main varieties of tea; green, black and oolong. The difference between the teas is in their processing. Green tea is made from unfermented leaves and reportedly contains the highest concentration of powerful antioxidants called polyphenols. Antioxidants are substances that scavenge free radicals damaging compounds in the body that alter cells, tamper with DNA (genetic material) and even cause cell death. Free radicals occur naturally in the body, but environmental toxins (including ultraviolet rays from the sun, radiation, cigarette smoke and air pollution) also give rise to these damaging particles. In spite of the popular opinion that herbs and herbal medicines are harmless, cases of poisoning with toxic heavy metals from herbal products are described in the literatures (Ernst and Coon, 2001; Van Vonderen et al., 2000).

Medicinal herbs are easily contaminated during growth, development and processing, this may be attributed to

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Table 1. Instrumental parameters for the GBC AAS determination of Cr, Mn, Fe, Pb and Zn.

Element	Wavelength (nm)	Sensitivity ($\mu\text{g/ml}$)	Working range (μg)	Slid width (nm)	Gas type
Cr	357	0.05	2 - 15	0.2	Air acetylene
Fe	248.3	0.05	2 - 9	0.2	Air acetylene
Mn	279.5	0.02	1 - 3	0.2	Air acetylene
Pb	217	0.06	2.5 - 20	0.2	Air acetylene
Zn	213.9	0.008	0.4 - 1.5	0.5	Air acetylene

many factors, such as, geo-climatic conditions, anthropogenic activities, such as fertilizer and insecticides fertilizers (Chan, 2003; Harrison and Chirgawi, 1989a, b; Djingova et al., 2003), industries, plants parts used and plant genotype since different plants also have different capacities to selectively accumulate some elements, that is, hyper accumulators. World Health Organisation (WHO) therefore, recommends that medicinal plants which form the raw materials for the finished products be checked for the presence of heavy metals (WHO, 1998). After collection and transformation into dosage form, the heavy metals confined in plants and finally enter the human body and may disturb the normal functions of central nervous system, liver, lungs, heart, kidney and brain, leading to hypertension, abdominal pain, skin eruptions, intestinal ulcer and different types of cancers. The possibility of the potential contamination cannot be over-looked as they may cause serious effects on human health. It becomes imperative to ensure the quality of the plant material, if it were meant for human consumption, since human body requires both metallic and non metallic elements within certain permissible limits for growth and good health. Determination of elemental compositions and elucidation in foods and related products is essential for understanding their nutritive importance and interpretation of their therapeutic actions which may help in designing chemically pure medication (Darinka et al., 2010).

There are no standards for herbal materials, which establish a permissible level of metals in such materials, only for the few which World Health Organization (WHO, 2006) has fixed maximum permissible levels in the dry mass of medical plants that is, for arsenic, cadmium and lead 1.0, 0.3 and 10 mg/kg, respectively indicating that, scientific evaluation of herbals has only recently begun. Level of essential and toxic heavy metals in medicinal plants beyond permissible limit is a matter of great concern to public safety all over the world (Shad et al., 2008), the problem is rather more serious in Nigeria, because medicinal plants which form the raw materials for the herbal tea are neither controlled nor properly regulated by quality assurance parameters. It is part of the effort made by this study therefore to contribute toward establishing a chemical profile database for quality standardization of herbal teas commonly consumed in Nigeria.

EXPERIMENTAL

Reagents

The concentrated nitric acid (HNO_3) and perchloric acid (H_2O_2) used for the digestion were of analytical grades. They were manufactured by Merck KGa A of Germany and BDH Limited Poole England, respectively; deionized water. Standard salts of chromium (Cr), iron (Fe), manganese (Mn), Lead (Pb) and zinc (Zn) were used for the preparation of aqueous standard solutions by appropriate dilution of 1.000 g/L. Solution of the tea samples and dilutions were made with deionized water. Trease and Evans methods (1883) were used for the phytochemical screening of the samples.

Apparatus

Atomic absorption spectrometer (AAS) GBC Avanta GF3000 Model under standard conditions using an air-acetylene gas; Vecstar Furnace, Oven, Desiccators and General Glass wares were used. The optimized experimental conditions of the instrument are as shown in Table 1.

Analytical techniques

Deionized water was used for the sample and standards preparations, reagents (BDH Pool, England) were used. Working standards of the selected metals were prepared by dilution of stock-standards which were prepared from analytical grade salts of the metals with HNO_3 and the results were corrected from blanks reagent.

The following wavelengths were chosen for the metal analysis: Fe (248.3 nm), Mn (279.5 nm), Cr (357.9 nm), Pb (217.0 nm) and Zn (213.9 nm). The equipment was calibrated for the investigation of the elements following the sensitivity and detection limits, respectively using standards calibration curve method. All results were calculated in micro grams per gram.

Sample preparation

Sampling

Six 6 samples of locally prepared teas were purchased directly from the retail shops in FCT, Abuja, Nigeria and coded as Loftier tea (LOT), Ketepe tea (KET), Lipton tea (LIT), Jerusalem tea (JET), Safari tea (SAT) and Top tea (TOT) for the purpose of this study. With the exception of LOT and JET, all the other brands were registered with National Agency for Food, Drug Administration and Control (NAFDAC) in Nigeria.

Table 2. Phytochemical analysis of the tea samples.

Sample	Alkaloid	Flavonoid	C.glycoside	Saponnin	Steroid	Tannin	Terpenoid	Phlobatannin
LOT	+	+	-	+	+	+	-	+
LIT	-	-	+	+	+	+	+	+
KET	-	-	-	+	+	+	+	-
TOT	-	-	+	+	+	+	+	-
SAT	-	-	+	+	+	+	+	-
JET	-	+	-	-	-	+	+	-

Table 3. Physico-chemical parameters of the tea samples.

Sample	Moisture (%)	Total ash (%)	Water extractable	Ethanol extractable
LOT	10.40	8.08	12.97	6.18
LIT	7.74	6.02	9.65	4.60
KET	21.20	5.52	8.86	4.22
TOT	11.95	9.28	14.80	7.05
SAT	7.55	5.87	9.41	4.49
JET	9.25	7.19	11.54	5.49

Acid digestion of the tea samples

Weighed quantities of the powdered sample in a crucible were heated in a furnace at 550°C for about 6 h. The contents of crucible were cooled in desiccators and 2.5 ml 6 M HNO₃ was added to the content to dissolve it. The solution was filtered and transferred to a 20 ml flask and was diluted to the mark (Radojevic, 1999) followed by quantitative determination of the metals on atomic absorption spectrophotometer (AAS) GBC Avanta.

Phytochemical screening

Prior to testing, 2.0 g of the plant material was rapidly extracted with 20 ml of the solvent by shaking for 3 to 30 min or heating on water bath depending on the test in question. The solutions were filtered using Whatman filter paper and each filtrate was used for the phytochemical test using Trease and Evans (1983) methods.

Physico-chemical analysis

Moisture

1.0 g each of the respective powdered samples was weighed each on aluminium foil on the automated moisture analyser pan and set at 105°C for 3 h where moisture content percentage of the sample was obtained (WHO, 1998).

Total ash

2.0 g of the respective powdered samples was ignited in a previously ignited and tarred crucible at 500°C for about 3 h until the sample was white, indicating the absence of carbon, and was cooled in a desiccators and was later weighed (WHO, 1998).

Extractable matter (EM)

4.0 g of the respective powdered samples were macerated each with 100 ml of the solvent specified by frequent shaking for 6 h and was allowed to stand for 18 h, and then it was filtered; followed by evaporating 25 ml of the filtrate in a flat bottom platinum dish on a water-bath. The extracts were dried at 105°C for about 6 h and was cooled in desiccator for 30 min, weighed and calculated as mg per gram of the powdered sample. The percentage of the solvent soluble extractive was calculated with reference to the air-dried sample (WHO, 1998).

RESULTS AND DISCUSSION

The preliminary phytochemical screening of the various brands of the tea samples indicated the presence of consistent tannins and steroids for all the brands, while terpenoids and saponins in five brands, cardiac glycosides in three brands, flavonoids in two brands, while alkaloids and phlobatannins in one brands each as shown in Table 2. The moistures content of the various brands ranges from 7.55 to 21.20% as shown in Table 3. The level of moisture in herbal products can influence the susceptibility of microbial activities on the sample. A literature revealed that less moisture keeps the product microbiologically safe by preventing bacterial, fungal and yeast growth. If moisture content is very high, enzymatic activation may occur and result in loss of therapeutically active substance. Ash value of the different tea brands ranges from 5.52 to 9.28% (Table 3) which gives the rough idea of the minerals content in the samples. The water soluble extractive value ranges from 8.86 to 12.97% (Table 3) indicating the presence of sugar, acids

Table 4. Toxic and essential metals ($\mu\text{g/g}$).

Sample	Pb	Fe	Zn	Mn	Cr
LOT	1.51	3.28	9.73	20.17	0.83
LIT	0.53	5.96	5.55	27.05	2.63
TOT	0.00	0.00	1.11	86.67	0.00
JET	2.85	0.00	0.00	7.45	0.00
KET	0.00	5.23	6.48	19.12	1.49
SAT	0.72	0.00	2.92	21.75	0.00
WHO limits	10.0	100	25*	-	-
RDA	*3 mg/week	10 - 60	100	11	50 - 200

WHO limit: World Health Organization Limit; RDA: Recommended Daily Allowance.

and inorganic compounds, while alcohol soluble extractive values was 4.22 to 7.05% which also indicated the presence of polar constituents.

Elemental quantification of the samples using AAS show evidently that the various brands of the teas selected for this study could be sources of both essential (Fe, Mn, Cr and Zn) and toxic metals (Pb). Various roles of these elements with regard to human health were discussed as follows.

Iron (Fe) metal play a vital role as an essential component of haemoglobin for human beings. It facilitates the oxidation of carbohydrates, protein and fat to control body weight, which is a very important factor in diabetes. The dietary limit of it in food is 10 to 60 mg/day (Kaplan et al., 1993), while low amount of it causes gastrointestinal infection, nose bleeding and myocardial infarction (Hunt, 1994).

Lead (Pb) induces various toxic effects in humans at low doses with typical symptoms, such as colic, anaemia, headache, convulsions and chronic nephritis of the kidneys, brain damage and central nervous system disorders. WHO prescribed maximum limit for its contents in herbal medicine as 10 $\mu\text{g/g}$, while the dietary intake limit of it per week as 3 mg/week.

Zinc (Zn) is an essential trace element which plays an important role in various cell processes, including normal growth, brain development, behavioural response, bone formation and wound healing. Zinc deficient diabetics fail to improve their power of perception and also cause loss of sense of touch and smell (Hunt, 1994). The dietary limit of it is 100 $\mu\text{g/g}$.

Manganese is referred to as humble trace element but essential to health. It enables the body to utilize vitamin C, B1, biotin and Cl. Neutralize free radicals, prevent diabetes, growth of connection tissue and brain functioning. Its deficiency result in poor growth, birth defects, blood glucose problem and reduced fertility; it also result in deafness, blindness and paralysis. Its recommended daily allowance (RDA) is 2 mg/day. The toxic effects of chromium (Cr) intake is skin rash, nose irritations, bleeding, stomach upset, kidney and liver damage, nasal itch and lungs cancer; chromium deficiency is characterized

by disturbance in glucose, lipids and protein metabolism (McGrath and Smith, 1990). The daily intake of Cr (50 to 200 μg) has been recommended for adults by US National Academy of Sciences (Watson, 1993).

The result of this work indicated that, the elemental content of all the brands of the tea analyse were below the RDA per day with the exception of manganese which is the only sample that could not meet the RDA.

Conclusion

In this study, all the detected metals were within the WHO permissible limits and may not result in any health hazards to the consumer of these products, except that there is need for monitoring the environment where the raw materials were cultivated and processed in order to avoid contamination by toxic metal like lead, because consumption of its trace over a long period of time may lead to gradual accumulation in the body system which may result in some complication over time. Apart from that, these teas can be recommended as suitable phytotherapeutical and nutritional products.

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