

Composition and *in vitro* Antioxidant Capacity of Swedish Bitters

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ABSTRACT

Bitters are generic term that denotes all bitter liquors and herbal bitters. They are produced from herb and root extracts, from the narcotic components of (primarily) tropical and subtropical plants and spices. They are usually dark in colour and valued for their ability to promote appetite and digestion. Bitters are made from numerous groups of chemical compounds extracted from the herbs and roots (medicinal plants) that have the common characteristics of a bitter taste and act to increase the vital energy centres of the body. The results of this study indicate that Swedish bitters possess high amounts of phytochemicals like alkaloids, tannins, flavonoids, phenols, saponins and cyanogenic glycosides. Swedish bitters contain significant amounts of Na, K, P, Ca, Mg, Zn, Mn, Fe, and Cu, while Pb, Cr, and Se were not detected. Swedish bitters have IC₅₀ values for 50% ABTS inhibition of 18.68mg/ml indicating that the bitters have a relatively high antioxidant capacity as claimed by the producers of the bitters.

Keywords: Swedish bitters, medicinal plants, antioxidant capacity and pharmacological properties.

INTRODUCTION

Unorthodox traditional medicine practice which employs the use of herbs (medicinal plants), have in recent times been gaining much publicity and recognition, for their solution to ailments seemingly elusive to the system of orthodox medical practice. Medicinal plants have been defined as those plants which contain in one or more of their organs, substances that can be used for the synthesis of useful drugs. Medicinal plants have been defined and associated with gods and spiritual invocations. However with the advent of science, civilisation and Christianity, there has been a drastic decline in this practice. Modern pharmacology had its origin in these medicinal plants and till date some drugs are products of active components from plants [1 and 2]. Modern science may have widened for some time the differences in terms of medication between orthodox and unorthodox/traditional medicine, this gap seems to be closing fast as the current trend is that they are both adopting practices from each other [1 and 2]. This has led to the resurgence of an ancient remedy for digestive problems in the repackaging of “herbal bitters” and products like it in an “orthodox way”. The term “bitters” as it is used presently, is a beverage, often alcoholic, flavoured with herbal essences that gives it a bitter or bittersweet flavour. The generic term applies to all bitter liquors and herbal bitters. Bitters are produced from herb and root extracts, from the narcotic components of (primarily) tropical and subtropical plants and spices. They are usually dark in colour and valued for their ability to promote appetite and digestion hence their use as patent medicine and as aid in digestion and as flavouring in cocktails. Bitters are made up of numerous groups of chemical compounds extracted from the herbs and roots (medicinal plants) that have the common characteristic of a bitter taste and act to increase the vital energy centres in the body [3 and 4].

The product to be studied is Swedish Bitters, a German product, composed of thirteen (13) herbal constituents. “Bitters” generally are claimed to be effective in curing all allergic, metabolic and

immunological conditions where the diagnosis points to a fault in the digestive process, improves immunity, help in anaemia, wound healing, and blood clotting by increasing the population in tissues, of red blood cells, white blood cells and platelets, help with inflammatory conditions of the gastrointestinal tract (Colitis, Crohn's disease, nonspecific inflammation). In addition to the action of bitters on digestive secretions aiding good digestion, they also strengthen the tone of tissues throughout the digestive tract, as well as aid in the healing of damaged mucous membranes. They are generally said to regenerate and heal mucosal lining of the G.I.T especially duodenal and gastric ulcers. This helps resolve conditions ranging from gastroesophageal reflux to ulcers to leaky gut syndrome.

Bitters have been claimed to help heal piles/haemorrhoids and improve sexual function. Enhance blood circulation, purification of blood by the kidneys, blood pressure regulation through arterial dilatation and prevent formation of kidney stones, cleanse the colon of impurities and have also been said to possess anti-tumour properties and especially protects against colo-rectal cancers. They are also said to have anti-inflammatory, antibiotic and antifungal properties.

Bitters have also been said to ensure good digestion of fats and oils, and proper functioning of the liver in excretion, reduce accumulated fat (triglycerides) and cholesterol levels thereby conferring on it hypolipidaemic properties. They are said to reduce excess body fat and promote healthy weight loss, act as a liver tonic and body detoxifier; being hepatoprotective and enhancing its functions generally and helping in body detoxification. Bitters act on the pancreas and liver, help in cell division and growth of the pancreas thereby helping to normalizing blood sugar and promote the production and release of pancreatic enzymes. Some are even said to have hypoglycaemic properties.

In modern herbal medicine, "bitter principles" occupy a central place in herbal therapeutics, bearing the acrid constituents. Most people consuming herbal medicines complain about the bitterness of the medicines prescribed. This is the only defining attribute of herbal medicine and the only feature to set it apart from other therapies [2 and 4]. In times past our traditional diets were not devoid of bitter foods as is presently the case in most modern diets, hence Green (1991) [5] desires that we see the medicinal side of bitters in an entirely different light in other that we use it to prevent what he termed the "Bitter Deficiency Syndrome" of our era, which in his opinion is the predisposing factor to many ailments of our time [4 and 5]. All these make the study of the constituent and pharmacological effects of present day bitters desirable.

Materials and Methods

Material

Swedish bitters were purchased from reputable pharmaceutical stores opposite the University of Benin Teaching Hospital (UBTH), Ugbowo Lagos Road, Benin City, Edo State, Nigeria. The bitters were bought as liquid formulations and stored at room temperature throughout the period of the experiment.

Proximate Analysis

The moisture content of the herbal bitters was determined using the gravimetric method [6]. The ash content was estimated using the method of AOAC [7]. The fat content was determined using the method of AOAC [8]. The crude fibre content was determined by the difference in weight after calcination, following the digestion of the sample in sulphuric acid and sodium hydroxide solutions and the residue being calcined [9]. The protein content of the bitters was determined from the organic nitrogen content by Kjeldahl method [9]. The carbohydrate content of the bitters was determined by the difference method by adding moisture, fat, protein, and ash content, and the value deducted from 100 [9]. The reducing sugar content of the bitters was determined using the dinitrosalicylic acid method [10]. The glucose content was determined using the glucose oxidase method [11]. Triplicate measurements were performed and the mean computed.

Alcohol Composition Analysis

The determination of the alcohol content was done using the AOAC [7] method.

Extraction of Bitters for Qualitative Phytochemical Analysis: because there may be differential solubility in the constituent of the bitters relative to the polarity of the solvent used the bitters were further extracted in distilled water and ethanol. Aqueous Extraction: 10ml of bitters sample was added to 90ml distilled water and boiled on slow heat for 2hours. It was then filtered using a Whatmann No. 42 filter paper (125mm); the filtrate was collected, and further concentrated to make the final volume one-fourth of the original volume and stored at 40C in an air tight container [12]. Preparation of ethanolic extract: 10ml of the bitters sample was taken and put into 50ml of absolute ethanol in a flat bottom flask. The flask was plugged with cotton wool and then kept on a rotary shaker at 190-220rpm for 24hrs. After 24 hours the sample-solvent mix was then filtered using a Whatmann No. 42 filter paper (125mm); the filtrate was collected, and the solvent evaporated to make the final

volume one-fourth of the original volume and stored at 40C in an air tight container [12].

Qualitative Phytochemical Analysis

The test for phytosterol/steroids, amino acids, protein, saponins, tannins, alkaloid, cardiac glycoside, terpenoid, flavonoids, phlobatannins, was determined using the method described in Santhi and colleagues [12]. The test for glycosides/reducing sugars was carried out using the method described by Onyeike and Osuji [9]. The Borntrager's test was used for the detection of anthraquinones [13].

Quantitative Phytochemical Analysis

The determination of total phenols was by spectrophotometric method [14], while alkaloid was as described by Harborne [15], and Edeoga and colleagues [14]. The determination of tannin was by the Van - Burden and Robinson method [14], while the determination of saponin was as described by Edeoga and colleagues [14]. The determination of flavonoids was by the method of Boham and Kocipai-Abyazan [16], while that of cyanogenic glycosides was by the AOAC [7] method. Elemental Analysis: Extraction and determination of calcium and magnesium in the bitters sample were determined by the titrimetric method using ethylenediaminetetraacetic acid (EDTA), [7]. The sodium and potassium concentrations were determined using the flame photometer (JENWAY PFP 7 model) [7], while phosphorus was determined by Olsen and Sommers [17] and the AOAC [7] methods. The determination of the trace metals iron, zinc, manganese, copper, lead, chromium and selenium were done using the bulk scientific VGP210 atomic absorption spectroscopy/spectrophotometry, [7.]

Determination of the Total Antioxidant Capacity

The ability of the herbal bitters to scavenge 2,2'-azinobis-(3ethylbenzothiazoline-6-sulphonic acid) radical cation (ABTS+) which gives an idea of the total antioxidant capacity, was determined by the improved spectrophotometric version described by Re and colleagues [18]. ABTS radical cation decolourisation assay: In this improved version, ABTS+-the oxidant, will be pregenerated by persulfate oxidation of 2,2'-azinobis (3-ethylbenzothiazoline-6-sulfonic acid) - (ABTS2-). Triplicate measurements were performed and the mean computed. DPPH free radical scavenging activity: DPPH (2,2-diphenyl-1-picrylhydrazyl radical) scavenging activity of the herbal bitters was measured by the spectrophotometric method described by Jain and colleagues [19]. Triplicate measurements were performed and the mean computed.

Hydroxyl radical scavenging activity: This was assayed as described by Kunchandy and Rao [20] with a slight modification [21]. The assay is based on quantification of the degradation product of 2-deoxyribose by condensation with TBA. Triplicate measurements were performed and the mean computed.

Statistical analysis: The results are expressed in Mean±SEM. Students t-test was used to compare the means. P<0.05 was considered significant.

RESULTS

Table 1: Proximate and Alcohol composition of the Swedish Bitters

Proximate composition	Ash	Moisture	Fibre	Fat & oil	Protein	Carbohydrates	Glucose	Reducing sugar	Alcohol
Quantity in									
Swedish Bitters (%)	4.35±0.1	89.21±0.7	0.00±0.0	1.00±0.0	1.24±0.1	4.20±0.10	0.94±0.0	1.05±0.0	39.59±0.6
	0	1	0	6	5		1	6	7

Table 1 shows that Yoyo bitters has a high moisture and alcohol content, no fibre and a higher ash content compared to other food nutrients.

Table 2: Qualitative and Quantitative Phytochemical Composition of Swedish Bitters

Parameters	Qualitative composition of Swedish Bitters		Quantitative composition of Swedish bitters (%)
	Aqueous extract	Ethanol extract	
Phytosterol	+	+	ND
Amino acids	+	+	ND
Proteins	+	+	ND
Saponins	+	++	5.48±0.11
Tannins	++	++	0.12±0.01
Alkaloids	+	+	0.66±0.01
Cardiac glycosides	-	-	ND
Glycosides/reducing sugar	+	++	ND
Cyanogenic glycosides	ND	ND	0.14±0.01

Terpenoids	+	+	ND
Flavonoids	+++	+++	3.36±0.03
Phlobatannins	+	+	ND
Anthraquinones	-	-	ND
Total phenols	ND	ND	1.62±0.05

Key: +++ = Highly Present; ++ = Moderately Present; + = Slightly Present; - = Absent; ND = Not Determined

Table 2 shows that considering both the aqueous and ethanolic extracts of the bitters, the bitters used in this research contains amino acids, proteins, saponins, tannins, alkaloids, phlobatannins, plant sterols (steroids), terpenoids and flavonoids but did not contain cardiac glycosides, glycosides/reducing sugar and anthraquinones. As the key indicates, these phytochemicals were present in varying degrees of slight, moderate and high. The quantitative phytochemical composition of the bitters, indicate saponins as the highest constituent and tannins the least among those determined.

Table 3: Quantitative Mineral Composition of the Swedish Bitters

Mineral composition	Ca	Mg	Na	K	P	Fe	Zn	Mn	Cu	Pb	Cr	Se
Quantity in Swedish bitters (mg/100ml)	50.10 ±1.10	354.59 ±4.70	3.90 ±0.38	250.67 ±2.85	36.12 ±1.04	12.12 ±0.28	2.40 ±0.12	1.90 ±0.08	5.00 ±0.36	<DL	<DL	<DL

Where <DL means less than detection limit. Triplicate measurements were performed and the mean computed. The values are expressed as Mean±SEM.

Table 3 summarizes the means of the quantitative elemental composition of the bitters, with magnesium being the highest constituent and manganese the lowest. The results show that the bitters contain significant amounts of Na, K, P, Ca, Mg, Zn, Mn, Fe, and Cu, while Pb, Cr, and Se were not detected.

Table 4:Antioxidant Capacity by IC₅₀ Values of the Control and Test Bitters using various methods.

Groups	IC ₅₀ (mg/ml) by Total antioxidant capacity	IC ₅₀ (mg/ml) by DPPH Scavenging ability	IC ₅₀ (mg/ml) by Hydroxyl Radical scavenging ability
Standard	0.08±0.00	0.05±0.01	204.64±4.68
Swedish bitters	18.68±0.03	12.95±0.20	341.56±11.36

Values are expressed as Mean±SEM. Values in the same column with different superscript letters differ statistically significantly (P<0.05) from one another.

*Standard for total antioxidant capacity and DPPH scavenging ability was ascorbic acid while that of hydroxyl radical scavenging ability was mannitol.

Table 4 shows that Swedish bitters has the ability to inhibit the ABTS radical, scavenge DPPH and the hydroxyl radical, hence it has antioxidant capacity. Statistical evaluation however shows that the concentration required for 50% inhibition of ABTS and DPPH by ascorbic acid (IC₅₀) and 50% inhibition of the OH radical by mannitol (IC₅₀) is significantly (P<0.05) lower than that of Swedish bitters.

DISCUSSION AND CONCLUSION

Discussion

Herbal bitters are claimed to have so many medicinal properties, since this study reveals they have appreciable amounts of secondary metabolites such as alkaloids, tannins, flavonoids, total phenols, saponins and cyanogenic glycosides, its claimed medicinal uses is therefore not surprising. In relation to the known medicinal uses of the identified phytochemical constituents of the herbal bitters and depending on the medical needs/ailment of the patient and the level of the phytochemical constituents in the herbal bitters, the most appropriate bitters can easily be prescribed.

Phytochemicals are chemical compounds formed during the plants normal metabolic processes. These chemicals are often referred to as “secondary metabolities” of which there are several classes including alkaloids, flavonoids, coumarins, glycosides, gums, polysaccharides,

phenols, tannins, saponins, terpenes and terpenoids [22,23 and 24]. Phytochemicals are present in a variety of plants utilized as important components of both human and animal diets. These include fruits, seeds, herbs and vegetables [25]. Diets containing an abundance of fruits and vegetables are protective against a variety of diseases, particularly cardiovascular diseases [24 and 26]. Herbs and spices are accessible sources for obtaining natural antioxidants (Okwu, 2004). In addition to these substances, plants contain other chemical compounds. These can act as agents to prevent undesirable side effects of the main active substances or to assist in the assimilation of the main substances [24 and 27]. The qualitative and quantitative estimation of the phytochemical constituents of a medicinal plant is considered to be an important step in medicinal plant research [28]. The presence of these secondary metabolites in plants probably explains the various uses of plants for traditional medicine [29].

Alkaloids and their derivatives have been certified to have important biological functions, physiological and medicinal effects in man and herbal bitters being a general body tonic can be said to be imparting some of its effects because of the presence of appreciable amounts of alkaloids in them which mimic the actions of the various alkaloids and their derivatives.

One of its derivatives, Isoquinoline alkaloids find many applications, including (but not limited to): anaesthetics; dimethisoquin is one example; antihypertension agents, such as quinapril, quinaprilat, and debrisoquine (all derived from 1,2,3,4-tetrahydroisoquinoline); antifungal agents, such as 2,2'-Hexadecamethylenediisoquinolinium dichloride, which is also used as a topical antiseptic; disinfectants, like N-laurylisoquinolinium bromide and vasodilators, a well-known example being papaverine [30].

Morphine alkaloid is a benzyloisoquinoline alkaloid with two additional ring closures. Morphine contributes a bitter taste to herbs; it is a potent opiate analgesic drug that is used to relieve severe pain [31]. Quinoline alkaloids e.g Quinine, belongs to the class of alkaloids which are derivatives of quinoline. It is a natural white crystalline alkaloid having antipyretic (fever-reducing), antimalarial, analgesic (painkilling), anti-inflammatory properties and a bitter taste. It is a stereoisomer of quinidine which, unlike quinine, is an anti-arrhythmic. Quinine contains two major fused-ring systems: the aromatic quinoline and the bicyclic quinuclidine [32 and 33].

Purine alkaloids (e.g caffeine in coffee): Caffeine is a bitter, white crystalline xanthine (purine) alkaloid that acts as a stimulant drug. Caffeine is found in varying quantities in the seeds, leaves, and fruit of some plants, where it acts as a natural pesticide that paralyzes and kills certain insects feeding on the plants. Coffee consumption is associated

with a lower overall risk of cancer [34]. This is primarily due to a decrease in the risks of hepatocellular and endometrial cancer, but it may also have a modest effect on colorectal cancer [35] and it may somewhat reduce the risk of type 2 diabetes [36]. It may protect people from liver cirrhosis [37]. Caffeine may increase the effectiveness of some medications including ones used to treat headaches [38]. Caffeine is metabolized in the liver by the cytochrome P450 oxidase enzyme system (to be specific, the 1A2 isozyme) into three metabolic dimethylxanthines, [34 and 39], each of which has its own effects on the body: Paraxanthine (84%): Increases lipolysis, leading to elevated glycerol and free fatty acid levels in the blood plasma; Theobromine (12%): Dilates blood vessels and increases urine volume. Theobromine is also the principal alkaloid in the cocoa bean, and therefore chocolate. Theophylline (4%): Relaxes smooth muscles of the bronchi, and is used to treat asthma. The therapeutic dose of theophylline, however, is many times greater than the levels attained from caffeine metabolism [34 and 40].

The results of this study indicates that Swedish bitters posses high amounts of phytochemicals like alkaloids, tannins, flavonoids, total phenols, saponins and cyanogenic glycosides. Compared to other phytochemical constituents all the bitters seem to have saponins as their highest constituent. This study is in agreement with that of Awa and James (2013) [41], which showed that Swedish bitters contain appreciable amounts of the phytochemicals tannin and phenol.

It is often summarized that bitters stimulate digestive secretions and the metabolism as a whole and in so doing increase appetite, relieve constipation, and generally ease the heavy glumness of sluggish digestion. But, this is really too simple and cursory a summation, and a deeper look into the actions of bitters is not only theoretically insightful but practically invaluable, especially as some plant products have been known to be toxic to the human system [3 and 4]. Their composition as they are presently constituted have never been ascertained neither has their numerous pharmacological claims being subjected to proper scientific scrutiny yet the use of bitters is getting popular.

The results of these studies show that swedish bitters were all found to have high moisture content of 89.21%. Swedish bitters have the highest ash, protein and glucose contents. The results of this research is in agreement with the findings of Awa and James (2013) [41], where Swedish bitters was found to contain carbohydrates, proteins, lipids, ash and a high moisture content, though with some variance in terms of the amount of these constituents compared to the amount of the same constituents found in the Swedish bitters of this study. Proteins, fats and carbohydrates are essential for life and studies have indicated that life is sustained by nutrient mixtures in which every component is definable chemically and soluble in water [42]. Important in the selection of herbs and herbal products for nutritive value are the quality and quantity of its

nutrient content [43]. Depending on the medical needs of the patient, the level of the proximate constituents in the herbal bitters outlined in results can therefore be taken into cognizance when deciding which of the bitters to prescribe.

The results shown in table 1 of this study indicate that Swedish bitters have very high alcohol contents of 40%. The high alcohol content (40%) of the Swedish bitters and the final presentation/nature of the product and its packaging may be the reason for it being prone to abuse as reported by Salaam and Brown (2012) [44].

Swedish bitters contain significant amounts of Na, K, P, Ca, Mg, Zn, Mn, Fe, and Cu, while Pb, Cr, and Se were not detected in them. Recent promotion of herbs as health foods commonly includes reference to their mineral contents. Unfortunately, little consideration is generally given to the fact that only five mineral elements are considered essential for metabolism in substantial amounts (calcium, magnesium, potassium, phosphorus and sodium), while ten others (chromium, cobalt, copper, fluorine, iodine, iron, manganese, molybdenum, selenium and zinc) are important in trace amounts only; of these, probably only selenium, molybdenum, manganese, chromium and fluorine are essential [45]. Controversy exists over metabolism need versus optimal intake. Toxic levels are often very near the required dosages for “normal diets” and minerals like lead (Pb), arsenic (As), mercury (Hg), silver (Ag) and cyanide (CN) are toxic and of no significant use in the human body [46]. In case of the Pb concentration, the suggested concentration in plant species that is “safe” is 0.2 to 0.6 mg/100ml, however, WHO recommendations for Pb level in humans, is that it should not exceed 10 ppm [47]. It is noteworthy that the bitters of this study are not contaminated with lead (Pb) so there is no danger of Pb toxicity from them. There has been some speculation that mild deficiencies of minerals may be beneficial. Dietary deficiencies are common with iron, calcium, iodine and fluorine [45]. So the bitters used in this study can be of help in mineral deficiencies especially in cases of Na, K, P, Ca, Mg, Zn, Mn, Fe, and Cu deficiencies.

Sodium (Na) and Potassium (K) play significant roles in acid-base balance, fluid balance, nerve function and proper neuromuscular and cardiac activity/function, [46], their presence in bitters may as well explain these same roles said to be played by bitters. Contribution of Phosphates to overall health by its involvement in energy transfer, phosphorylation/dephosphorylation reactions, lipid metabolism by being a constituent of lipoproteins and acid-base balance and enzyme action [46] may as well explain the claim of bitters contribution to overall health and lipid metabolism. Normal extracellular calcium concentrations are necessary for blood coagulation and for the integrity of intracellular cement substances, and integrity and proper functioning of nerves, skeletal muscle and heart/smooth muscle [48] so the presence of calcium in the bitters may well explain these same claims about bitters.

Concentration on which Zn affects human health ranges from 100 to 500 mg/l (10-50mg/100ml) [49].

The presence of zinc in the plants could mean that the plants can play valuable roles in the management of diabetes, which result from insulin malfunction [48] so apart from the claim of bitters playing a role in glucose metabolism, the presence of Zinc may well contribute to the claim that bitters play a role in free radical scavenging activity, improved growth, sexual activity and wound healing.

That Swedish bitters have IC_{50} values for 50% ABTS inhibition of 18.68mg/ml indicate that the bitters can be said to have a relatively high antioxidant capacity as claimed by the producers of the bitters. Herbal products have been said to have phytochemical constituents that confer on them antioxidant properties [50 and 51] this is in agreement with this research as the fact that these bitters can inhibit the ABTS radical confirms the antioxidant capacity of the herbal bitters. The potential of the phytochemicals of the plant/herbal materials have large scale pharmacological and biological implications, for example its antioxidant constituents (hydrolysable tannins, phenolic acid and flavonoids) have been proven to be effective for the care of health and protection from coronary heart diseases, cancer, anti-carcinogenic and anti-mutagenic effects [50 and 51].

The result of this study is in agreement with the findings of Awa and James (2013) [41] reporting that the DPPH radical scavenging activity of Swedish bitters was dose dependent as it increased as the concentration of the Swedish bitters increased. The fact that Swedish bitters have IC_{50} values for 50% DPPH radical inhibition of 12.95mg/ml indicates that the bitters can be said to have a relatively high antioxidant capacity as claimed by the producers of the bitters. Herbal products have been said to have phytochemical constituents that confer on them antioxidant properties [50 and 51] this is in agreement with our findings as the fact that these bitters can inhibit the DPPH radical confirms the antioxidant capacity of the herbal bitters. The fact that the phytochemicals of the plant/herbal materials can have large scale pharmacological and biological implications, have been proven by the finding that its antioxidant constituents (hydrolysable tannins, phenolic acid and flavonoids) have been proven to be effective for the care of health and protection from coronary heart diseases, cancer, anti-carcinogenic and anti-mutagenic effects [50 and 51].

Herbal products have been said to have phytochemical constituents that confer on them antioxidant properties [50 and 51] this is in agreement with our findings as the fact that this bitters can inhibit the OH radical confirms the antioxidant capacity of the herbal bitters. Antioxidant constituents can delay or inhibit the oxidation of lipids and other compounds by inhibiting the propagation of oxidation chain reaction [51

and 52]. Primarily, antioxidant effect is due to phenolic compounds such as phenolic acid, flavonoids and phenolic diterpenes and their mode of action as antioxidant compounds is due to their redox reaction properties which can absorb and neutralize free radicals by quenching singlet and triplet oxygen [51 and 53].

Conclusion

The biochemical assay results of this study with inferences derived from some of the already established effects of some of the phytochemical and mineral constituents of these bitters, gave some evidence that the herbal bitters of this study may be said to have the potential or possibility of having the following pharmacological properties - hypolipidaemic, hypoglycaemic, anti-anaemic and anti-inflammatory, stimulant and immunity-boosting/immuno-modulatory, choleric/hepatoprotective and antihepatotoxic, *invivo* and *invitro* antioxidant capacity and by extension antimutagenic/antitumour as well as vasodilatory and antihypertensive properties and the ability to protect against/prevent coronary artery disease and cardiovascular diseases generally.

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