Original Research Article

Chemical Profile of the Stem Extract of *Costus afer* (Bush Cane) from Imo State in Nigeria

ABSTRACT

Aim: The aim of the study was to investigate the chemical profile of the stem extract of *Costus afer (Bush cane).*

Methodology: Fresh stems of *Costus afer* were obtained from Obizi in Ezinihitte Mbaise Local Government Area of Imo State. The stem extract of *Costus afer* a medicinal important plant of the Costaceae were extracted with hot water (aqueous extraction) and proximate composition were determine through AOAC method. Fatty acids were determined through saponification and fatty acid methyl esters were thrice extracted from the mixture with redistilled n-hexane. The phytochemicals of the stem extract were determined by GC/MS analysis.

Result: Proximate composition of stems of *Costus afer* showed that it contained moisture (22.15%), crude fat (1.15%), ash (4.60%), crude protein (7.72%), crude fibre (9.40%) and carbohydrate (54.98%) while its calorific value is 261.15kcal/100g. Phytochemical analyses revealed the presence of alkaloids (70.59mg/100g) ranging from papaverine (44.72%) to narcotine (14.11%). Total flavonoids (28.29mg/100g) consisted mainly of myricetin (69.79%), quercetin (14.88%) and kaemferol (9.78%). The saponins (2.87mg/100mg) consisted mainly of sapogenin (39.20%), saponine (22.12%) and diosgenin (26.13%) while the glycosides (22.35mg/100mg) consisted mainly of costugenin (65.60%), digitoxin (18.73%), digoxin (6.28%) and salicin (4.76%). The fatty acid composition showed moderate concentrations of linolenic acid (32.27%), linoleic acid (25.90%), palmitic acid (25.48%) and low concentrations of oleic acid (7.11%) and stearic acid (6.37%).

Conclusion: Chemical studies on *Costus afer* have reported the presence of alkaloids, saponins, glycosides and flavonoids as the main constituents and were confirmed by phytochemical screening. As a rich source of bioactive compound coupled with the presence of the nutrients the stem of *Costus afer* studied can be seen as a potential source of food, drugs, fodder and a good source of important nutrients for livestock.

Keywords: *Costus afer*; proximate composition; phytochemicals; fatty acid.

1. INTRODUCTION

Plants are important sources of foods and natural drugs. Nature has been a source of medicinal agents for thousands of years and an impressive number of modern drugs have been isolated from natural sources, mainly based on their use in traditional medicines or phytomedicines. Various medicinal plants have been used for years in daily life to treat diseases all over the world. Over 50% of all modern clinical drugs are of natural product origin and natural products play an important role in drug development programs in the pharmaceutical industry. Some drugs have become obsolete because of drug resistance and consequently new drugs must be sought, for which herbal treatment is one possible way to combat diseases. The use of plant extracts and phytochemicals, with known anti-diabetic and anti-hyperlipidemic properties may be of immense importance in therapeutic treatment [38, 11].

In Nigeria many indigenous plants are used as spices, food or medicine. These plants often exhibit a wide range of biological and pharmacological activities. Extracts from the roots, barks, seeds and fruits of these plants are used in the preparation of syrups in traditional medicine as cough suppressant and in the treatment of oxidative related diseases [32]. It is generally assumed that the active constituents contributing to these protective effects are the phytochemical constituents, vitamins and minerals [32]. Phytochemical constituents exhibit a wide range of biological effects resulting in their protective or disease preventive properties.

Costus is a genus of perennial tropical herbaceous plants from the Costus family (*Costaceae*). They are often characterized and distinguished from relatives such as Zingiber (true ginger) by their

spiraling stems. The genus as a whole is thus often called spiral gingers [45]. Costus is the wonderful world of spiral ginger. Its foliage spirals around bamboo like stalks. Some varieties have a velvety soft texture on the backs of its leaves, while others maybe smooth with purple undersides. The stems are crushed and applied as a poultice for treating inflammation or drank cold or hot for cough. The juice of the stems can be sucked to reduce thirst while working in the tropics. The flowers are edible and make a beautiful and delicious salad [5].

It is a useful medicinal plant that is highly valued for its anti-diabetic, anti-inflammatory and anti-arthritic properties in South-East and South-West Nigeria [44]. The leaves are reputed to be an effective remedy for fever and malaria when boiled with leaves of *Carica papaya* (pawpaw), citrus species (orange) and bark of *Magnifera indica* (mango). The stem and juice has traditional use for treatment of cough, measles and malaria. The juice of *costus afer* is extracted and used as an instillation for eye inflammation and defects. The young and tender leaves when chewed are believed to give strength to the weak and dehydrating patient.

The seeds and rhizome of *Costus afer* contain several steroidal sapogenins, of which diosgenin is the most important one. The rhizome yields 0.5% diosgenin. Diosgenin is a very important raw material used as a precursor in the synthesis of a number of steroidal drugs, including corticosteroids, sex hormones, oral contraceptives and anabolic agents. The rhizomes also contain the saponins aferosides A–C, as well as dioscin and paryphyllin C and the flavonoid glycoside kaempferol 3-O-α-L-rhamnopyranoside. The last compound showed an ability to potentiate in vitro cisplatin cytotoxicity in a human colon cancer cell line [3]. Phytochemical reports indicate that the genus Costus is rich in steroidal saponins, sapogenins, oxalates, furans, furan derivatives and starches [34]. The TLC of the tubers extracted with petroleum ether and chloroform yielded lanosterol, tigogenin and diosgenin. Iwu (1982) isolated costugenin and sapogenin from the chloroform extract of the plant.

The present study was designed to determine the chemical profile of aqueous extract of *Costus afer* stem from Imo State in Nigeria.

2. MATERIAL AND METHODS

2.1 Collection of Plant Samples

Fresh stems of *Costus afer* were obtained from Obizi in Ezinihitte Mbaise Local Government Area of Imo State. They were authenticated by a Plant taxonomist at the Department of Plant Science and Biotechnology, University of Port Harcourt, Nigeria. The stems were cut into pieces and sun dried. They were later ground into fine powder with the aid of a clean dry electric grinder and stored in an air tight container.

2.2 Preparation of the Stem Extract

Preparations used in traditional medicines are in cold water or hot water [1].
The plant stems were sun dried and ground into powder. The resultant powder was soaked in boiled water for 24hrs, after which the filtrate was filtered and the filtrate (aqueous extract) was stored for subsequent use. Ten millimetres of this extract was evaporated to dryness and the weight of the residue used to determine the concentration of the filtrate, which was in turn used to determine the dose of administration of the extract to the test animals.

2.3 Analytical Methods

2.3.1 Determination of proximate composition

Proximate analysis to determine the moisture, crude protein, fat, ash, fiber and total carbohydrate contents of the samples were carried out according to the standard methods (AOAC, 2006). The analysis are carried out in triplicate determinations.

2.3.2 Determination of fatty acid composition [36]

Fifty milligrams of the extracted fat content of the sample was saponified (esterified) for five minutes at 95^{o}C with 3.4ml of the 0.5M KOH in dry methanol. The mixture was neutralized by using 0.7M HCL. 3ml of the 14% boron triflouride in methanol was added. The mixture was heated for 5 minutes at the temperature of 90^{o}C to achieve complete methylation process. The Fatty acid methyl esters were thrice extracted from the mixture with redistilled n-hexane. The content was concentrated to 1ml for gas chromatography analysis. The analysis are carried out in triplicate determinations.

2.3.3 Phytochemical analysis

2.3.3.1 Calibration, identification and quantification

The linearity of the dependence of response on concentration was verified by regression analysis. Identification was based on comparison of retention times and spectral data with standards. Quantification was performed by establishing calibration curves for each compound determined, using the standards.

2.3.3.2 Chromatographic analysis

Chromatographic analyses were carried out on an HP 6890 (Hewlett Packard, Wilmington, DE, USA), GC apparatus, fitted with a flame ionization detector (FID), and powered with HP Chemstation Rev A 09.01 (1206) software. The capillary column was an AC-5 Column (30m × 0.32mm × 0.25µm film thickness).

2.3.3.3 Determination of alkaloid composition [28]

Five grams of the pulverized sample was macerated in hexane of 25ml for about 72 hours. The extract was filtered and the residue was air dried, later treated with 10% aqueous ammonia and macerated in chloroform for 24 hours. After filtration and evaporation at reduced pressure, the resultant filtrate was treated with 7.5ml, 5% aq. HCl. The aqueous phase was made alkaline with aqueous ammonia and extracted thrice with chloroform. The chloroform was washed with water. The extract was poured into the round bottom flask of the rotary evaporator arrangement. It was separated by driving the solvent off the extract. Then the concentrated extract was dried of water by using the anhydrous sodium sulphate before gas chromatography analysis.

2.3.3.4 Determination of flavonoid composition [14].

One gram of the sample was weighed into the 250ml conical flask capacity with addition of distilled water and boiled for 10minutes. The flavonoid extract was obtained by pouring 100ml of the boiling methanol: water (70:30) v:v into the samples in the test tubes. The mixture was allowed to macerate for about 4 hours and then filtered with Whatman filter paper No.1. The filtrate was concentrated to 5ml for gas chromatography analysis.

2.3.3.5 Determination of saponin composition [27].

The sample was pulverized and the saponin was extracted three times with redistilled methanol. The saponins were removed with 20ml of the solvent for 20 minute with ultra-sonification. The combined extracts were concentrated to syrup under reduced pressure and then suspended in water. The suspension was extracted with petroleum ether, chloroform and 1-butanol saturated with water, successively to give the respective extract after removal of the solvent. The combined extract was filtered and concentrated to 1ml in the vial for gas chromatography analysis and 1 µl was injected into the injection port of GC.

2.3.3.6 Determination of glycoside composition [35]

One gram of the pulverized sample was weighed into a pre-cleaned borosilicate beaker, and extracted by pouring 10ml of ethanol/water (7:3v/v) mixture on it, and allowing to stand for 2hrs. The mixture was filtered with Whatman No. 1 filter paper. The extract was purified by washing with lead

acetate. The purified extract was further purified by adding sodium hydrogen phosphate. The extract was concentrated to 1ml, for gas chromatographic analysis.

2.4 Statistical Analysis of Data

All Data for biochemical analysis were analyzed for statistical differences and in rat treatment groups, by means of one-way ANOVA and post hoc LSD, on SPSS 19. In all, $p<0.05$ was considered significant. Data are presented as mean$\pm$S.D (standard deviation).

3.0 RESULTS AND DISCUSSION

3.1 Results

3.1.1 Proximate composition of *Costus afer* stem.

The results of the proximate composition of the stem of *Costus afer* are presented in Table 1. The total carbohydrate composition of *Costus afer* stem was the highest (54.98%) while crude fat had the lowest value of 1.15%. The moisture content had a moderate value of 22.15% while total ash (4.60%), crude protein (7.72%) and crude fibre (9.40%) were low.

Table 1: Proximate compositions of *Costus afer* stem

Parameter	Composition
Moisture (%)	22.15
Total Ash (%)	4.60
Crude Protein (%)	7.72
Crude Fat (%)	1.15
Crude Fibre (%)	9.40
Total Carbohydrate (%)	54.98
Caloric value (kcal)	261.15

3.1.2 Fatty acid composition of *Costus afer* stem

The content of fatty acids present in the stem of *Costus afer* investigated is shown in Table 2. The plant showed high contents of palmitic acid (25.48%), linoleic acid (25.89%), and linolenic acid (32.26%) and moderate levels of oleic acid (7.11%) and stearic acid (6.36%) while myristic acid, palmitoleic acid, arachidonic acid, behenic acid and lignoceric acid was low and caprylic acid, capric acid, lauric acid, margaric acid, arachidonic acid, erucic acid were absent.

Table 2: Fatty acid composition of *Costus afer* stem

Compounds	*Costus afer*	
	Retention time (min)	**Composition (%)**
Caprylic acid (C8:0)	8.908	0.00

Capric acid (C10:0)	10.363	0.00
Lauric acid (C12:0)	12.100	0.00
Myristic acid (C14.0)	13.743	0.02
Palmitic acid (C16:0)	15.160	25.48
Palmitoleic acid (C16:1)	16.248	2.06
Margaric acid (C17:0)	17.230	0.00
Stearic acid (C18:0)	18.057	6.37
Oleic acid (C18:1)	18.844	7.11
Linoleic acid (C18:2)	19.523	25.90
Linolenic acid (C18:3)	21.824	32.27
Arachidonic acid (C20:0)	22.359	0.52
Arachidonic acid (C20:4)	23.234	0.00
Behenic acid	23.970	0.20
Erucic acid	24.793	0.00
Lignoceric acid	25.619	0.07
Total fatty acids		100.00

3.1.3 Phytochemical Profile

The results of the phytochemical analysis of the stem of *Costus afer* are shown below. Table 3 shows the alkaloid composition of the stem of *Costus afer*. The total alkaloid composition was 70.59mg/100. The plant showed high composition of papaverine (44.72%), methyl morphine (23.24%), morphine (17.92%) and narcotine (14.11%) while biflorin, daphnoline, aromoline, homoaromoline, ambelline, 6-hydroxyphanidine, monocrotalline, 6-hydroxypowelline and nitidine concentrations were negligible.

The flavonoid composition of the stem of *Costus afer* is presented in Table 4. The total flavonoids concentration was 28.29mg/100g. Myricetin (69.79%) had the highest value with moderate levels of quercetin (14.88%) and kaempferol (9.78%) while catechin, resveratrol, apigenin, daidzein, butein, naringenin, biochanin, luteolin, epicatechin, salvegin, epicatechin-3-gallate, gallocatechin, sinensetin, kaempferol-3-arabinoside, quercitrin, isorquercetin, orientin, isoorientin and rutin levels were negligible.

The concentrations of saponin compounds in the stem of *Costus afer* investigated are presented in Table 5. The total composition of saponin was 2.87mg/100mg. The sapogenin content of the stem (39.20%) was the highest with moderate levels of diosgenin (26.13%), saponine (22.12%) and tigonine (9.76%) while gitogenin (2.28%) was low and solagenin, neohecogenin, hecogenin and euphol were absent.

The concentrations of glycoside compounds in the stem of *Costus afer* investigated are presented in Table 6. Costugenin (65.60%) had the highest value with moderate levels of digitoxin (18.73%), salicin (4.76%), digoxin (6.28%) and low levels of ouabain (1.95%) and kaemferol-3-rhamnoside (1.08%) while arbutin, amygdalin and vitexicarpin were absent.

Table 3: Alkaloid composition of *Costus afer* stem

Compounds	*Costus afer*

	Retention time (min)	Composition(mg/100g)
Morphine	12.412	12.65
Methyl morphine	13.794	16.41
Papaverine	15.111	31.56
Biflorin	15.722	0.01
Narcotine	16.368	9.96
Daphnoline	16.664	0.00
Aromoline	18.042	0.00
Homoaromoline	18.988	0.00
Ambelline	19.665	0.00
6-Hydroxybuphanidine	20.599	0.00
Monocrotalline	21.251	0.00
6-Hydroxypowelline	21.794	0.00
Nitidine	22.559	0.00
Total alkaloids		70.59

Table 4: Flavonoid Composition of *Costus afer* stem

Compounds	*Costus afer*	
	Retention time (min)	**Composition(mg/100g)**
Catechin	13.549	0.00
Resveratrol	14.904	0.00
Apigenin	16.036	0.92
Daidzein	16.246	0.06
Butein	16.458	0.00
Naringenin	16.671	0.00
Biochanin	17.357	0.00
Luteolin	17.769	0.07
Kaempferol	18.050	2.77
Epicatechin	19.395	0.00
Salvagenin	20.467	0.00

Epicatechin-3-gallate	21.501	0.00
Gallocatechin	22.065	0.00
Quercetin	22.597	4.21
Isorhamnetin	23.471	0.00
Myricetin	23.965	19.75
Sinensetin	24.997	0.00
Kaempferol-3-arabinoside	25.360	0.00
Naringenin	26.041	0.00
Quercitrin	27.294	0.04
Isoquercetin	27.480	0.07
Orientin	27.910	0.00
Rutin	28.195	0.39
Isoorientin	28.529	0.02
Total flavonoids		28.29

Table 5: Saponin Composition of *Costus afer* stem

Compounds	*Costus afer*	
	Retention time (min))	**Composition(mg/100g)**
Gitogenin	17.545	0.08
Solagenin	18.588	0.01
Diosgenin	19.516	0.75
Tigogenin	20.115	0.28
Neohecogenin	20.979	0.00
Hecogenin	21.819	0.00
Sapogenin	22.600	1.12
Euphol	24.185	0.00
Saponine	25.480	0.63
Total saponins		2.87

Table 6: Glycoside composition of *Costus afer* stem

Compounds	*Costus afer*	
	Retention time (min)	**Composition(mg/100g)**
Kampferol-3-0-Rhamnoside	15.395	0.24
Arbutin	17.464	0.21
Salicin	18.758	1.06
Amygdalin	19.513	0.00
Ouabain	20.469	0.44
Digitoxin	21.436	1.03
Vitexicarpin	22.688	0.15
Digoxin	23.110	1.40
Costugenin	23.963	14.66
Total glycosides		**22.35**

3.2 DISCUSSION

3.2.1 Proximate composition of *Costus afer* stem.

Proximate composition of the stems of *Costus afer* in Table 1 showed that its moisture content was 22.15% and is high compared to 11.23% reported for the stems of *Balanites aegyptiaca* (Idris *et al*., 2010) but lower than those of *Tridax procumbens* (88.30%) and *Ocimum gratissimum* (82.60%) [17,15]. The moisture content of any food is used as a measure of stability and the susceptibility to microbial contamination [49]. This implies that *Costus afer* may have a short shelf life due to its high moisture content.

The study indicated that the ash content of the stem was 4.60% and is lower than 13.67% reported for the stem of *Ocimum gratissimum* [15] which implies that the stems of *Costus afer* is a poor source of mineral element since the ash content of a plant material is an index of mineral contents in biota.

The protein content of the stem of *Costus afer* was 7.72% which is lower than 37.44% reported for *Tridax procumbens* [17] but higher than those of *Ocimum gratissimum* (1.65%) [15]. Proteins act as enzymes, hormones and antibodies.

The crude fat content of the plant was 1.15% and is lower than that of *Aspilia africana* which was 3.86% [10]. The finding showed that the plant is a poor source of plant lipid thus advantageous healthwise in avoiding overweight [22].

The crude fibre content was 9.40% and is high compared to that of *Eugenia uniflora* (0.67%) [30]. Adequate intake of dietary fibre can lower the serum cholesterol level, and thus risk of coronary heart disease, hypertension, diabetes, breast cancer and constipation [18, 39]. Dietary fibers alter the colonic environment in such a way as to protect against colorectal diseases. They provide protection by increasing fecal bulk, which dilutes the increased colonic bile acid concentrations that occur with a high fat diet [8].

The study revealed the carbohydrate content of the plant to be 54.98% which is higher than that of *Tridax procumbens* (41.03%) [17] but is lower than 58.35% reported for the stems of *Balanites aegyptiaca* [16]. Carbohydrates are the human body's key source of energy, providing 4 calories of energy per gram. Carbohydrates provide the body with a source of fuel and energy that is required to carry out daily activities and exercise. The caloric value of the plant (261.15 kcal/100g) is lower than those of *Ocimum gratissimum* (278.42 kcal) and *Tridax procumbens* (321.54 kcal) [17, 15].

3.2.2 Fatty acid composition of *Costus afer* stem

The result of the fatty acid composition of the plant (Table 2) indicates the presence of linolenic acid which had the highest value of 32.27%. Linolenic acid has been beneficial in lowering body fat. α-linolenic acid is a polyunsaturated (Omega-3) fatty acid. Preliminary research has found evidence that α-linolenic acid is related to a lower risk of cardiovascular disease. Dietary α-linolenic acid has been assessed for its role in cardiovascular health [37]. Linoleic acid was also found to be present at the concentration of 25.90%. It is a polyunsaturated fatty acid used in the biosynthesis of arachidonic acid and thus some prostaglandins [6]. Linoleic acid is an essential fatty acid that must be consumed for proper health. These polyunsaturated fatty acids are able to decrease the plasmatic levels of VLDL, LDL cholesterol and increases in serum High density lipoprotein cholesterol expression of LDL receptors in liver. These LDL receptors increases uptake and subsequent removal of LDL, VLDL and thus restore cholesterol homeostasis.
Palmitic acid was found to be 25.48%. Palmitic acids are needed for energy, hormone production, organ padding and cellular membranes. It is also needed for important signaling and stabilization processes in the body.

Oleic acid composition was 7.11%. It is a monounsaturated fat in human diet. Monounsaturated fat consumption has been associated with decreased low density lipoprotein (LDL) cholesterol and possible increased high density lipoprotein (HDL) cholesterol. Oleic acid may be responsible for the hypotensive (blood pressure reducing) effects of olive oil [48].

3.2.3 Phytochemical profile of *Costus afer* stem

The result of the phytochemical analysis indicated the presence of alkaloids, saponins, flavonoids, glycosides. Alkaloids are known to have anti-microbial, antifungal and anti-inflammatory effect [33] and it also acts as an anti-hypertensive agent [33]. Table 3 shows the result of the quantification of alkaloid compounds present in the stems of *Costus afer*. The plant contained papaverine, an alkaloid which had the highest value of 31.56mg/100g than other alkaloid compounds. It is used to treat spasms of the gastrointestinal tract, bile ducts and ureter and for use as cerebral and coronary vasodilators in subarachnoid hemorrhage [24] and coronary artery bypass surgery [48]. It relaxes veins and arteries, which makes them wider and allows blood to pass through them more easily, thereby increasing the amount of oxygen rich blood in the brain, heart and muscles. It is also used as an erectile dysfunction drug, alone or sometimes in combination [7, 4].

Morphine, an alkaloid with the value 12.65mg was present in the plant and they are narcotic analgesics used to relieve severe pain. It is primarily used to treat both acute and chronic pain. Also used for pain due to myocardial infarction and for labour pains [25]. Also methyl morphine an alkaloid referred to as codeine with the value 16.41mg/100mg was present in the plant. It is used as a cough suppressant, analgesic and hypnotic. It is also used to treat diarrhoea [47]. Narcotine (9.96mg/100g) was also present. It has an antitussive effect. It is currently under investigation for use in the treatment of several cancers and hypoxic Ischemia in stroke patients.

Table 4 shows the result of flavonoid compounds present in the stems. Collectively, flavonoids are of particular importance in the human diet as there is evidence that they act as antioxidants, antiviral and anti-inflammatory agents [43] and are associated with reduced risk of cancer and cardiovascular diseases [26, 13]. Myricetin, a flavonoid was found to have the highest concentration of 19.74mg/100g in the plant. Myricetin in high concentrations can modify LDL cholesterol such that uptake by white blood cells is increased and also lowers rates of prostate cancer [21]. Invitro studies show that flavonoids have anti- diarrheal activities [42]. Flavonoids such as Quercetin (4.21mg/100g) were also present and it has efficacy against the Group 1 carcinogen *helicobacter pylori* [12] and kaempferol (2.77mg/kg) was also detected. Kaempferol, quercetin and myricetin reduced the risk of pancreatic cancer by 23 percent in an 8 year study [29]. The presence of flavonoids suggests that the plant might have anti-oxidant, anti allergic, anti-inflammatory, anti-microbial, anti-cancer activity.

Table 5 shows saponin compounds present in the stem of *Costus afer*. Saponins are reported to have broad range of pharmacological properties [43]. The presence of saponin (2.86mg/100g) in *Costus afer* stems suggests that the plant may act as anti-inflammatory, anti-fungal, expectorant, vasoprotective, hypocholesterolemic, anti-parasitic hypoglycaemic and many others [41]. Sapogenin

had the highest value of 1.12mg/100g. Diosgenin, a saponin had a concentration of 0.75mg/100g. Diosgenin is the precursor for the semi-synthesis of progesterone [25] which in turn was used in early combined oral contraceptive pills [9]. It has an estrogenic activity and can reduce the level of serum cholesterol [23]. Saponins are used as adjuvants in vaccines, they form complexes with cholesterol to form pores in cell membrane bilayers [9]. They are anti-inflammatory compounds that lower blood cholesterol and prevent heart disease as well as some cancers [20].

Table 6 shows the compositions of glycoside compound present in the plant. Costugenin had the highest value of 14.66mg/100g. Cardiac glycosides are used in the treatment of heart diseases eg. congestive heart failure and arrhythmia. Digoxin and Digitoxin were present in the plant with values 1.40mg/100g and 1.03mg/100g. They are widely used in the treatment of various heart conditions, namely atrial fibrillation and sometimes heart failure that cannot be controlled by other medication. Digoxin and Digitoxin increases the strength of heart contraction. Salicin content was 1.06mg/100g. Salicin has been shown to have anti-inflammatory, anti-pyretic effect. Salicin aids in lowering production of two enzymes, prostaglandins and thromboxanes, which reduces inflammation and the potential of platelets to stick to one another, by acting as a natural oil cleanser to wipe up the sticky and greasy layer on platelet surfaces, lessening risk of blood clots, heart attacks and strokes [41]. The presence of cardiac glycosides in *Costus afer stems* shows that the plant is good for the treatment of diseases associated with heart. The alkaloid composition (70.58mg/100g) of the plant was higher than other phytochemicals present.

4. CONCLUSION

Chemical studies on *Costus afer* have reported the presence of alkaloids, saponins, glycosides and flavonoids as the main constituents and were confirmed by phytochemical screening. As a rich source of bioactive compound coupled with the presence of the nutrients the stem of *Costus afer* studied can be seen as a potential source of food, drugs, fodder and a good source of important nutrients for livestock. One or more of these pharmacology active compounds may contribute to the hypolipidemic activity of *Costus afer*. A myriad of nutritional benefits has been attributed to these phytochemicals. Other research can be carried out on the ethanol stem extract of *Costus afer* and the effects of the active constituents on the liver enzymes activities on hyperlipidemic rat.

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