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include all nourishments of plant basis, predominantly tea,

Tea is processed from the vegetative parts of *Camellia sinensis*

by the US Food and Drug Administration's (FDA) list of

Normally, Tea refers to dried leaves processed from leaves of *Camellia sinensis* (true tea). Other infusions got from parts of other suitable plants are also noted as tea, but, are called tisanes or herbal tea, hence, there are true or traditional

True tea is grouped as green, black/dark, white, yellow and oolong which is established

harvested vegetation of the tea plant without fermentation

hand, black tea is wholly fermented tea, processed with polyphenol oxidase converting its polyphenols into a series of

fermented tea gotten when leaves are wilted in the sun and moderately battered to attain brief partial oxidation resulting

Herbal tea or tisanes implies any infusions taken as a drink derived from other parts of vegetation other than *Camellia sinensis*

traditional teas. It could be gotten from plants like chamomile, rose hip, ginger, turmeric, valerian, hibiscus, peppermint,

Chamomile is one of the early therapeutic herbs

of Matricaria species and of the daisy family, Asteraceae/ Chamomile (*Matricaria chamomilla*) and Roman Chamomile (*Chamaemelum nobile*

spasms, menstrual disorders, insomnia, ulcers, wounds, gastrointestinal disorders, rheumatic pain and haemorrhoids while their essential oils are applied widely in cosmetics and

irritations, bruises, burns, canker sores, neuralgia, sciatica,

from their use as tea, and tincture, they are used as poultices

known to bind to benzodiazepine receptors in the brain to

their essential oils are used in aromatherapy to enhance sleep

to other medications or their safety among children and pregnant women. Therefore, the present study aims to identify

ionization detection (GC-FID) methods.

Materials and Methods

Preparation of Samples

Five brands of chamomile herbal tea (CHT) were randomly sourced from retail outlets in Port Harcourt, Nigeria and coded CHT-A, CHT-B, CHT-C, CHT-D and CHT-E. from a retail outlet in Abuja and coded as CHT-F while its oil extract was coded as CHT-G.

Preparation of Samples and Extraction of Phytochemicals

A teabag of each CHT was macerated in 200 ml of and evaporated to obtain the extract. A 0.1 g of the extract in a water bath (60 °C) and transferred into a separatory funnel. The test tube was washed in steps with 20 ml of ethanol, 10 ml of cold water, 10 ml of hot water and 3 ml of *n*-hexane (BDH, England) respectively and transferred into the separatory funnel. The extracts were pooled and washed solution was dried with anhydrous sodium sulphate (Sigma-Aldrich, USA) and the solvent was evaporated. The sample was solubilized in 1000 *u*l of pyridine (Sigma-Aldrich, USA), of which 200 *u*l was transferred to

Analysis of Phytoconstituents by GC-FID

The analysis of phytoconstituents was carried out on a involved an electron ionization system which used high- with respective solvents was injected in a splitless mode. The

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relative quantity of the chemical compounds present in each of the extracts was expressed as a percentage based on the peak area produced in the chromatogram [36, 37]. Bioactive compounds extracted from the respective batches of extracts were identified based on the GC retention time on the HP-5MS column and matching the spectra with the computer software standards data (Replib and Mainlab data of GC–FID systems).

Results

GC-FID Quantified Phytoconstituents of selected Chamomile Herbal Tea

Discussions

The results obtained from the GC-FID of selected chamomile herbal tea and dry chamomile flower and essential oils are summarised in Tables 1 – 7. These results are discussed in this section under flavonoids, alkaloids, glycosides, saponins, tannins, steroids, anti-nutrients and other phenols such as resveratrol.

Flavonoids

The level of flavonoids detected in the various CHT were as CHT-B > CHT-E > CHT-G > CHT-A > CHT-C > CHT-C > CHT-D > CHT-F. The types of flavonoids identified include proanthocyanin, anthocyanin, flavan-3-ol, naringenin, rutin, flavanones, kaempferol, flavone, catechin, epicatechin, etc. (Tables 1-7). The variation in the composition of these flavonoids from one CHT to the other may be attributed to differences in environment or influences like latitude, longitude, rainfall, temperature and soil quality [38]. Given these differences, and with CHT-B presenting the highest concentration of flavonoids displayed its subgroup of flavonoids as Rutin > flavonone > flavone > anthocyanin > epicatechin > kaempferol > naringenin > proanthocyanin, etc. (Table 2). Flavonoids have been known to possess immense pharmacological benefits such as anti-oxidative, anti-mutagenic, anti-inflammatory, anti-carcinogenic, antitumour, anti-HIV, antidiarrhoeal, antihepatotoxic, antifungal, antilipolytic, vasodilator, immunostimulant and anti-ulcerogenic properties and enzyme modulatory functions [39, 40]. Rutins have been found in fresh leaves, red wine and tea [12, 41, 42]

Alkaloids

The composition of alkaloids detected was CHT-A > CHT-D > CHT-G > CHT-E > CHT-B > CHT-F > CHT- C. The various forms of alkaloids detected were ribalinidine, lunamarin, spartein, ephedrine, etc., though, ephedrine was not detected in CHT-A and CHT-G. Alkaloids are natural products that have heterocyclic nitrogen atoms [43-45]. They found use in the ancient preparation of spices, drugs and poisons. Lunamarin retains anticancer, immunomodulatory, anti-estrogenic and anti-amoebic activities [46] while ribalinidine possesses a radical scavenging influence.

Glycosides

The composition of glycosides identified in the various

Table 1: Composition of the phytochemical constituents detected in CHT-A

Phytochemical	Component	Retention	Area	Height	Conc. (ug/mol)	% Composition
Flavonoids (48.76%)	Naringin	0.873	4824.9767	377.473	3.7794	5.42
	Anthocyanin	5.483	2954.8422	231.937	2.6609	3.81
	Flavan-3-ol	7.873	4968.2281	389.42	2.886	4.14
	Naringenin	14.036	3250.6604	255.555	2.7644	3.96
	Rutin	19.973	4928.684	387.165	3.976	5.7
	Flavonones	20.616	3419.6849	268.983	2.6396	3.78
	Kaempferol	25.96	7289.2832	570.18	5.721	8.2
	Flavone	34.15	3084.5871	241.227	2.6798	3.84
	Epicatechin	36.773	4449.9298	348.939	5.1499	7.38
	Catechin	38.64	8024.0488	624.601	1.7616	2.53
Alkaloids (13.25%)	Ribalinidine	10.83	6003.0656	470.455	4.9682	7.12
	Lunamarin	0.386	2631.0434	206.27	1.1557	1.66
	Spartein	43.536	5031.2166	394.788	3.123	4.48
Glycoside (2.11%)	Cardiac glycoside	3.093	3389.3006	265.8	1.4722	2.11
Tannin (2.54%)	Tannin	9.35	3057.1151	240.132	1.7753	2.54
Steroids (12.95%)	Steroids	23.363	6954.4788	536.637	9.0361	12.95
Anti-nutrients (20.38)	Phytate	29.326	5273.2844	410.247	5.3158	7.62
	Oxalate	31.653	6802.6676	532.675	8.9007	12.76

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Table 2: Composition of the phytochemical constituents detected in CHT-B

Phytochemical	Component	Retention	Area	Height	Conc. (ug/ml)	% Composition
Flavonoids (61.18%)	Proanthocyanin	0.113	1472.1354	410.405	0.6902	0.71
	Proanthocyanin	0.17	5680.6418	256.735	2.6632	2.75
	Anthocyanin	3.946	8222.3654	131.434	7.4044	7.66
	Flavan-3-ol	6.893	4472.4692	71.805	2.598	2.69
	Naringenin	13.3	4660.7432	77.1	3.9636	4.1
	Rutin	15.783	12553.4794	203.066	10.1269	10.47
	Flavonones	19.573	12438.6034	195.876	9.601	9.93
	Kaempferol	26.003	6617.3268	107.594	5.1937	5.37
	Flavone	34.073	9054.95	127.289	7.8665	8.13
	Epicatechin	37.363	5799.3524	113.423	6.7116	6.94
	Catechin	38.293	10686.5711	156.747	2.3461	2.43
Alkaloids (10.38)	Riblinidine	10.59	4269.5216	68.918	3.5335	3.65
	Ephedrine	42.72	11673.1373	120.423	6.5073	6.73
Saponins (2.16%)	Sapogenin	40.976	2989.3324	57.369	2.0892	2.16
Steroids (6.23%)	Steroids	22.29	4635.9377	75.497	6.0235	6.23
Glycosides	Cyanogenic glycoside	28.653	10030.8184	98.828	14.8305	15.34
18.48%	Cardiac glycoside	2.22	7007.3973	110.755	3.0439	3.15
Other Phenols	Resveratrol	39.563	3987.0637	71.359	1.5148	1.57
1.57%						

Table 3: Composition of the phytochemical constituents detected in CHT – C

Phytochemical	Component	Retention	Area	Height	Conc. (ug/ml)	% Composition
Flavonoids (46.89%)	Proanthocyanin	0.086	469.529	179.446	0.2553	0.18
	Anthocyanin	4.063	4293.166	73.064	3.8661	2.65
	Flavan-3-ol	6.07	27561.7994	195.841	16.0103	10.99
	Flavonones	12.966	5856.362	62.803	4.5203	3.1
	Naringenin	15.46	4561.1764	49.349	3.9752	2.73
	Rutin	17.966	11050.1446	115.177	7.3233	5.03
	Catechin	20.313	12511.0674	129.573	3.0213	2.07
	Kaempferol	25.683	9599.0294	103.696	7.5339	5.17
	Flavone	33.03	20029.9992	149.673	12.4294	8.53
	Epicatechin	36.88	6804.3615	71.638	9.3826	6.44
Alkaloids (5.68%)	Lunamarin	0.173	3559.1162	92.448	1.5633	1.07
	Epihedrine	42.4	2720.3349	37.666	1.2832	0.88
	Spartein	44.16	10938.5209	109.349	5.4319	3.73
Saponins (4.90%)	Sapogenin	39.196	10225.2962	105.22	7.1464	4.9
Steroids (10.05%)	Steroids	22.726	9150.8282	96.755	14.6366	10.05
Glycosides (15.41%)	Cardiac glycoside	2.413	13711.4174	130.202	5.3774	3.69
	Cyanogenic glycoside	27.513	11552.32	118.637	17.08	11.72
Anti-nutrients	Oxalate	29.853	5038.285	54.96	5.1795	3.55
17.06%	Phytate	10.366	19525.9631	201.089	19.6834	13.51

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Table 4: Composition of the phytochemical constituents detected in CHT-D

Phytochemical	Component	Retention	Area	Height	Conc. (ug/ml)	% Composition
Flavonoids (43.17%)	Proanthocyanin	0.086	357.1588	179.448	0.2679	0.16
	Naringin	0.233	2989.6825	117.856	2.7796	1.62
	Anthocyanin	4.12	6154.4164	144.253	5.5421	3.23
	Flavan-3-ol	6.016	18053.9923	409.964	13.1092	7.65
	Flavonones	12.97	6235.5473	141.356	4.813	2.81
	Naringenin	15.46	4965.0218	112.527	4.2223	2.46
	Rutin	17.966	11330.0842	256.503	8.2963	4.84
	Catechin	20.313	12744.4217	285.881	3.6373	2.12
	Flavone	32.996	14335.5145	323.847	12.4541	7.27
	Kaempferol	25.65	991 7.8566	226.671	7.7841	4.54
	Epicatechin	36.876	6977.1841	158.007	11.0654	6.46
	Lunamarin	0.16	539.1959	116.491	0.2368	0.14
Alkaloids (12.33%)	Ephedrine	42.276	3426.0155	78.72	1.9099	1.11
	Spartein	44.17	10459.4821	237.898	8.4403	4.93
	Ribalinidine	7.47	8392.9472	191.094	10.5452	6.15
Saponins (4.17%)	Sapogenin	39.2	10228.6703	231.342	7.1488	4.17
Glycosides (13.40%)	Cyanogenic glycoside	27.536	11365.4653	259.34	16.8038	9.81
	Cardiac glycoside	2.39	12099.0446	277.929	6.1565	3.59
Steroids (8.93%)	Steroids	22.73	9568.19	216.422	15.3042	8.93
Other Phenolics (2.28%)	Resveratol	34.6	6049.213	137.14	3.9072	2.28
Anti-nutrients (15.71%)	Oxalate	29.86	5472.7816	124.058	7.1606	4.18
	Phytate	10.366	19594.4088	442.508	19.7524	11.53

Table 5: Composition of phytochemical constituents detected in CHT-E

Phytochemical	Component	Retention	Area	Height	Conc. (ug/ml)	% Composition
Flavonoids	Proanthocyanin	0.116	3681.8254	411.025	3.4523	3.51
57%	Anthocyanin	3.95	8180.0436	637.037	8.4186	8.56
	Flavan-3-ol	6.893	4491.1913	350.845	2.6089	2.65
	Naringenin	13.3	4918.608	385.135	4.4167	4.49
	Rutin	15.783	12794.3857	919.8	7.9394	8.07
	Flavonones	19.516	12631.1433	566.996	9.7496	9.91
	Kaempferol	26	6833.3794	529.584	4.7323	4.81
	Flavone	34.206	5932.5289	458.609	5.1539	5.24
	Epicatechin	37.26	6525.2532	508.857	7.5517	7.68
	Catechin	38.326	9393.7324	727.257	2.4747	2.52
Alkaloids (10.60)	Ephedrine	42.086	6000.1311	470.143	3.3448	3.4
	Spartein	42.943	6524.2634	510.968	4.0498	4.12
	Ribalinidine	10.593	4339.0384	337.681	3.0329	3.08
Steroids (6.27%)	Steroids	22.293	4749.7578	372.508	6.1714	6.27
Glycosides (12.71%)	Cyanogenic glycoside	28.566	5744.9478	450.313	8.4939	8.63
	Cardiac glycoside	2.223	6793.2211	528.999	4.0047	4.07
Other Phenolics (1.70%)	Resveratol	39.586	4412.4024	345.673	1.6764	1.7
Saponins (2.45%)	Sapogenin	40.93	3451.568	270.978	2.4123	2.45
Anti-nutrients (8.83%)	Phytate	29.493	4459.3978	349.793	4.4954	4.57
	Oxalate	33.753	3207.2732	252.912	4.1939	4.26

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Table 6: Composition of the phytochemical constituents detected in CHT-F

Phytochemical	Component	Retention	Area	Height	Conc. (ug/ml)	% Composition
Flavonoids (42.46)	Proanthocyanin	0.19	5184.3944	427.802	2.4306	1.72
	Naringin	1.583	4709.7496	369.572	4.3788	3.09
	Anthocyanin	3.55	3903.4112	306.58	3.5151	2.48
	Flavan-3-ol	4.4	10229.5051	797.09	7.4278	5.24
	Flavonones	12.99	7261.1404	564.292	5.6047	3.96
	Naringenin	15.62	5351.2845	419.38	4.5508	3.21
	Rutin	18.95	6368.0202	498.244	4.6629	3.29
	Flavone	35.65	17427.5578	1329.989	15.1403	10.69
	Epicatechin	36.526	5159.9954	404.908	5.9717	4.22
	Kaempferol	25.563	4875.0349	382.357	3.8262	2.7
	Catechin	28.276	9186.5206	716.488	2.6218	1.85
Alkaloids (7.39%)	Ephedrine	42.706	13247.6644	1026.936	7.3851	5.21
	Ribalinidine	13.973	3725.9862	292.76	3.0837	2.18
Tannins (2.22%)	Tannin	13.273	5414..6802	430.677	3.1444	2.22
Steroids (7.83%)	Steroids	22.456	8539.7226	666.846	11.0958	7.83
Glycoside	Cardiac glycoside	2.633	12170.5138	945.575	6.1929	4.37
18.70%	Cyanogenic glycoside	27.91	13725.1531	1063.342	20.2926	14.33
Anti-nutrients	Oxalate	33.81	18147.5364	1384.596	23.7444	16.77
21.40%	Phytate	12.62	6505.2012	510.587	6.5577	4.63

Table 7: Composition of the phytochemical constituents detected in CHT-G

Phytochemical	Component	Retention	Area	Height	Conc. (ug/ml)	% Composition
Flavonoids (49.61%)	Naringin	0.763	5779.5425	98.904	5.3734	8.11
	Naringenin	14.036	3240.2268	52.096	2.7555	4.16
	Rutin	20.17	8342.6846	101.927	6.1088	9.22
	Kaempferol	25.956	7126.6852	115.871	5.5934	8.44
	Anthocyanin	5.48	2719.094	45.696	2.4486	3.7
	Flavone	34.15	2915.6571	48.251	2.533	3.82
	Epicatechin	36.643	7925.2515	127.307	2.2619	3.41
	Catechin	38.643	7925.2515	127.307	2.2619	3.41
	Flavan-3-ol	7.876	4852.1955	78.442	3.5232	5.32
Alkaloids (12.23%)	Ribalinidine	10.83	6000.1402	95.538	4.9658	7.5
	Spartein	43.533	5050.4626	80.811	3.135	4.73
Tannins (2.48%)	Tannin	9.346	2829.2458	48.179	1.643	2.48
Glycosides	Cardiac glycoside	3.093	3039.8329	51.73	1.5468	2.34
2.34%						
Steroids (13.12%)	Steroids	23.366	6688.5282	108.88	8.6905	13.12
Anti-nutrient (20.22%)	Phytate	29.33	4936.9085	81.904	4.9767	7.51
	Oxalate	31.65	6434.1545	106.616	8.4185	12.71

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CHT were CHT-F > CHT-B > CHT-C > CHT-D > CHT-E > CHT-G > CHT-A with cardiac and cyanogenic glycosides prevailing (Tables 1-7). With the highest level of glycosides detected in CHT-F, the extent of cardiac and cyanogenic glycosides was 4.37 and 14.33 % respectively. In CHT-B, they were 3.15 and 15.34 % correspondingly whereas it was 3.69 and 11.72 % in CHT-C. Further, it was 3.59 and 9.81% in CHT-D while in CHT-E it was 4.07 and 8.63%. Only cardiac glycoside was detected in CHT-A and CHT-G at 2.11 and 2.34 % respectively. The cyanogenic glycosides retained higher concentrations where it was detected. Glycosides are plant-based substances comprising of a glucose unit confined to an aglycone like alcohol, phenol or steroid nucleus through a glycosidic bond [47] with potent antibacterial, antifungal, anti-inflammatory, antioxidant, antiviral and anticancer activities [48, 49]. Cardiac glycosides are used in the treatment of cardiac insufficiency [48, 50] by increasing the output force of the heart and decreasing its rate of contractions by inhibiting the cellular Sodium-Potassium-ATPase pump [50]. However, their relative toxicity prevents their extensive application [51]. On the other hand, cyanogenic glycosides which are mostly found in foods including linamarin, amygdalin and prunasin [52] are known to release hydrogen cyanide when chewed or digested [53] resulting in significant cyanide poisoning. However, processing methods, such as peeling, drying, grinding, soaking and fermentation, boiling or cooking have been reported to cause a significant reduction in the cyanogenic glycosides of processed foods [54].

Saponins

The saponin detected was sapogenin which occurred in these CHTs as CHT-C (4.90 %) > CHT-D (4.17 %) > CHT-E (2.45 %) > CHT-B (2.16 %) (Tables 1-7). Saponins constitute a vast group of glycosides occurring in many plants and are characterized by their surfactant properties. They are grouped as triterpenoid and steroid saponins [55]. The steroidal saponins are essential precursors for steroid drugs, comprising anti-inflammatory agents, androgens, oestrogens and progestins [56] while triterpene saponins exhibit various pharmacological activities, including anti-inflammatory, molluscicidal, antitussive, expectorant, analgesic and cytotoxic influences and include the ginsenosides, which are responsible for some of the pharmacological activity of ginseng and the active triterpenoid saponins from liquorice [57, 58].

Tannins

Tannins were detected only in these CHTs as CHT-A (2.54 %) > CHT-G (2.48 %) > CHT-F (2.22 %). The existence of tannins in tea leaves accounts for the bitter and dry sensation felt when tea is tasted. Tannins are higher in black tea than in oolong, green and white teas [59]. Tannins also occur in red wine, coffee, grapes, apple juice, strawberry, raspberry, blackberry, pomegranate, plums, walnuts, olives, chickpeas, lentils, chocolate and cocoa [60]. Foods rich in tannins have been considered to be of low nutritional value since tannins have been reflected as an anti-nutrient, due to their ability to decrease the efficiency in converting the absorbed nutrients to relevant substances [61, 62]. Tea polyphenols and several components of tannin have been suggested as anti-carcinogenic and many tannin molecules have also been shown to reduce the mutagenic activity of several mutagens. These properties have been attributed to their anti-oxidative properties which enable them to defend against oxidative impairment [61].

Anti-nutrients

The 'anti-nutrients', comprise lectins, oxalates, phytates, phytoestrogens and tannins [63]. Phytates and oxalates were detected in the CHTs as CHT-F > CHT-A > CHT-G > CHT-C > CHT-D > CHT-E (Tables 1, 3-7). Oxalate was higher than phytate in CHT-F (16.77 %), CHT-A (12.76 %) and CHT-G (12.71 %) whereas phytate was higher than oxalate in CHT-C (13.51 %), CHT-D (11.53 %) and CHT-E (4.57 %). Anti-nutrients limit the bioavailability of vital nutrients by binding to vital micronutrients which prevents the body from absorbing them or hindering the peak effects of some digestive enzymes, thereby, inhibiting the appropriate breakdown of food [63]. For example, oxalates are known to affect calcium absorption and use by forming calcium oxalate crystals which could lead to kidney stones. They also irritate and cause swelling in the mouth and throat, and are capable of forming tissue crystals leading to indications of arthritis [64]. Some of the health benefits derivable from dietary phytate include anti-cancer, anti-calcification, antioxidant, antihyperglycaemic and hypolipidaemic activities [63, 65]. They can bind to harmful trace elements like lead and cadmium thereby reducing their bioavailability. It has been associated with certain health benefits, including blood glucose – and lipid-lowering effects, anticancer activity, antioxidant properties, and anti-calcification. The ability of phytate to bind toxic trace elements such as cadmium and lead and reduce their bioavailability has been documented [66].

Steroids

Steroids were detected in the CHTs, but, due to the limitations of the study, the type of steroid identified was not identified. However, steroids were detected in the order CHT-G (13.12 %) > CHT-A (12.95 %) > CHT-C (10.05 %) > CHT-D (8.93 %) > CHT-F (7.83 %) > CHT-E (6.27 %) > CHT-B (6.23 %) (Tables 1-7). Amongst the plant-based steroids, phytosterols are the most abundant [67]. They are known to reduce blood cholesterol by inhibiting intestinal absorption of cholesterol thereby reducing the risk of heart attack and stroke [67]. They have also been demonstrated to slow the *in vitro* development and progression of various cancers [68].

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Resveratrol

Resveratrol, a non-flavonoid polyphenol was detected in low levels in CHT-D (2.28 %) > CHT-E (1.70 %) > CHT-B (1.57 %). It is a polyphenolic phytoalexin formed by plants like grapes, peanuts and berries and retains anti-inflammatory, antioxidant, antiplatelet, anticancer and anti-diabetic activities [69, 70]. *In vitro* investigations have also revealed its ability to prevent all phases of carcinogenesis comprising initiation, promotion and progression at lower doses [71]. However, at higher doses, resveratrol acts as a pro-apoptotic compound which signals the death of cancer cells. They are also able to depress cardiac function [71].

Conclusion

The GC-FID-guided phytochemical identification and quantification of selected CHTs showed that they contain mostly detectable flavonoids, alkaloids, glycosides, saponins, tannins, steroids, anti-nutrients and other phenols such as resveratrol. This present study corroborates the literature on the abundant phytochemical constituents of chamomile which serves as the basis for the numerous health benefits ascribed to chamomile herbal tea.

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