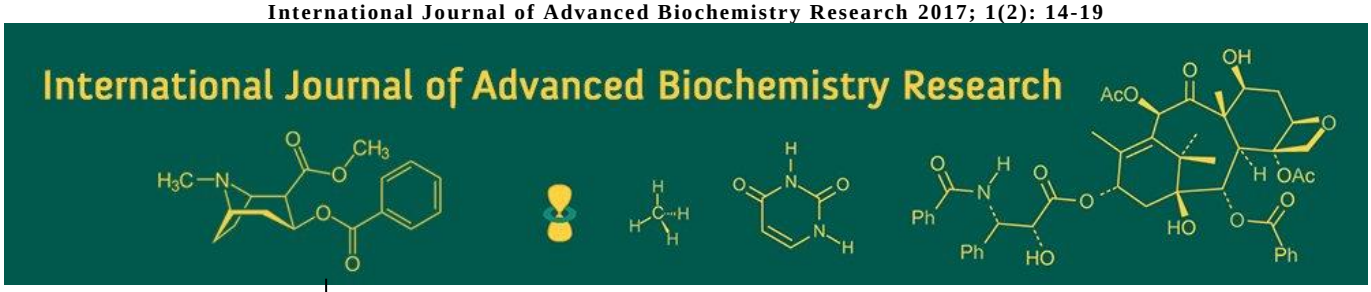

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Phytochemical and antioxidant profiling of aqueous and ethanol extracts of *Curcuma longa* and *Cinnamomum zeylanicum*

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Abstract
Spices are essential as food and as medicine. They enhance the natural flavour of cuisines and can be used to alter the appearance of food to make it more appealing in colour. Two spice samples which include *C. longa* and *C. zeylanicum* were selected for this present study. Antioxidant, phytochemical analysis (including GC-MS analysis), and nutritional composition were carried out on their aqueous and ethanol extracts in this study. The phytochemicals reported include; alkaloids, glycoside, tannins, saponins, terpenoids, flavonoids, phenols and steroids. Alkaloids were present in all the samples except the aqueous extract of *C. longa*. Glycoside was present in all the samples. Tannins, steroids and terpenoids were present in all the samples, while flavonoid was present in only the ethanol extract of *C. zeylanicum* and aqueous extract of *C. longa*. The presence of phenols, tannins and flavonoids in appreciable concentrations tells the antioxidant potential these spices possess. Cinnamaldehyde, which is detected in the ethanol extract of *C. zeylanicum*, has been shown to reduce NO generation in LPS-stimulated macrophages. This further explains the potential anti-inflammatory *C. zeylanicum* possesses. Therefore, the results obtained may help find the active ingredients and provide a helpful chemical basis of these spices in the management of diseases for future research.

Keywords: Spices, *C. longa*, *C. zeylanicum*, antioxidants, phytochemicals, micronutrients, GC MS

Introduction
Spices are derived from plants and have a multitude of properties which can positively impact human health. Many spices contain antioxidant, anti-inflammatory, antibacterial and antiviral properties which have health benefits and benefit the body. For instance, frequent consumption of spicy foods was linked to a lower risk of death from cancer and ischemic heart and respiratory diseases (Vazquez-Fresno *et al.*, 2019) [22].

Phytochemicals are physiologically active, naturally occurring chemical compounds found in plants that provide health benefits for humans that go beyond what macronutrients and micronutrients can deliver (Hasler and Blumberg, 1999) [9]. They protect plants from disease and damage and contribute to the plant's colour, aroma and flavour. Curcuma longa, also known as turmeric, is prized for its underground rhizome, which contains *Curcumin*, a yellow-coloured phenolic pigment used as a natural colourant in food, cosmetics, and colouring, as well as an active ingredient in some medicines (Olojede *et al.*, 2009; Singletary, 2010) [14, 17].

Curcumin offers a surprising number of health benefits, including anti-inflammatory, antioxidant, chemopreventive, and chemotherapeutic characteristics. Curcumin is a free radical scavenger and hydrogen donor that has both pro-and anti-inflammatory properties (Hasler and Blumberg, 1999, Hatcher *et al.*, 2008) [9, 10]. Cinnamaldehyde and trans-cinnamaldehyde (Cin) are the most important elements of *C. zeylanicum*, both of which are present in the essential oil and contribute to the smell as well as the different biological activities associated with *C. zeylanicum* (Chou *et al.*, 2013) [5]. The essential oil from *C. zeylanicum* leaves contains a significant quantity of Cin, according to a study on *Cinnamomum osmophloeum* (*C. osmophloeum*).

As a result, *C. osmophloeum* is also utilized as a substitute for C. cassia (Chang *et al.*, 2008). (E)-cinnamaldehyde, one of the major constituents of essential oil extracted from *C. zeylanicum*, has anti-tityrosinase activity (Hasler *et al.*, 2008) [9], with cinnamaldehyde being

the main compound responsible for this activity (Chou *et al.,* 2013) [5]. Procyanidins and catechins are found in *C. zeylanicum* bark (Tanaka *et al.*, 2008) [20]. Both procyanidin A-type and B-type connections are found in procyanidins (Tanaka *et al.*, 2008; Moure *et al.*, 2001) [20, 12] Antioxidant properties are also seen in procyanidins derived from *C. zeylanicum* and berries (Shumaila and Mah, 2009) [18]. The development of analytical techniques, particularly GC-MS, has been a useful tool for identifying and determining phytochemical substances.

There is paucity of information on the phytochemical and antioxidant profiling of aqueous and ethanol extracts of Curcuma longa and Cinnamomum zeylanicum. The present study is to ascertain this information and which may provide some facts about their active constituents and why they are important as spices in human nutrition.

Materials and Methods

Chemicals and Reagents

All of the chemicals and reagents used were analytical grade and purchased from Sigma Chemical Company, USA. They were not purified further before use for the study.

The plant material

The *C. zeylanicum* sticks and *C. longa dried* barks were obtained from the Oyingbo market, Lagos, Lagos State, Nigeria in 2019, and were authenticated at the Department of Botany, University of Lagos, Nigeria, with a Voucher Specimen No. BOT/021/00115 and deposited at the herbarium.

Extraction of the sticks and barks

Cinnamomum zeylanicum sticks and *Curcuma longa* barks were sun-dried and pulverized at room temperature. For the ethanol extracts of those plant samples, 80 per cent (v/v) ethanol was extracted by maceration using three consecutive cold extractions (25 °C) for 72h. For the aqueous extracts, distilled water was used to soak another fraction of the plant samples for 24h. On a rotary evaporator at 500 °C, the whole filtrate was concentrated to dryness.

Phytochemical screening

The crude extract and fractions were subjected to a qualitative test for phytochemical components such as alkaloids (Sofowora, 1984) [19], flavonoids, glycosides (Trease and Evans, 1978) [21], saponins (Harbone, 1973) [8], and tannins (El-Olemyl *et al.,* 1994) [6].

Test for terpenes (Salkowski test)

Two tests revealed the presence of terpenes in the plant. The extracts were tested on TLC in the first test, after which the plate was coated with ceric sulphate solution and activated at 105 °C. The presence of terpenes was shown by brown coloured dots on the plate. In the second test, 2ml of chloroform was added to 0.5g of each fraction in a test tube before carefully adding conc. H_2SO_4. The presence of terpenes is indicated by a reddish-brown tint.

Test for phenols

Two ml neutral solution of $FeCl_2$ were added to 0.5g of each fraction. The appearance of bluish-green colour indicated the presence of phenols.

Test for saponins

Saponins were detected by vigorously shaking 0.5g of plant fraction with 0.5ml distilled water; the presence of saponins was determined by the formation of persistent foam. Shaking after adding a few drops of olive oil results in the production of an emulsion, confirming their presence.

Test for flavonoids

10% ammonia solution was added to 5.0ml of each plant component, followed by 1.0ml of concentrated H_2SO_4 to test for flavonoids. The presence of flavonoids is indicated by the presence of a yellow hue that fades with standing.

Test for alkaloids

In a steam bath, each plant sample (0.5g) was dissolved in 5 ml dilute HCl and filtered. There were three main approaches used.

The presence of alkaloids was determined by turbidity or precipitation with one of the following reagents. A cream or pale yellow precipitate was obtained by treating 1 ml of the aforementioned filtrate with a few drops of Mayer's reagent. 1 mL of filtrate was treated with a few drops of Dragendorff's reagent, resulting in an orange precipitate. Finally, Wagner's reagent was added to 1 ml of filtrate, resulting in a brown or reddish-brown precipitate.

Test for tannins

Tannins were indicated by boiling 0.5g of each fraction in 10ml of distilled water. After filtration, a few drops of 1% $FeCl_3$ solution was added and the appearance of brownish-green or bluish-black colouration confirms the presence of tannins.

Test for cardiac glycosides

1ml of glacial acetic acid was added to the plant fraction, along with a drop of $FeCl_3$ and 1ml of conc. H_2SO_4. A violet or brown coloured ring formation indicates the presence of cardiac glycosides.

Test for Steroids

2 ml acetic anhydride and 2 ml H_2SO_4 was added to a 5 ml sample of the extracts. The presence of steroids is indicated by a shift in colour from violet to blue or green.

Test for Reducing Sugar (Fehling's reagent)

2ml sample of the aqueous extracts was boiled with an equal volume of Fehling's solutions A and B for 15 minutes. A brick-red precipitate indicates the presence of reducing sugar.

Proximate analysis

On the dry ground sticks and barks of *C. longa* and *C. zeylanicum*, the proximate composition of carbohydrates, fat, protein, and other nutrients was determined using the proper protocol identification number (Horwitz, 2000). The proximate composition of the plant extracts was determined according to the methods of AOAC (2000) [3] as follows: in the various parameters: 955.04 (2.4.03), 962.09 (4.6.01), moisture 934.01 (4.1.03), ash 942.05 (4.1.10), crude fat 920.39 (4.5.01), and carbohydrate by difference.

GC-MS Analysis of essential oils

Hydrodistillation was used to extract essential oils from the chopped pieces of the samples. Steam distillation: Samples of known weight were placed in a reaction vessel and connected to a steam generator. The reaction vessel was also

connected to a cool water condenser. The steam generator generated steam, which condensed and was collected with essential oils after passing through the sample. The oil was dried over anhydrous sodium sulphate and kept at 4°C until the GC-MS analysis.

Analyses via GC-MS: Different components of Curcuma longa essential oil were identified using a Varian Saturn model 2000 GC-MS fitted with an iron trap detector (ITD). A DB-5MS (30 m 0.25 mm id, 0.25 film thickness) column was used to inject the sample. With a flow rate of 7.0-9.5 psi and a split ratio of 1:5, helium was used as the carrier gas. The column temperature was kept at 75 °C for 5 minutes, rising at a rate of 2.5°C per minute to 250 °C.

The retention duration and peak enhancement of various components of the essential oil were determined using standard samples in gas chromatographic mode and an MS library search based on the derived mass fragmentation pattern.

Results

Table 1: Qualitative phytochemical composition of the ethanol and aqueous extracts of *C. zeylanicum and C. longa*

	***C. zeylanicum* Ethanol**	***C. zeylanicum* Aqueous**	***C. longa* Ethanol**	**C. longa Aqueous**
Saponin	_	+	_	+
Flavonoid	+	_	_	+
Tannin	+	+	+	+
Phenol	+	+	+	+
Steroid	+	+	+	+
Alkaloid	+	+	+	_
Terpenoid	+	+	+	+
Cardiac Glycoside	+	+	+	+
Reducing sugar	-	+	+	+

All experiments were done in triplicate: Key: (-) not present, (+) present

Table 2: Quantitative phytochemical composition of the ethanol and aqueous extracts of *C. zeylanicum* and *C. longa*

	***C. zeylanicum* Ethanol**	***C. zeylanicum* Aqueous**	***C. longa* Ethanol**	***C. longa* Aqueous**
Alkaloid (mg/100g)	64.60 ± 4.92	38.50 ± 2.94	80.97 ± 2.69	-
Phenol (mg/100g)	72.99 ± 8.10	110.38 ± 1.86	34.66 ± 1.98	61.75 ± 8.16
Tannins (mg/100g)	33.18 ± 5.11	48.34 ± 7.39	15.60 ± 0.82	28.34 ± 2.02
Saponins (mg/100g)	-	124.18 ± 8.10	-	61.76 ± 5.74
Flavonoids (mg/100g)	48.96 ± 7.92	-	-	79.02 ±8.16

All experiments were done in triplicate.

Identified phytochemical constituents

The phytochemical composition of *Curcuma longa* and *Cinnamomum zeylanicum* ethanol and their aqueous extracts are provided in Table 1.

Flavonoids, alkaloids, steroids, phenols, saponins, tannins, terpenoids, reducing sugar, and cardiac glycoside were among the phytochemicals found. The quantitative phytochemical analysis of Curcuma longa and Cinnamomum zeylanicum ethanol and aqueous extracts are shown in Table 2. *C. longa* ethanol extract contains the most alkaloid (80.97 mg/100g), while *C. zeylanicum* aqueous extract contains the most tannins (48.33 mg/100g). The aqueous extract of *C. zeylanicum* has the most saponins (124.18mg/100g). *C. longa* aqueous extract has the highest flavonoid content (79.02mg/100g), *C zeylanicum* aqueous extract also has the highest phenol present (110.38mg/100g).

Table 3: Total Antioxidant Capacity of the *C. zeylanicum* and *C. longa* extracts

Plant Extract	**Total Antioxidant Capacity (mg/100g)**
C. zeylanicum eth	11.27 ± 1.02
C. zeylanicum aq	10.21 ± 0.85
C. longa eth	38.40 ± 2.46
C. longa aq	2.85 ± 0.06

All experiments were done in triplicate

Table 4: DPPH Scavenging Activity of the plant extracts

Plant Extracts	DPPH (% Inhibition)
C. zeylanicum eth	46.58 ± 6.17
C. zeylanicum aq	31.69 ± 4.06
C. longa eth	70.98 ± 6,24
C. longa aq	27.82 ± 2.16

All experiments were done in triplicate

Antioxidant concentration in the plant extracts

Tables 3 and 4 reveal that all of the plant extracts had variable quantities of total antioxidant capacity and DPPH scavenging activities, however, the ethanol extract of *C. longa* was the most prominent, as seen in the Tables 3 and 4. From these Tables, the aqueous extracts of C. *longa* and *C. zeylanicum* exhibited the least antioxidant potentials, total antioxidant capacity and the DPPH scavenging activities.

Nutrient Components

Table 5. Proximate composition of *C. zeylanicum* and *C. longa*

Parameter	***C. zeylanicum***	***C. longa***
% Protein	8.40 ± 1.04	11.73 ± 1.24
% FAT	1.6 ± 0.03	3.4 ± 0.08
% FIBRE	18.2 ± 2.49	6.13 ± 0.52
% ASH	5.15 ± 0.81	2.94 ± 0.06
% Moisture	14.65 ± 1.06	18.41 ± 2.39
% Carbohydrate	48.56 ± 6.12	54.39 ± 6.17

All macronutrients were present in the plants, with carbohydrates being the most plentiful in both *C. zeylanicum* and *C. longa*, according to proximate analyses. Fat, on the other hand, is the least abundant macronutrient in both extracts (Table 5).

GC – MS Analysis Report

In the aqueous and ethanol bark extracts of Curcuma longa, as well as the stick extract of *Cinnamomum zeylanicum* shown in Tables 6 - 9, components were analyzed using Gas Chromatography and Mass Spectrometry. In the ethanol and aqueous extracts of *C. zeylanicum*, twenty (20) chemicals were found. The *C. longa* aqueous extract and *C. longa* ethanol extract both contained eighteen (18) and nineteen (19) components, respectively.

Table 6: GC – MS Profile for *C. zeylanicum* Aqueous Extract

S/N	RT (min)	% in Total	Phytochemical	Molecular Weight	Exact Mass
1	3.457	1.084	ACETIC ACID	60	60.0211
2	9.544	1.967	2-PROPEN-1-OL	58	58.0419
3	10.398	4.965	HYDROXYCOUMARIN	207	204.237
4	11.115	11.407	COUMARIN	146	146.037
5	11.23	1.344	TRANS-CINNAMIC ACID	148	148.052
6	11.45	1.806	A-MUROLENE	204	204.188
7	11.681	1.954	2-PROPENAL	56	56.0262
8	12.684	3.037	1,2-ETHANEDIOL	62	62.0368
9	13.055	1.492	AR-TURMERONE	216	216.151
10	13.246	1.051	BENZALDEHYDE	106	106.042
11	13.396	1.027	2-NITRO-1-PHENYL-ETHANOL	167	167.058
12	13.661	1.057	2H-TETRAZOLE-2-ETHANOLE	190	190.20
13	14.314	3.842	2-PROPENOIC ACID	72	72.0211
14	14.747	1.955	BUTANOIC ACID	89	89.0558
15	15.642	1.194	N-HEXADECANOIC ACID	270	270.256
16	17	2.137	9,12-OCTADECADIENOIC ACID	280	280.24
17	18.634	1.219	(R)- (+)-1-BENZYLGLYCEROL	182	182.094
18	19.171	1.325	2-PROPENOIC ACID	72	72.0211
19	19.425	1.065	ISOQUINOLINE	409	409.153
20	20.696	2.196	BENZO{B}THIOPHENE-5-CARBOXYLIC ACID	178	178.009

Table 7: GC – MS Profile for *C. zeylanicum* Ethanol Extract

S/N	RT (min)	% In Total	Phytochemical	Molecular Weight	Exact Mass
1	9.163	18.858	CINNAMALDEHYDE	132	132.058
2	9.734	2.213	2-PROPENAL	56	56.0262
3	9.919	2.199	2-PROPEN-1-OL	58	58.0419
4	10.606	1.554	HYDROXYCOUMARIN	204	204.237
5	11.068	2.716	Acetic ACID	60	60.0211
6	11.294	4.349	COUMARIN	146	146.037
7	11.45	4.102	COUMARIN	146	146.037
8	11.548	1.904	α-MUROLENE	204	204.188
9	12.108	4.255	2-PROPENAL	56	56.0262
10	12.304	1.336	2,3,5,6-TETRAFLUOROANISOLE	273	273.02
11	12.616	1.757	PHENOL	350	350.152
12	12.974	1.78	MUUROLOL	222	222.37
13	13.153	1.441	Ar-TURMERONE	216	216.151
14	13.252	1.082	NAPHTHALENE	130	130.075
15	13.459	1.189	CURLONE	218	218.33
16	13.65	1.02	2-NAPHTHALENAMINE	143	143.18
17	14.002	1.008	TETRADECANOIC ACID	228	228.37
18	14.418	3.26	2-METHYLBENZYL CYANIDE	131	131.174
19	14.597	2.086	STYRENE	104	104.15
20	15.77	1.626	n-HEXADECANOIC ACID	270	270.256

Table 8: GC – MS Profile for *C. longa* Aqueous Extract

S/N	Rt (Min)	% In Total	Phytochemical	Molecular Weight	Exact Mass
1	3.647	1.464	ACETIC ACID	60	60.0211
2	4.363	4.699	2,3-BUTANEDIOL	90	90.0681
3	6.771	1.228	PHENOL	350	350.152
4	6.87	1.084	PHENOL	350	350.152
5	8.533	2.392	BENZOFURAN	118	118.042
6	9.503	3.535	2-METHOXY-4-VINYLPHENOL	150	150.068
7	11.224	1.292	BENZENE	78	78.047
8	12.489	3.291	BENZENE	78	78.047
9	12.801	2.288	CURLONE	218	218.33
10	13.222	13.959	TURMERONE	218	218.167
11	13.927	1.131	GERANYL TIGLATE	236	236.178
12	14.089	4.21	(E)-ATLANTONE	218	218.167
13	14.256	1.637	CARVYL ANGELATE	234	234.33
14	14.481	4.364	4-AMINOSTYRENE	119	119.16
15	14.712	1.813	1-METHYL-1-3,- CYCLOHEXADIENE	94	94.15
16	15.053	2.447	DIGLYCOLIC ACID	134	134.022
17	15.4	1.838	PINOCAMPHYL ANGELATE	194	194.27
18	16.018	4.577	2-NONEN-4-ONE	140	140.22

Table 9: GC – MS profile for *C. longa* Ethanol Extract

S/N	Rt (min)	% in total	Phytochemical compound	Molecular weight	Exact mass
1	6.829	1.855	PHENOL	350	350.152
2	8.591	2.79	BENZOFURAN	118	118.042
3	9.549	2.89	2-METHOXY-4-VINYLPHENOL	150	150.068
4	11.247	1.495	BENZENE	78	78.047
5	11.686	2.151	CYCLOHEXENE	81	81.0704
6	12.373	2.26	BENZENE	78	78.047
7	12.576	6.655	PYRAZINE	80	80.0374
8	13.165	11.702	TURMERONE	218	218.167
9	13.477	2.198	(Z)-γ-ATLANTONE	218	218.167
10	13.748	3	BENZANAMINE	93	93.13
11	13.962	2.572	(6R,7R)-BISABOLONE	236	236.178
12	14.071	2.138	TURMERONE	218	218.167
13	14.21	4.831	(E)-ATLANTONE	218	218.167
14	14.406	2.369	ADAMANTANE	136	136.125
15	14.516	2.293	PINOCAMPHYL ANGELATE	194	194.27
16	14.655	2.708	3-BUTEN-2-ONE	70	70.09
17	14.73	1.811	IMIDAZOLE	370	370.189
18	16.052	2.388	FURAN	68	68.0262
19	17.051	1.257	9,12-OCTADECADIENOIC ACID	280	280.24

Discussion

C. longa, particularly its most active ingredient curcumin, has a long list of scientifically documented health advantages, including the prevention of heart disease, Alzheimer's disease, and cancer. It's a powerful anti-inflammatory and antioxidant that may also aid with depression and arthritis problems. *C. zeylanicum* includes an active ingredient called coumarin, which has been linked to the prevention of multiple sclerosis, Alzheimer's disease, and chronic wounds (Olojede *et al*., 2009, Vazquez and Fra, 2019) [14, 22]. *C. zeylanicum*, like C. *longa*, is a powerful anti-inflammatory and antioxidant. The antioxidants, phytochemicals (including GC-MS analysis), and nutritional composition of aqueous and ethanol extracts of C. *longa* and *C. zeylanicum* were investigated in this work.

Alkaloids, glycosides, tannins, saponins, terpenoids, and steroids were all examined subjectively and quantitatively for phytochemicals. Except for the aqueous extract of C. *longa*, alkaloid was found in other plant extracts. *c. longa* ethanol extract exhibited the greatest content of alkaloid (80.97mg/100g); Michael *et al.* reported the existence of a high concentration of alkaloid in ethanol extract of *C. longa* in 2017. The high concentration of alkaloids in this extract should provide it significant bactericidal activity, and the overall presence of alkaloids in the plant samples should lengthen its shelf-life because the foods it contains are not easily damaged by pests and rodents. Flavonoids were only found in the ethanol extracts of the plant samples (in moderate concentrations-48.96mg/100g and 79.02mg/100g), as compared to Al-Reza *et al.*, 2010 [2], who found the same. This must have contributed to these two extracts having a higher total antioxidant capacity than the aqueous extracts. Saponin, unlike flavonoids, was only found in aqueous extracts, which may have contributed to the foams observed during plant maceration in water. All of the extracts contained tannins, steroids, terpenoids, and phenols, which matched the findings of (Ahaotu and Lawal, 2019, Al-Reza *et al.*, 2010, Tanaka *et al.*, 2008) [1, 2, 20]. In comparison to ethanol extracts (72.99mg/100g – *C. zeylanicum*, and 34.66mg/100g – *C. longa*), aqueous extracts of the plants had higher total phenol content (110.38mg/100g- *C. zeylanicum*, and 61.75mg/100g - *C. longa*). Furthermore, Moure *et al.*, 2001 revealed that solvents with a higher polarity generate more polyphenols. As a result, the solvents of the extracts may be to blame for the large disparities in TPC identified in this investigation.

The total antioxidant capacity content of all four extracts was determined using the phosphomolybdenum technique, with TAC values ranging from 2.86 to 38.3991.97 mg/100g. The ethanol extract of *C. longa* (38.399mg/100g) had the highest value, while the aqueous extract of *c. longa* (2.86mg/100g) had the lowest. The total antioxidant capacity of the ethanol extract of *C. zeylanicum* was 11.27mg/100g, which was greater than the total antioxidant capacity of the aqueous extract (10.21mg/100g). When it reacted with potassium ferricyanide (Fe^{3+}) to form potassium ferrocyanide (Fe2+), which then reacts with ferric chloride to form ferric–ferrous complex that has an absorption maximum at 700 nm, the aqueous extract of *C. zeylanicum* (in 0.5ml) has the highest absorbance (0.830nm), indicating that it has the highest reducing power, i.e. it has the highest reduction potential (Nayan *et al.*, 2013) [15]. The absorbance of C. *longa* aqueous extract (1ml) is the lowest (0.642nm), indicating that it has a low reducing power action. For 1ml and 0.5ml quantities, *C. longa* ethanol extract and *C. zeylanicum* ethanol extract showed a decreasing power range of (0.706nm to 0.791nm). This revealed that the *C. zeylanicum* aqueous extract had the greatest ability to minimize the impacts of reactive oxygen species.

The effect of antioxidants on DPPH radical scavenging was assumed to be related to their hydrogen donating ability or radical scavenging activity for the DPPH scavenging activity. When a DPPH solution is combined with a material that may give a hydrogen atom, the violet color disappears (Oghenejobo *et al.*, 2017, Shumaila and Mah, 2009, Al-Reza *et al.*, 2010) [13, 18, 2]. Higher antioxidant activity is indicated by a lower percentage inhibition value (and its related IC50). The *C. longa* bark ethanol extract exhibits the strongest scavenging action (70.98%). *C. longa* has a protein content of 11.725%, a fat content of 3.40%, an ash content of 2.94%, a fibre content of 6.13%, a moisture content of 18.411 percent, and a carbohydrate content of 18.411% (54.59%) When compared to the results of (Ahaotu and Lawal, 2019) [1], moisture content (10.54%), ash (7.87%), protein (6.54%), and fiber (6.54%) were

reported (4.14%). *C. zeylanicum* is high in protein (8.40%), fat (1.60%), fiber (18.2), ash (5.147%), moisture (14.65%), and carbohydrate (14.65%). (48.56%) When compared to the results of (Shumaila and Mahpara, 2009) [18], moisture (5.1%), ash (2.4%), protein (3.5%), and fiber (3.5%) were reported (33.0%). *Curcuma longa* rhizome was used for GC-MS analysis. *Curcuma longa* rhizome is a traditional medication used to relieve pain, reduce blood stasis, and slow the ageing process (Al-Reza *et al.,* 2010) [2]. Hundreds of compounds were discovered in the aqueous and ethanol extracts of *c. longa* bark, but the main constituents were -turmerone, which was found in both extracts, curlone, which was only found in the aqueous extract, benzofuran, -(Z)-atlantone (detected in the ethanol extract), (E)-atlantone (detected in the aqueous extract), and phenol, which was found in both extracts Coumarin, trans-cinnamic acid, and hydrocoumarin were all found in the ethanol and aqueous extracts of *C. zeylanicum*. Cinnamaldehyde, the most potent ingredient, was only found in the ethanol extract of *C. zeylanicum*, which made up the highest percentage of the total (18.8%).

Herbs and spices have played and continue to play important roles as flavouring agents, food preservatives and medicines for centuries (Nayan *et al.,* 2013) [15] Over the last few decades, research into their health benefits has increased significantly as many spices and herbs are known to possess properties associated with reducing the risk of developing chronic diseases, such as neurodegenerative, arthritis, cardiovascular, obesity, diabetes, cancers etc (Bi *et al.,* 2017) [4]. The mode of action of the spices and herbs appear too mediated through the direct action of their phytochemicals, especially polyphenols or by products targeting specific receptors or enzymes involved in inflammatory or immune responses (Tapsell *et al.,* 2006, Moure, *et al.,* 2001, Peng *et al.,* 2008) [12, 16].

Conclusion

Data of the present study indicate that the high contents of phytochemicals in the *C. zeylanicum* and *C. longa* sticks and barks respectively, mainly as antioxidants, which are mostly polyphenolic in nature may have mediated through direct action of their active constituents or by products targeting specific receptors or enzymes involved in inflammatory or immune responses.

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References

1. Ahaotu EO, Lawal M. Determination of proximate and minerals content of turmeric (Curcuma longa Linn) leaves and rhizomes. Journal of Food, Nutrition and Packaging. 2019;B6:1-4.
2. Al-Reza SM, Rahman A, Sattar MA, Rahman MO, Fida HM. Essential oil composition and antioxidant activities of Curcuma aromatica Sahibs. Food Chem. Toxicol. 2010;48:1757-1760.
3. AOAC. Official Methods of Analysis. 17th edition. Association of Official Analytical Chemists, Arlington, USA, Methods, 2000, 925.10, 65.17.
4. Bi X, Lim J, Henry CJ. Spices in the management of diabetes mellitus. Food Chemistry. 2017;217:281-293.
5. Chou WL, Chang CT, Chang SL, Hsu YC Lin, Shih Y. Cinnamomum cassia Essential Oil inhibits MSH induced melanin production and oxidative stress in murineB16 melanoma cells. International Journal of Molecular Sciences. 2013;14(9):19186-19201.
6. El-Olemyl MM, Al-Muhtadi FJ, Afifi AA. Experimental phytochemistry. A laboratory manual, College of Pharmacy, King Fahad University. King Fahad, Saudi University Press, 1994, 1-134.
7. Garcea G, Jones DJ, Singh R, Dennison AR, Farmer PB, Sharma RA, *et al.* Detection of curcumin and its metabolites in hepatic tissues and portal blood of patients following oral administration. Br. J. Cancer. 2004;905:1011-1015.
8. Harborne JB. Phytochemical methods - A guide to modern techniques of plant analysis. 3rd edition, Chanpman and Hall publishers, London, 1973.
9. Hasler CM, Blumberg JB. Phytochemicals: biochemistry and physiology. Introduction. J. Nutr. 1999;129(3):756S-757S.
10. Hatcher H, Planalp R, Cho J, *et al.* Curcumin: FRrom ancient medicine to current clinical trails. Cellular and Molecular Life Sciences. 2008;65:1631-1652.
11. Jager R, Lowery RP, Calvanese AV, Joy JM, Purpura M, Wilson JM. Comparative absorption of curcumin formulations. Nutr J. 2014;13:11.
12. Moure A, Cruz JM, Franco D, *et al.* Natural antioxidants from residual sources. Food Chemistry. 2001;72(2):145-171.
13. Oghenejobo M, Opajobi OA, Oghenejobo Bethel, Uzoegbu U. Antibacterial Evaluation, Phytochemical screening and Ascorbic Acid Assay of Turmeric: MedCrave, 2017.
14. Olojede A, Nwokocha CC, Akinpelu AO, Dalyop T. Effect of variety, rhizome, and seed bed types on yield of turmeric (*Curcuma longa* L.) under a humid tropical agroecology. Advances in Biological Research. 2009;3(1-20:40-42.
15. Nayan Bhalodia R, Pankaj Nariya B, Acharya RN, Shukla VJ. *In vitro* antioxidant activity of hydroalcoholic extract from the fruit pulp of Cassia fistula Linn. Journal of research in Ayurveda. 2013;23:112-116.
16. Peng X, Cheng KW, Ma J, *et al.* Cinnamon bark proanthocyanidins as reactive carbonyl scavengers to prevent the formation of advanced glycation end products. Journal of Agricultural and Food Chemistry. 2008;56(6):1907-1911.
17. Singletary Oregano K. Overview of the literature on benefits: Nutrition Today. 2010;45(3):129-138.
18. Shumaila Gul, Mahpara Safdar. Proximate Composition and Mineral Analysis of Cinnamon. Pakistan Journal of Nutrition. 2009;8:1456-1460.
19. Sofowora A. Medicinal plants and tropical medicine in Africa. 1st ed., Spectrum Books Limited, Ibadan, Nigeria, 1984, 150-172.
20. Tanaka Y, Sasaki N, Ohmiya A. Biosynthesis of plant pigments. Anthocyanins, betalains and carotenoids. Plant Journal. 2008;54:733-749.
21. Trease GE, Evans WC. A Textbook of Pharmacognosy. 11th Edition, Bailliere Tindall, London, 1978, 530.
22. Vazquez-Fresno R, Rosana AR, Wilshart DS. Herbs and spices -Biomarkers of intake based on human intervention studies -Asystematic review. Genes and Nutrition. 2019;14:18-29.