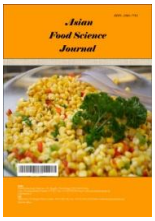

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Biochemical Composition of Two Zinziberaceae: Ginger (*Zingiber officinale roscoe*) and Turmeric (*Curcuma longa*)

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Authors' contributions

This work was carried out in collaboration among all authors. Author EAC designed the study, Author KKB performed the statistical analysis. Authors EAC and DGA wrote the protocol, wrote the first draft of the manuscript and managed the analyses of the study. Authors BGAM and KCS managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The objective of this work is to analyze the biochemical parameters of *Zingiber officinale* (ginger) and *Curcuma longa* (turmeric) found in the locality of Daloa. The samples were purchased in the markets of Daloa. The dry matter, ash and lipid contents were determined by the AOAC (Association of Official Analytical Chemists) method. Those of proteins, total sugars, reducing sugars were carried out respectively by the methods of Kjeldahl, Bernfeld and Dubois. A phytochemical study was done by Evans method. The contents of total flavonoids and total polyphenols were determined respectively according to the methods of Wood and Marinova. It emerges from the analyzes that the contents of dry matter (27.66 ± 0.06%), total sugars (31.25 ± 0.6 mg / g) and fibers (8.21 ± 0.01%) are higher in ginger than in turmeric. The lipid contents of the two species are less than 8%. The results also reveal the presence of tannins, saponins, polyphenols, alkaloids and flavonoids. Ginger has a high content of total polyphenols (53.55 ± 0.45 mg EAG / g)

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than turmeric (35.25 ± 0.52 mg EAG / g). However, the flavonoid values are high in turmeric (92.52 ± 0.54 µg EQ / g) than ginger (86.27 ± 0.62 µg EQ / g). Both turmeric have revealed that ginger and turmeric are low in fat, reducing sugars, and high in fiber and polyphenols. Both rhizomes have the same protein content. The presence of secondary metabolites in the rhizomes of ginger and turmeric justifies the therapeutic importance of these two plants, hence the importance of consuming them to take full advantage of the beneficial effects of its active ingredients. However, the compounds vary from species to species.

Keywords: Turmeric; ginger; Zingiber officinale; Curcuma longa; polyphenols.

1. INTRODUCTION

Ginger (*Zingiber officinale*) and turmeric (*curcuma longa*) are two plants of the Zingiberaceae family. They contain nearly 50 genera which are divided into more than 1400 species. Ginger widely used in cooking for its taste as well as facilitating digestion, ginger is also a medicinal spice with multiple properties [1], cultivated mainly for its rhizomes which are generally used for human consumption. Ginger is gaining more and more attention around the world for its various healing properties and its use in different culinary and gastronomic types [1]. Much of the Ivorian production of ginger is used for the manufacture of juice and is also used in the pharmacopoeia [2]. This activity is not very popularized, however it is an important source of income. The price of a kilogram of ginger can vary from 320 francs to 500 CFA francs [2].

Similar to ginger, turmeric is a perennial plant belonging to the Zingiberaceae family. The most widely used part, the rhizome serves as a food spice, a preservative, and is used as a colorant in foods and textiles [3]. In addition, turmeric or Indian saffron (*Curcuma longa)* is a plant famous for its culinary and medicinal uses [4]. It has also been used for centuries in traditional medicine to treat asthma, allergies, liver disorders such as jaundice, anorexia, rheumatism, colds, sinusitis [5,6,7]. It also serves as a natural dye [8].

These two spices contain many active ingredients that are widely used in therapy, such as antioxidant, antimicrobial and anti-inflammatory preventive agents [9]. In Côte d'Ivoire, ginger is widely available and consumed, unlike turmeric, which is still unknown to the population. Knowledge of these two spices could add value to these very little valued products. Therefore, it would therefore be appropriate to determine the biochemical characteristics of ginger and turmeric for efficient recovery. The objective of this study is therefore to determine the composition of the biochemical properties of ginger (*Zingiber officinale*) and turmeric (*Curcuma longa*), in order to assess the different uses in nutrition and in food technology.

2. MATERIALS AND METHODS

2.1 Biological Material

The plant materials that were was used to carry out this study consists of two roots. They are: ginger (*Zingiber officinale roscoe*) and turmeric (*Curcuma longa*) (Fig. 1). These rhizomes were bought from in the markets of the city of Daloa during the month of July 2020.

Ginger (*Zingiber officinale*)

Turmeric (Curcuma longa)

Fig. 1. Photograph of ginger and turmeric

2.2 Methods

2.2.1 Biochemical analyzes of dried roots of *Zingiber officinale roscoe* from *Curcuma longa*

2.2.1.1 Sampling

To ensure sample homogeneity, fresh ginger (*Zingiber officinale roscoe*) and turmeric (*Curcuma longa*) roots from Daloa markets were dried at room temperature for two months. A number of thirty (30) samples of each root species were collected. These root samples were purchased at random from markets in the city and transported in sachets to the laboratory for possible analysis. These dried samples were then labeled (by species) and sent directly to the Laboratory. In addition, the dried ginger roots and turmeric (*Curcuma longa*) are crushed using a grinder (RETSCH type: SK100 / C Gusseinsen) and sieved with a 200 micron sieve to give a fine powder. This fine powder was packaged in polyethylene sachets and stored at room temperature for the various biochemical analyzes.

2.2.2 Biochemical analysis

2.2.2.1 Dry matter content

The method used for the determination of dry matter is based on that proposed by the [10], the principle of which is based on the loss of mass of the sample up to a constant mass at 105 ° C.
Protein content Crude protein is determined from the determination of total nitrogen, according to the Kjeldhal method [10]. The nitrogen in the dry matter is determined using the Kjeidahl method after sulfuric mineralization, in the presence of a selenium catalyst. The nitrogen content is multiplied by 6.256.25 (conversion coefficient of nitrogen to protein). (Protein content (%) = % N x 6, 25).

2.2.2.2 Lipid content

The lipid content is determined according to the method described by [11] using the Soxhlet as an extractor. The extraction of the oils is obtained by hexane in a Soxhlet type extractor (Unid Tecator, System HT2 1045, Sweden). After evaporating the solvent and drying the capsule in an oven at 105˚C for 30 minutes, the difference in weight gives the lipid content of the sample. Total sugars and reducing sugars content The determination of the total sugars was carried out according to the method of [12] using phenol and sulfuric acid and that of reducing sugars was carried out according to [13] using 3,5-dinitro-salicylic acid (DNS).

2.2.2.3 Ash content

The method used for the determination of ash is that described by [10] which consists of incinerating a sample until white ash is obtained. The capsule containing the sample is placed in a muffle furnace (NABERTHERM, Germany), then subjected to 550˚C ± 2˚C for 24 hours. After removing the capsule from the muffle furnace and cooling it in a desiccator (GLASWERK WERTHEIM at 2 bar), it is weighed again.

2.2.2.4 Determination of fiber content

The determination of the fiber content was carried out according to the method of [14]. A 2 g sample of ground ginger or turmeric (P0) was introduced into a flask to which 50 mL of 0.25N sulfuric acid was added. The resulting mixture was homogenized and boiled for 30 min under reflux condenser. After 30 min, 50 mL of 0.31N NaOH was added to the contents and again boiled under reflux condenser for 30 min. The resulting extract was filtered through Whatman No. 4 filter paper and the residue was washed several times with hot water until the alkali was completely removed. The residue was dried in an oven at 105 ° C for 8 h. After cooling in a desiccator, the residue was weighed (P1) and then incinerated in an oven at 550 ° C for 3 h. After cooling the ashes obtained were weighed (P2). The crude fiber content was obtained in g per 100 g of DM according to the formula:

$$\text{Crude fibers (\%)} = ((P1-P2))/(P0) \times 100 \quad (6)$$

2.2.3 Phytochemical analyzes (phytochemical screening)

The photochemical screening made it possible to highlight the different compounds present in the samples of ginger (*Zingiber officinale roscoe*) and turmeric (*Curcuma longa*) roots. The determination of the phytochemicals was carried out according to the method developed by [15].

2.3 Searches for Tannins

2.3.1 Reaction with ferric chloride 1%

In a volume of 1 mL of the extract contained in a test tube, were added 2 mL of distilled water, then one to two drops of 1% (w / v) ferric

chloride. The appearance of a blue or blue-black color indicates the presence of tannins.

2.3.2 Reaction to 10% lead acetate

In a volume of 1 mL of the 10% (w / v) aqueous solution of lead acetate is added to 3 mL of extracts. The formation of a blue, blue-black, whitish or brownish precipitate indicates the presence of tannins.

2.4 Alkaloid Research

2.4.1 Drag end or ff test

A few drops of Dragendorff's reagent were added to a test tube containing 2 mL of extract solution. The formation of a red-orange precipitate indicates the presence of alkaloids.

2.4.2 Mayer's test

Adding a few drops of Mayer's reagent to 2 mL of the extract solution will cause a white or white-yellow precipitate to form in the presence of alkaloids.

2.4.3 Search for saponins

In a test tube containing 2 mL of the extract, 3 mL of distilled water are added. After stirring the mixture, a persistent foam forms in the presence of saponins.

2.4.4 Research for polyphenols

To 2 mL of each extract was added a drop of 2% (w / v) alcoholic or aqueous ferric chloride solution. The positive reaction results in the appearance of a blue-blackish or green color, more or less dark (control test with a phenol solution).

2.5 Flavonoids Research

2.5.1 Iron perchloride test

Two to three drops of dilute iron perchloride (FeCl3) solution were added 2-3 mL of the extract solution in a test tube. The observation of a greenish color indicates the presence of flavonoids.

2.5.2 Soda test

2 to 3 mL of the extract solution are added to a test tube, followed by 2 to 3 drops of the 0.1N sodium hydroxide solution. The appearance of a yellow-orange color characterizes the presence of flavonoids.

2.5.3 Determination of total polyphenols

The total polyphenols were determined according to the method modified and described by [16]. The principle is based on the reduction of the Folin ciocalteu reagent during the oxidation of polyphenols. For this, a volume of 100 µL of each solution of ginger (*Zingiber officinale roscoe*) or turmeric (*Curcuma longa*) roots introduced into a 25 mL flask was added with a volume of 1 mL of Folin-ciocalteu reagent. (diluted to 1 / 10th). After 2 min, a volume of 2 ml of sodium bicarbonate (Na2CO3) at 20% (m / v) is added thereto. The resulting solution is kept in the dark for 30 minutes at room temperature. Next, the absorbance of each solution is read with a "JASCO UV-530" brand visible UV spectrometer at 760 nm against the control where the sample is replaced with double-distilled water. The calibration is carried out with a gallic acid extract at different concentration (0 to 0.5 g / L). The readings are repeated three times. The content of phenolic compounds in each extract of ginger (*Zingiber officinale roscoe*) or turmeric (*Curcuma longa*) roots was calculated from the calibration curve and expressed in g / 100g of the gallic acid equivalent dry matter.

2.5.4 Determination of total flavonoids

The method of [17] was used for the determination of the total flavonoids of the roots of ginger *(Zingiber officinale roscoe)* or turmeric (*Curcuma longa).* In a 25 mL capacity flask, a volume of 0.75 mL of 5% (w / v) sodium nitrite (NaNO2) was added to a volume of 2.5 mL of ginger root extract (*Zingiber officinale roscoe*) or turmeric (*Curcuma longa*).

The homogenized mixture was added to a volume of 0.75 mL of 10% (w / v) aluminum chloride (AlCl3), then the whole solution was incubated for 6 minutes in the dark. After incubation, a volume of 5 mL of sodium hydroxide (NaOH, 1N) and a volume of 25 mL of distilled water were added. The mixture was stirred manually before assaying with a UV-visible spectrophotometer. The reading was taken at 510 nm. The tests were carried out in triplicate. The flavonoid content was expressed in milligram quercetin equivalent per gram of extract (µg Eq Q / g). 2.5 mL of this solution is mixed with 2.5 mL of DPPH (100 µM) also prepared in methanol. After homogenization, the

mixture is incubated at room temperature (25 ° C) protected from light. After 15 minutes of incubation, the absorbance is read at 517nm against a "blank" which contains only methanol. The percentage inhibition of the DPPH radical is calculated according to the following equation: DPPH inhibition (%) = (1- (OD test / OD blank)) x 100.

The IC50 which is the concentration of plant extract responsible for 50% inhibition of radicals DPPH is determined on the graph representing the percentage inhibition of DPPH as a function of the concentrations of the extracts.

3. RESULTS AND DISCUSSION

3.1 Results

3.1.1 Biochemical composition of ginger (*Zingiber officinale*) and turmeric (*Curcuma longa*) samples

The physicochemical composition of the ginger and turmeric samples from Daloa were ~~was~~ determined. The results obtained are shown in (Table 1). On analysis, the average total sugar content of the root samples is 31.25 ± 0.6 mg / g for ginger and 30.23 ± 0.54 mg / g for turmeric. The fat contents of the samples are between 7 ± 0.31% for ginger and 6.86 ± 0.19% for turmeric. It can also be seen from this table that there is a significant difference between the content of reducing sugars in turmeric and ginger. Indeed, the contents of reducing sugars (11.11 ± 0.54 mg / g) of turmeric are higher than those of ginger (8.82 ± 0.3 mg g). There is also a significant difference between the fiber content of ginger and turmeric. Indeed, the fiber contents (8.21 ± 0.01%) of ginger are higher than those of turmeric (4.31 ± 0.04%).

3.1.2 Phytochemical characteristics of ginger (*Zingiber officinale roscoe*) and turmeric (*Curcuma longa*) roots

3.1.2.1 Identification of phytochemicals in turmeric ginger

The phytochemical study of the roots of ginger (*Zingiber officinale roscoe*) and turmeric (Curcuma longa), reveals the presence of several families of molecules which are: tannins, saponins, polyphenols, alkaloids and flavonoids (Table 2).

3.2 Phytochemical Composition

The contents of total polyphenols and total flavonoids are recorded in (Table 3). It emerges from the analysis of this table that there is a significant difference ($p < 0.05$) between the polyphenol contents of the two species of roots. Indeed, the roots of ginger (Zingiber officinale roscoe) (53.55 ± 0.45 mg (EAG) / g) have higher contents than those of turmeric (Curcuma longa) (35.25 ± 0.52 mg (EAG) / g). The total flavonoid levels obtained also show a significant difference ($p < 0.05$) between the two species. Indeed, the contents are higher for turmeric roots (*Curcuma longa*) (92.52 ± 0.54 µg (EQ) / g) than for ginger roots (*Zingiber officinale roscoe*) (86.27 ± 0, 62 µg (EQ) / g).

4. DISCUSSION

It should be noted that the biochemical compositions of the species have been determined in order to understand their dietary importance and their contribution in the treatment of diseases. This study indicated ash contents for the two species which are 3.66% for ginger and 1.33% for turmeric. Ash contents indicate the

Table 1. Biochemical characteristics of ginger and turmeric roots

Settings	Ginger	Turmeric
Dry matter (%)	27.66±0.06[a]	19±0.02[b]
Ashes (%)	3.66±0.01[a]	1.33±0.03[b]
Protein (%)	18.73±0.07[a]	18.38±0.43[a]
Total sugars (mg /g)	31.25±0.6[a]	30.23±0.54[a]
Reducing sugars (mg /g)	8.82±0.3[b]	11.11±0.54[a]
Lipids (%)	7±0.31[a]	6.89±0.19[a]
Crude fibers (%)	8.21±0.01[a]	4.31±0.04[b]

The values are the mean ± the standard deviation (n = 3). The contents with the different alphabetical letters on the same line are significantly different (P < 0.05), according to Tukey's test

Table 2. Phytochemical constituents of ginger (*Zingiber officinale*) and turmeric (*Curcuma longa*)

Species	Polyphenols	Flavonoids	Saponins	alkaloids	Tannins
ginger	+	+	+	+	+
turmeric	+	+	+	+	+

NB : (+) : presence, (-) : absence

Table 3. Phytochemical composition of the roots of ginger (*Zingiber officinale*) or turmeric (*Curcuma longa*)

Composition	Ginger	Turmeric
total polyphenol (mg EAG/g)	53.55 ± 0.45[a]	35.25±0.52[b]
Total flavonoid (µg EQ/g)	86.27 ± 0.62[b]	92.52±0.54[a]

The values are the mean ± the standard deviation (n = 3). The contents with the different alphabetical letters on the same line are significantly different (P < 0.05), according to Tukey's test.

presence of minerals in food products [18]. This is because ashes are residues of mineral compounds that persist after the incineration of a sample containing organic substances of animal and plant origin [19]. Ginger is a good nutritional source because according to [20] the leaves or vegetables which are to be used as food for humans, should contain about 3.0% ash. The total sugar content is 31.25 mg / g for ginger and 30.23 mg / g for turmeric. The reducing sugars values are 8.82 ± 0.3 mg / g and 11.11 ± 0.54 mg / g respectively for ginger and turmeric. The low levels of total sugars are indications of the nutritional quality of these species, as excess sugars are often associated with certain metabolic diseases such as diabetes [21]. So *Zingiber officinale* and *Curcuma longa* could be safely consumed by diabetics.

The amounts of lipids contained in the ginger and turmeric samples studied are low and less than 8%. These low levels of fat could mean that they are not a good source of fat. These species could be recommended for individuals with obesity reported by [22].

Dietary fiber is necessary for the maintenance of the body in good health [23,24]. Consuming dietary fiber lowers LDL cholesterol levels, considered a risk factor for cardiovascular disease [25,26]. This study indicates that the fiber contents of ginger (8.21 ± 0.01%) are higher than those of turmeric (4.31 ± 0.04%). These two rhizomes could be incorporated into food formulations. The medicinal virtues of ginger and turmeric lead us to do a phytochemical screening to determine the active ingredients.

The phytochemical study of the two species of rhizomes revealed the existence of several molecular families: tannins, saponins, polyphenols, flavonoids and alkaloids. The presence of these secondary metabolites in ginger and turmeric would justify the local use of these plants for the treatment of various ailments. Indeed, these active ingredients are responsible for the pharmacological potential of medicinal plants [27]. The presence of flavonoids in ginger and turmeric have been reported. Flavonoids have a beneficial effect on health, prevent cancer and cardiovascular disease [28,29]. Therefore, we can say that ginger and turmeric could be recommended for consumption.

The presence of tannins in the two rhizomes would justify the anti-diuretic and anti-diarrheal properties reported by [30,31]. Tannins are also bitter polyphenolic compounds, which accelerate wound healing [32]. This would justify the use of ginger and turmeric for the treatment of injuries, reported in our investigations. Saponins have anti-inflammatory properties [33]. The presence of this compound in ginger and turmeric could explain the anti-inflammatory properties of these rhizomes.

The study carried out revealed the presence of alkaloids in the rhizomes of ginger and turmeric. Alkaloids are substances with pharmacological properties. Some play the role of anesthetics (cocaine), antimalarials (quinine) [34,35]. Both species of rhizomes contain polyphenols and provide very important antioxidant activity. Indeed, antioxidants and phenols reduce the oxidative actions of free radicals which could be responsible for cardiovascular diseases. To decrease oxidative damage, our body therefore needs a diet rich in exogenous antioxidants [36]. Polyphenols are also believed to be involved in the prevention of cancer. They are active against

many cancers such as colon, stomach, liver, breast, prostate, lung, skin, bladder, etc. [37].

In this study, the content of phenolic compounds in the two rhizomes varied from species to species. Indeed, ginger is richer (53.55 ± 0.45 mg (EAG) / g) in polyphenols than turmeric (35.25 ± 0.52 mg EAG / g). The results confirm those of [38], according to this author ginger is richer in polyphenols than turmeric. This difference in phenolic compounds between the two rhizomes could be linked to the origin of ginger and turmeric, climatic conditions, maturity at harvest and storage conditions. [39]. The polyphenol values of ginger are significantly lower than those found by [40] in ginger in Algeria which is 71.64 mg EAG / g. However, the total polyphenol contents of turmeric are higher than those found by this same author, which is 10.28 mg EAG / g. Thus, the levels of phenolic compounds observed in the two species could constitute very interesting data for the nutrition of the local population.

As for the total flavonoids of ginger and turmeric studied, relatively high values were recorded (86.27 ± 0.62 (µg EQ / g) for ginger and 92.52 ± 0.54 (µg EQ / g) for turmeric). These values are higher than those of [41] which is 5 (µg (EQ) / g) in ginger. Overall, the ginger and turmeric studied are high in flavonoids, however turmeric is richer in flavonoids than ginger.

Flavonoids belong to the groups of phenolic compounds which have a high therapeutic value in the organism since they act as an antioxidant, either by blocking the formation of free radicals, or by directly fixing oxygen or by inhibiting the activity. lipoxygenase [42]. They are molecules which provide more stability in the membranes of the liver microsomes and also play an important role in the instinctive protection against oxidative stress with the contribution of certain vitamins [43]. The high levels of flavonoids confirm the therapeutic virtues attributed to these species of ginger mentioned in the survey.

5. CONCLUSION

The present study was carried out with the aim of evaluating the knowledge, nutritional and biochemical nature of the two species of rhizomes which are: *Zingiber officinale* (ginger) and *Curcuma longa* (turmeric) with a view to their valorization. nutrition in the diet and the Ivorian pharmacopoeia.

The biochemical compositions of the rhizomes of *Zingiber officinale* (ginger) and *Curcuma longa* (turmeric) revealed that ginger and turmeric are low in lipids, total sugars, reducing sugars, and high in water and fiber. The presence of secondary metabolites in the rhizomes of ginger and turmeric justifies the therapeutic importance of these two plants, hence the importance of consuming them to take full advantage of the beneficial effects of its active ingredients. However the compounds are in variable proportions, they vary from one species to another.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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