EVALUATION OF THE NUTRITIONAL COMPOSITION OF COLD AND HOT WATER EXTRACTS OF *FICUS CAPENSIS* LEAF

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ABSTRACT

Ficus capensis hot water is used by some locals as beverage. The present study aimed at determining the nutritional composition of cold and hot water extracts of *Ficus capensis* leaf. Matured and fresh leaf of *Ficus capensis* were collected and extracted. Nutritional analysis of the extracts were performed in accordance to standard methods. The result of the study showed the presence of protein, carbohydrate as well as appreciable amounts of minerals and vitamins. The protein and carbohydrate contents of the hot water extract was significantly ($p < 0.05$) different from that of cold water extract. The study concludes that the hot water extract will serve as a good source of these nutrients when consumed in appreciable amount. Therefore, this finding will aid in meeting the human nutritional needs for normal growth and development when used as an alternative source of raw material in brewery industry.

Key words: *Ficus capensis*; hot water extract; cold water extract; nutrition; amino acids; vitamins.

INTRODUCTON

The increasing cost, scarcity and expansion of rural areas for the production of fruits and vegetables as a result of enormous utilization by large percentage of the world's population has necessitated the search for underutilized vegetable in Nigeria and other humid countries (Tochukwu and Oyinloye, 2017). Man's consumption of fruits and vegetables is thought to contribute significantly to the improvement of human health due to the important nutritional and bioactive constituents (Waheed and Sadiya, 2021). However, numerous plants with important bioactive constituents and nutritional benefits are still underutilized today as food (Dario and Federica, 2020). Although the world is abundant in plant species designated for consumption as grains, vegetables, and fruits, only a small number are used as commercial cash crops (Baldermann *et al*., 2016). *F. capensis* , often known as Cape Figure or broom cluster in English, is a member of the mulberry family (Moraceae), which has over 1000 species, including *F. sycomorus* and *F. glomosa* (Abubakar *et al*., 2022). It is called Agba (Urhuobo), Alokoro (Igbo), Opoto (Yoruba), Obada (Edo) and Uwaraya (Hausa) in Nigeria (Okoroh *et al.,* 2019). It is an evergreen tree that grows throughout the tropics. The word "Ficus" originates from the hollow, pear shape inflorescence known as "Syconia". Both male and female varieties are available (Pawlos *et al*., 2021). The plant, which multiplies swiftly, is propagated by cuttings and wildlings. Even in the warmest and driest seasons, it thrives in the plains and around rivers where the soil is moist or humid. The plant is a deciduous tree that grows to a height of 35 to 40 meters. Young leaves have an upper surface that is glabrous and a lower surface that is hairy (Pawlos *et al*., 2021).

To improve human health, *F. capensis* has been used as a food source. They are crucial as food additives and as nutraceuticals. Consuming fruits, green vegetables, and whole grains regularly may reduce the risk of oxidative stress-related disorders, according to epidemiological and animal research (Obi *et al*., 2022). According to Elwira *et al.,* 2022, bioactive compounds have significant antioxidant capacity and are effective in the prevention of specific diseases.They are well recognized for having a high amino acid content and being low in fat and cholesterol. Traditionally, *F. capensis* leaves serve as vegetables both in soup and yam pottage in several parts of Nigeria (south east) (Otitoju *et al*., 2014). The hot water extract has also being used traditionally as beverage which serve as remedy for malaria, cough, sour throat, diarrhoea and has rapidly increased the haemoglobin levels in the treatment of anaemia (Onwurafor *et al*., 2022). The leaves have shown to contain high moisture, carbohydrates, moderate protein, ash and low concentration of fat and fibre (Ngozi *et al*., 2017). It is also rich in carotenoids and vitamin A while the B and E are in reasonable amounts (Kevwe *et al*., 2018). The aqueous leaves extract also contain Vitamin C and flavonoid which are effective antioxidants (Elwira *et al.,* 2022).

According to Uzoekwe and Mohammed, 2018, the aqueous leaves of *F. capensis* have minor amounts of iron, zinc, copper, and manganese but high concentrations of calcium, magnesium, and phosphorus. Currently, researchers all over theworld have indicated interest to evaluate wild plants for their nutritional, phytochemical, as well as important bioactive features for the well-being of human society as alternative source of raw material for industrial purpose. However, no work has been documented on the nutritional composition of hot water extracts of *F. capensis leaf*. Therefore, in this present study, the researchers aimed at determining the nutritional composition of hot water extracts of *F. capensis* .

MATERIALS AND METHODS

Chemicals/reagents

High quality analytical grade reagents made from Merck, Germany; Hopkins and Williams Essex, England; May and Baker Ltd, England; BDH chemicals Ltd, England and Riedel-De-Haen Hannover, Germany were used.

Collection, identification, and cleaning of plant leaf

Fresh matured *F. capensis* leaf separated from stalks was collected from a local- bush in Abraka, Ethiope East Local Government Area of Delta State, identified and authenticated by a taxonomist, “Dr. H.A. Akinnibosun”, at the Division of Botany, University of Benin, Nigeria. A voucher specimen (UBH-f331) was given and kept for reference purposes in the herbarium.

Preparation of *F. capensis* extracts/samples

Cold water sample

The plant tissue homogenization technique was applied for the preparation of cold water leaf samples of *F. capensis*. About 100 g *F. capensis* leaf was weighed, and crushed to a smooth paste using mortar and pestle. Before filtering, about one litre of deionized water was added and shaken vigorously at 36.8 ^{O}C for 5 – 10 minutes. The centrifugation of filtrate was done for sample clarification (Sahira and Cathrine, 2015).

Hot water sample

The decoction technique was applied for the preparation of the hot water leaf sample of *F. capensis*. This was achieved by heating 150g of the fresh leaf for 15 - 20 minutes at 100 degrees Celsius and thereafter left to cool down (Sahira and Cathrine, 2015). Both sample extracts were appropriately labelled and stored in a refrigerator at 4 ^{0}C to avoid deterioration and wastage for future use.

Determination of carbohydrate and protein of cold and hot water samples of *F. capensis* leaf

The nutritional (carbohydrate, protein, vitamins, and minerals) properties of *F. capensis* leaf cold water and hot water samples were explored. The protein concentration of sample extract was assessed by means of the Biuret method as described by Gornall *et al.* (1949). Samples of hot and cold water filtrates of 1 ml were taken each and added to 3 ml of Biuret reagent. The optical density was recorded at 540 nm with deionized water as a blank at 37 °C of incubation, after 30 minutes. Bovine serum albumin (BSA) (200 - 1000µg/ml) served as standard protein and the protein sample concentration was extrapolated from it.

Determination of carbohydrate

Total carbohydrate was ascertained using the phenol sulphuric acid method (Dubois *et al.,* 1956). Standardized solutions ranging from 0.2 to 1.0 mL (200 - 1000 g/mL) were pipetted into test tubes and filled to 1.0 mL with distilled water. In other tubes, 1.0 mL of sample was collected and 1.0 mL of distilled water served as the blank. After 10 minutes, the tubes were heated in a water bath at 25 - 30 °C for 20 minutes with 1.0 mL of phenol solution and 5.0 mL of 96% H_2SO_4. At 490 nm, the developed colour was read.

Determination of minerals analysis

The analysis of minerals were conducted at the Nigeria Institute for Oil Palm Research (NIFOR), located in Benin City

Sample preparation for minerals analysis

The cold water sample was made by blending 45 grams of the leaf and filtered with 300ml distilled water while the hot water sample was made by boiling 75 grams of the leaf in 0.5L of water using a beaker at 100^{o}C for about 15 minutes. The sample was cooled and subjected to mineral analysis. About 10 ml of the sample aliquot was mixed with diluted 5 ml of 10 % nitric acid (HNO_3) and warmed up in a bunsen burner to expel all the reddish-yellow fumes. The media was cooled, moved into a 10ml standard flask, and was made up to the mark with distilled water which was kept for examination of metal using Flame AAS. Pyrex glassware was employed for the acid digestion at 150 ^{o}C for 10 minutes. The solution was sieved with an acid washed filter paper into a 100 ml beaker and made to volume with 10% HNO_3 and well mixed.

Sodium (Na), calcium (Ca), magnesium (Mg), iron (Fe), zinc (Zn), potassium (K), and manganese (Mn) were determined following standard analytical procedures (AOAC1990; Achikanu *et al*., 2013), Phoshorous (P), (Pearson 1976), Zn and Fe were determined by Atomic Absorption Spectrophotometer (Perkin-Elmer 1982; Buchanan and Muraoka, 1964).

Determination of vitamins of cold and hot water extracts of *F. capensis* using high performance liquid chromatography (HPLC)

To evaluate the vitamins present in the cold and hot water extracts of *F. capensis* leaf, the HPLC method described by Seal (2016) was employed.

Principle

The separation of different parts of a sample is the underlying principle of HPLC and the chromatographic method in general. This separation is accomplished through a series of equilibrium stages in which the injected sample components interact through partition or adsorption between the stationary and mobile phases. The components in the sample have different affinity for the mobile and stationary phases and migrate at different rates through the column. The resolution is a degree of separation efficiency that is determined by how far apart and how broad the peaks in a chromatogram are (a graph representing the detector response as a function of time).

Chromatographic Analysis of vitamin Compounds in the Cold and Hot Extracts of *F. Capensis*

The mobile phase contains 1% aqueous acetic acid solution (Solvent A) and acetonitrile (Solvent B), and the flow rate was set to 2ml/min. The column temperature was set to 28 ^{0}C, and the sample injection volume was 5µL. The proportion of solvent B to solvent A was varied to perform gradient elution. In 55 minutes, the mobile phase composition was returned to its initial state of solvent B: solvent A: 10: 90, and it was left to stand for another 10 minutes before another sample injection. Per sample, the total analysis time was 65 minutes. According to the compounds studied, the HPLC chromatograms were detected using a photo diode array UV detector at three different wavelengths: 272, 280, and 310 nm. Compounds were identified based on their retention time and by spiking with the standards under the same conditions. Sample quantification was completed by measuring the integrated peak area and the content was calculated.

Calculation

Total and Individual parameter standards

Total and Individual standard concentration of the cold and hot water extract were calculated as follows;

$$\text{Concentration of parameter (mg/g)} = \frac{\text{Peak area}}{\text{Standard peak area}} \text{ x Standard concentration}$$

RESULTS AND DISCUSSION

Protein, carbohydrate and mineral Composition of the Cold and Hot Water Extracts of the Leaf of *F. capensis*

Evaluations on the cold and hot water extracts of *F. capensis* leaf revealed the presence of important nutritional compounds such as protein, carbohydrates and minerals (Table 1). The protein and carbohydrate contents of the hot water extract was significantly (p>0.05) different from that of cold water extract. Potassium, Magnesium, Zinc and Iron were found to be higher in the hot water extracts while Sodium, Phosphorus and Calcium were found to be higher in the cold water extract of the leaf of *F. capensis*. The predominant minerals were calcium, potassium, iron and magnesium while Sodium and phosphorus were relatively low with zinc content the least among the minerals in cold and hot water leaf extracts of *F. capensis*. Protein and carbohydrate present in the cold water extract were found in the hot water extract with the concentration of the nutrient higher in the hot water extract. The high concentration of the nutrients could be as a result of the heat applied during the preparation method. The heat would have extracted the nutrient present in the leaf into the liquid extract thereby enhancing the nutrient. Heat has been reported to affect protein and carbohydrate contents of vegetable leaves (Bello *et al*., 2021). It has also been reported that proteins in raw leafy vegetables are usually low, but they have high biological value (Kalu *et al*., 2020). Proteins in nuts and grains are in a strong pool while the proteins in leaves are in the form of enzymes (Oboh and Masodje, 2021). Carbohydrates are energy suppliers and are important for an adequate diet (Dennis- Eboh *et al*., 2020).

In this study, sodium, phosphorus, calcium, potassium, magnesium, zinc and iron present in the cold water extract were found in the hot water extracts (Table 1). This implies that the hot water extract is a good source of minerals.The hot water extract of *F. capensis* was found to be rich in iron (Table 1). Iron helps in blood haemoglobin formation, meaning that it will help to build the blood of patients suffering from anemia (Okoroh *et al*., 2019).

Table 1. Protein, carbohydrate and mineral compositions of cold and hot water extracts of *Ficus capensis* leaves

Parameter	**Cold water**	**Hot water**
Proteins (mg/g)	0.62 ± 0.010a	1.07 ± 0.070b
Total Carbohydrate (mg/gGluE)	0.26 ± 0.010a	0.33 ± 0.000b
Na (mg/kg)	18.7 ± 0.051a	14.5 ± 0.035a
K (mg/kg)	418.2 ± 0.013a	457.3 ± 0.006b
Mg (mg/kg)	281.6 ± 0.016a	307.2 ± 0.003a
P (mg/kg)	11.52 ± 0.130a	3.72 ± 0.003b
Zn (mg/kg)	4.0 ± 0.011a	11.7 ± 0.011b
Fe(mg/kg)	361.4 ± 0.005a	1141.2 ± 0.021b
Ca(mg/kg)	1749.4 ± 0.046a	1109.4 ± 0.050b

Values are means ± standard deviations of triplicate determinations a-b and c-d mean values with superscripts bearing different alphabets in the same row are significantly different at ($P<0.05$)

Vitamin composition of cold and hot water extracts of F. capensis

The results of the vitamin profile of *F. capensis* leaf extracts and HPLC chromatograms are shown in Fig 1-3. The following Vitamins were seen in the following order of concentration: (Vit A >Vit C >Vit B6 >Vit D >Vit E >Vit K >Vit B1 >Vit B12) in the cold and hot water leaf extract of *F. capensis*. Vit A (10.47 ppm) and Vit C (1.09 ppm) had the highest concentrations while Vit B_1 (0.25ppm) and Vit B_{12} (0.13 ppm) had the lowest concentrations in the cold-water extract of the *F. capensis*. Vit A (2.74 ppm) and Vit C (1.25 ppm) had the highest concentrations while Vit B_1 (0.3 ppm) and Vit B_{12} (0.13 ppm) had the lowest concentrations in the hot water extract of the *F. capensis*. The total vitamin concentrations (11.35 ppm) of the hot water extract were shown to be higher than the total vitamin concentrations (9.21 ppm) of the cold-water extract of *F. capensis*.

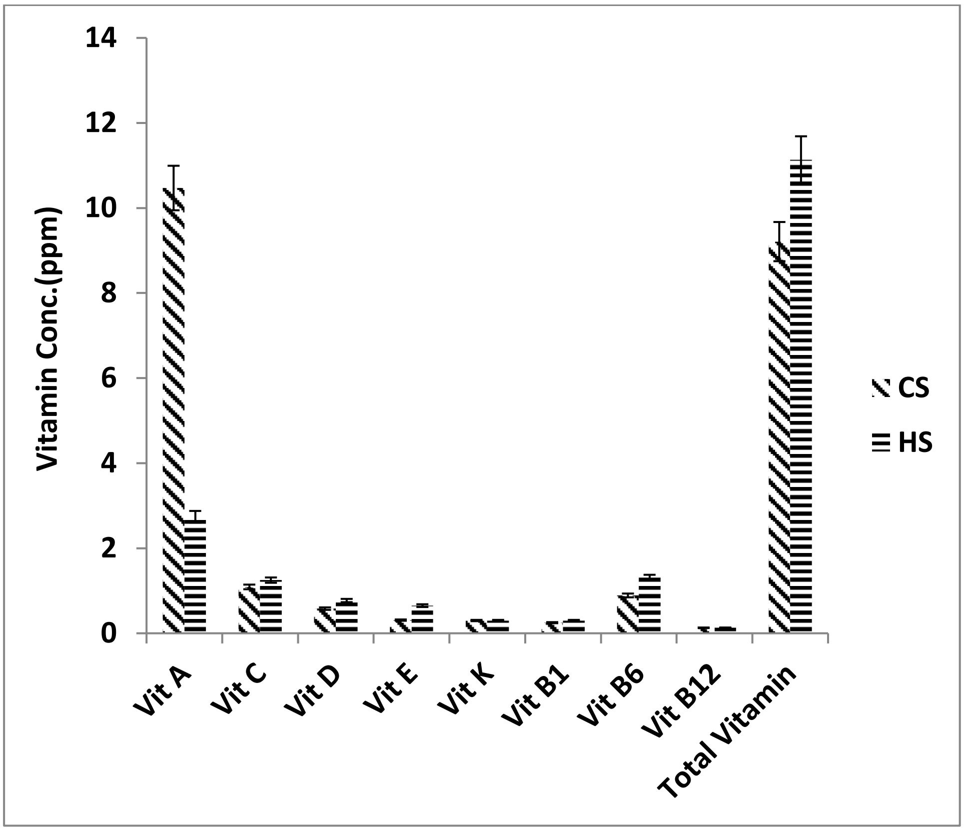

Fig1. Vitamin profile of cold and hot water extracts of *F. capensis* leaf.

CS – Cold sample

HS- Hot sample

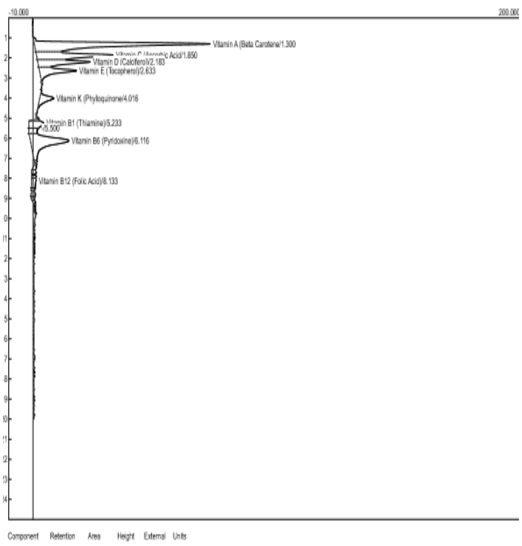

Fig2. Chromatogram of vitamin profile of cold water leaf extract of *Ficus capensis*

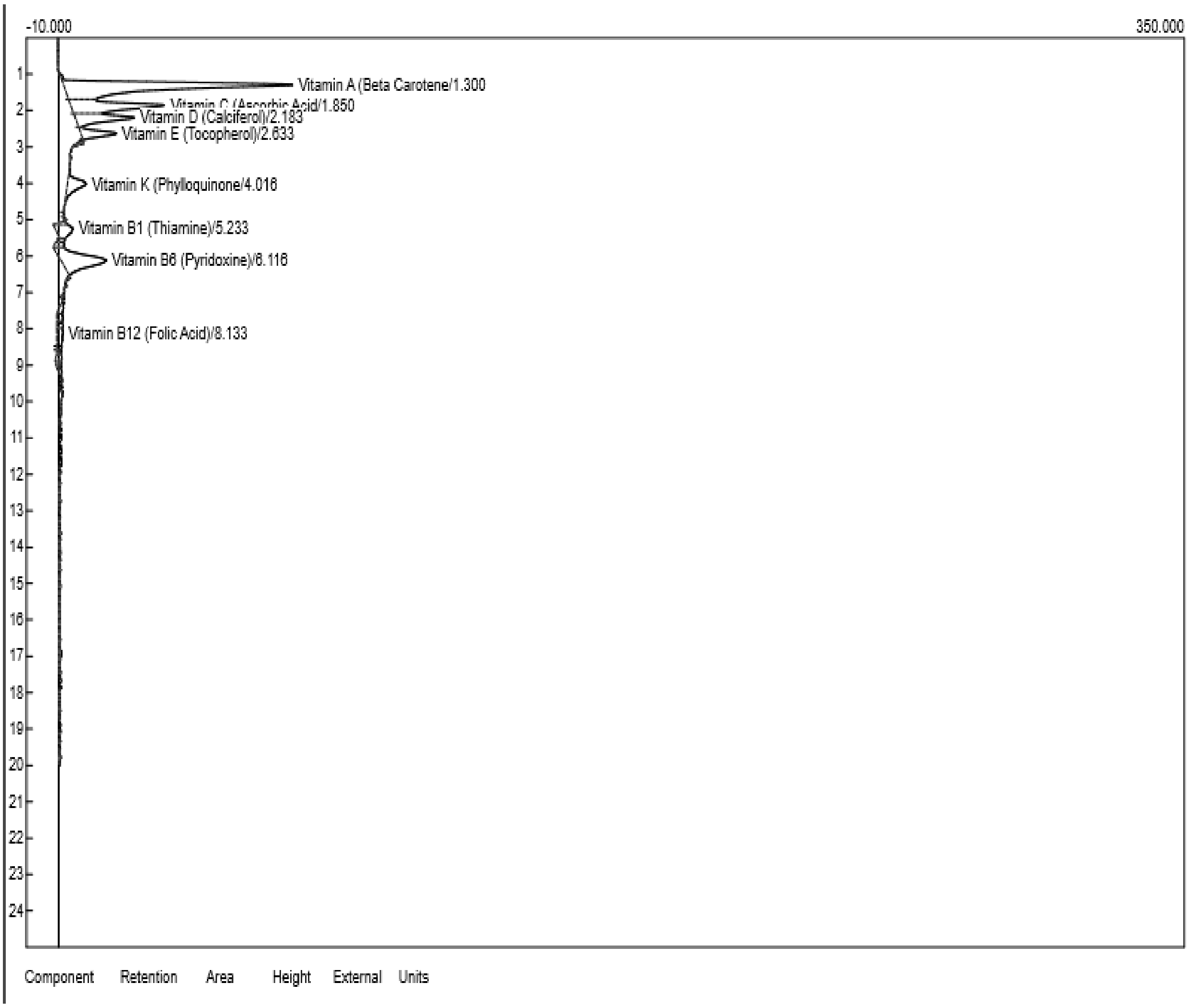

Figure 3. Chromatogram of vitamin compositions of hot water leaf extract of *Ficus capensis*

The results (Fig 1) of the presence of vitamins in cold and hot water extracts of *F. capensis* leaf is in line with the results of Ezeigwe *et al*. (2020) and Ngozi *et al.* (2017). Vitamins are micronutrients which play protective roles in the body and need to be obtained from diets. The presence of vitamin A in water extracts showed its importance for clear vision, healthy immune system and cell growth. Vitamin A possess anti-cancer property through inhibition of DNA synthesis in cancer cells. It also delays tumor growth and inhibits division of leukemia cells. The water extracts also contain Vitamin C and E which are essential antioxidant that helps to protect the cell membrane from oxidative stress caused by free radicals, facilitates the absorption of dietary iron from the intestine (Gombart *et al*., 2020) required for wound healing and maintenance of normal connective tissues (Ezeigwe *et al*., 2020).

4. Conclusion

This study highlights that carbohydrate, total protein, amino acids and vitamins present in the cold water extract were present in reasonable amount in the hot water extract of *F. capensis*. It also revealed that essential minerals calcium, magnesium, potassium, sodium, iron and manganese were present. These results therefore suggest that the hot water extract is a good source of these nutrients which when consumed in appreciable amount will aid in meeting the human nutritional needs for normal growth, development and prevention of deficiency disease. The hot water extract of this underutilized tropical plant in the south-south Nigeria may therefore be incorporated as source of food and feed supplement based on this findings.

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Conflict of interest

There is no conflict of interest to be disclosed by authors.

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