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Nutrient And Anti-Nutrient Compositions Of *Brassica Oleracae* Var. *Capitata L.*

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ABSTRACT: *The proximate, mineral, vitamin and anti-nutrient compositions of Brassica oleracae var. capitata L. were evaluated using standard procedures. The result for the proximate composition showed the contents of moisture (87.93±0.54%), ash (1.05±0.10%), Crude fibre (3.77±0.11%), Crude protein (1.94±0.10%), Crude fat (0.31±0.06%), Carbohydrate (4.52±0.22%) and calorie value of 28.72kcal/100g. The mineral composition showed the concentration of sodium (176.00±1.16mg/100g), Potassium (678.00±2.65mg/100g), Calcium (28.90±1.51mg/100g), Manganese (0.67±0.02mg/100g), Phosphorus (26.92±0.47mg/100g), Copper (0.05±0.003mg/100g), Iron (2.15±0.10mg/100g) and Zinc (2.11±0.04mg/100g). Vitamins present include vitamin C (56.37±5.21mg/100g), vitamin A (86.30±0.69µg/100g) and Folate (7.14±0.13µg/100g). The anti-nutrient compositions are Oxalate (19.67±0.88mg/100g), Phytate (22.00±0.81mg/100g), Hydrogen cyanide (15.74±0.30mg/100g) and Tannins (2.84±0.60mg/100g). The results showed that Brassica oleracae var. capitata L. contained essential and valuable nutrients which are beneficial to human health.*

KEYWORDS: *Anti-nutrients, Brassica oleracae, Nutrients, Phytochemicals, Vegetables*

I. INTRODUCTION

Vegetables are the fresh, edible and succulent parts of herbaceous plants. They are considered as special food crops owing to their valuable food ingredients that can be effectively utilized by the body. They contain appreciable amount of vitamins and minerals which are highly beneficial for the maintenance of health and prevention of diseases. They also contain high amount of dietary fibre and a minimal amount of protein [1, 2] *Brassica oleracae* var. *capitata L.* is an herbaceous green leafy vegetable belonging to the *Brassica* genus, of the *Brassicaceae* family with several other crop species including Brussels sprout, broccoli, cauliflower, kale and kohlrabi [3]. It has a defined taste and crunchy texture, with a characteristic compact head in which the leaves snug against each other [4], and colours ranging from pale or light green to dark green [5]. It is an excellent source of a variety of vitamins, minerals and dietary fibre [6], and has been ranked by the food and Agriculture Organization among the top twenty vegetable crops grown worldwide, establishing it as an important food source globally [7]. *Brassica oleracae* var. *capitata L.* has been used in ancient times both as food and as medicine. It is helpful in the management and/or treatment of several ailments and disease conditions including yeast infections, gout and rheumatism, relieving of gastric pain and hyperacidity, short-term rapid weight loss, reduction of painful breast engorgement in breast feeding women, hangover remedy, urine retention, menstrual pain or irregularities, scurvy, immune stimulant, constipation and as a poultice to clean infected wounds [8, 9]. The proximate, minerals, vitamins and anti-nutrient composition of *Brassica oleracae* var. *capitata L.* were evaluated in this study in order to aware people about the massive nutrients inherent in this vegetable and also serve as a useful tool for nutritionists to formulate balanced diets.

II. MATERIALS AND METHODS

Sample preparation : Fresh samples of *Brassica oleracae* var. *capitata L.* were purchased from main market Minna, Niger State and verified at the department of Biological Sciences, Federal University of Technology, Minna, Nigeria. The samples were washed with clean water to remove dirt and other contaminants, sliced into pieces, dried at room temperature for four weeks, ground into powder and stored in an air tight container for analysis.

Laboratory analysis : Laboratory analysis was carried out to determine the proximate, minerals, vitamins and anti-nutrient compositions. The proximate composition which includes moisture, crude protein, crude fat, ash and carbohydrate were determined in triplicate according to standard procedure [10]. The mineral content was analyzed using the standard methods [11]. Atomic absorption Spectroscopy (Model: Accusy 211 Bulk Scientific USA) was used to determine Calcium, Phosphorus, Manganese, Iron, Copper and Zinc, while flame photometer (Model: FP6410 Harris Medical Essex, England) was used to determine the sodium and Potassium contents. Vitamin A and C were determined using standard described methods [12], while Folate was determined using the method described [13]. Tannin was determined using the method described by [14], Oxalate and Hydrogen cyanide were determined using the method described [12] and Phytate was determined using the method described by [15].

Statistical analysis : The results generated from the analysis were subjected to statistical analysis using the Statistical Package for Social Science (SPSS) Version 19, and expressed as Mean± standard error of mean (SEM) of triplicate determinations

III. RESULTS AND DISCUSSION

The results of the various analyses conducted on the sample are presented in Tables 1, 2, 3 and 4

Proximate Composition : The result in TABLE 1below showed that the moisture content of 87.93±0.54% is higher compared to some common Nigeria leafy vegetables such as *Xanthosema sagittifolum* 14.7%, *Vernonia amygdaline* 27.4% and *Adansonia digitata* 9.5% [16], but lower when compared to 88.4% in green cabbage, 88.2% in broccoli, 96% in lettuce, 93.5% in spinach [17], 92.0±0.12% in green cabbage, 92.0±0.26% in Cauliflower and 91.0±0.06% in lettuce [18]. High moisture content above 15% in fruits was reported to favour microbial activities during storage; however the fibrous and compact head nature of *Brassica oleracae* var. *capitata L.* makes it a bit difficult for microorganism to access, giving it a longer shelf life. The ash content which is a measure of the inorganic matter of the sample was found to be 1.05±0.10%. This value is higher compared to that of cauliflower 0.7%, broccoli 0.6%, carrot 0.6%, and lettuce (0.4%), but lower compared to 2.0% in spinach [17]. The sample contained 0.31±0.06% crude fat, which is lower when compared to 0.5% in Brussels sprout and 0.6% in kale, but slightly higher when compared to 0.3% in broccoli and 0.3% in cauliflower [19]. Fats and oils in diets are the major sources of energy; however diet high in fat are implicated in obesity and certain cardiovascular disorders such as atherosclerosis, cancer and ageing [20].

The crude fiber content of 3.77± 0.11% is higher compared to 2.3% in cauliflower, 2.0% in Kale, 2.5% in Brussels sprout [19], but lower when compared to 4% in broccoli, and 3.9% in carrot [17]. Dietary fiber is an important constituent in *Brassica oleracae* var. *capitata L.* and other vegetables of the *Brassica* family, helping to reduce serum cholesterol level, risk of coronary heart disease, and contributing to prevent colon and breast cancers and hypertension [2]. The crude protein content of 1.94±0.10% in the sample is higher compared to 1.6±0.20% reported for the same vegetable [18], 1.40% in Brussels sprout and 1.8% in cauliflower, but lower compared with 4.6% in broccoli, 3.4% in Kale [19], and 2.1±0.15 in spinach [18]. The protein content is also lower when compared to some edible vegetables eaten in Zaria (*Vernonia amygdalina*-6.5±1.55%, *Telferia occidentalis*-20.04±0.24%, and 18.15±0.61% in Amaranthus *tricolor) [21]*. The carbohydrate content of 4.52±0.22% is slightly lower compared to 4.8±0.01% reported by [18] for the same vegetable, but falls within the range of 2.0 – 4.6% reported by [19] in *Brassica* vegetables. The key role of carbohydrate in the body is the provision of energy and low level of carbohydrate in fruits and vegetable has been reported to be beneficial for diabetic patients and individuals watching weight [22]. The metabolizable energy content of 28.72kcal/100g which was calculated using the Atwater factor [23] falls within the range of 24–40kcal/100g in different *Brassica* vegetables [19], but is significantly lower compared to 248.8 – 307.1 kcal/100g reported in some Nigeria leafy vegetables [24]. This attests to the fact that *Brassica oleracae* var. *capitata L.* is a low energy food source and as such may be very helpful in weight management program.

Table 1: Proximate composition of *Brassica oleracae* var. *capitata L.*

Parameter	Composition (%)
Moisture	87.93±0.54
Ash	1.05±0.10
Crude fat	0.31±0.06
Crude fiber	3.77±0.11
Protein (6.25×%N)	1.94±0.10
Carbohydrate	4.52±0.22
*Metabolizable Energy (Kcal/100)	28.72±0.71

Values are expressed as Mean ± Standard error of mean (SEM), n=3. * = calculated using the Atwater factor.

Mineral compositions : The result for mineral analyses of *Brassica oleracae* var. *capitata L.* in TABLE 2 below showed that Potassium content is higher in the plant compared to other minerals analyzed. The potassium content of 678.00±2.65mg/100g falls within the range of 221–712mg/100g [25], but higher when compared to the range of 300mg/100g– 400mg/100g reported for various species of *Brassica* vegetables [19]. The value is also higher compared to 35.4mg/100g in *Ossinum gratissimum*, 44.8mg/100g in *Vernonia amygdalina*, 48.8mg/100g in *Telferia occidentalis* [26], 222 mg/100g in lettuce, and 178 mg/100g in carrot [17]. With the recommended daily allowance (RDA) of potassium to be 2000mg for adults [19], *Brassica oleracae* var. *capitata L.* is able to contribute 33.9% to the RDA. The sodium content of 176.00±1.16mg/100g falls within the range of 30–192mg/100g reported for *Brassica oleracae* vegetables [25], but higher when compared to 11.4mg/100g in *Ossinum gratissimum*, 12.6mg/100g in *Vernonia amygdalina,* and 14.4mg/100g in *Telferia occidentalis* [26]. The sodium content of this vegetable is high, contributing 29.33% RDA proportion for adults in relation to the 600mg RDA requirement of adult [19]. A ratio of sodium ion to potassium ion less than one ($Na^+/K^+ < 1$) has been reported to be suitable for reducing high blood pressure. It therefore suggests that the vegetable could be a good source of food for hypertensive patients. The content of calcium 28.9± 1.51mg/100g falls within the range of 24 – 48mg/100g for species of *Brassica oleracae* vegetables [19], but higher compared with 15.4mg/100g in *Ossinum gratissimum*, 15.8mg/100g in *Vernonia amygdalina,* and 18.7mg/100g in *Telferia occidentalis* [26]. The value indicate that this vegetable can contribute meaningful amount of dietary calcium which is needed for growth and maintenance of bones, teeth and muscle, and as such may be used as supplements in diets low in calcium ion.

Phosphorus content of 26.92mg/100g obtained in this study is in comparison with the reported value of 26mg/100g [17], but lower compared to 40mg/100g reported for the same vegetable [19]. It is higher when compared to the phosphorus content of *Ossinum gratissimum*-13.8mg/100g, *Vernonia amygdalinai*-13.1mg/100g, *Telferia occidentalis*-15.08mg/100g [26], 16mg/100g in carrot, and 22mg/100g in lettuce [17]. Phosphorus is an important mineral that aids the absorption of calcium which is required for growth, maintenance of bones, teeth and muscles [27]. The iron content of 2.15±0.10mg/100g is higher compared to 0.4mg/100g for same vegetable, 1.1mg/100g in broccoli [19], 1.6mg/100g in spinach and 0.7mg/100g in lettuce [27]. Iron is a micro nutrient required for haemoglobin production and is the constituent necessary for the transportation of oxygen in the body. Iron is also a cofactor for several important enzyme activities. The zinc content of 2.11±0.04mg/100g is higher compared to 0.2mg/100g for the same vegetable, 0.95mg/100g in broccoli, 0.64mg/100g in cauliflower [25], 1.2mg/100g in *Vernonia amygdalina*, and 1.4mg/100g in *Telferia occidentalis* [26], but lower when compared to 3.2mg/100g in *Ossinum gratissimum* [26]. Zinc is essential in gene expression, in regulation of cellular growths and also acts as a cofactor of many enzyme activities [28]. The Manganese content 0.67±0.02mg/100g is higher compared to 0.2mg/100g reported in the same vegetable, 0.3mg/100g in kale, 0.23mg/100g in Brussels sprout and 0.13mg/100g in cauliflower [25]. Manganese is involved in enhancement of normal skeletal growth and development, and also functions with vitamin K in the formation of prothrombin. It is also an important cofactor for many enzyme activities [29]. Copper content of 0.05±0.003mg/100g is in comparison with the value of 0.05±0.05 mg/100g reported for the same vegetable, and falls within the range of 0.04-0.09mg/100g for various species of *Brassica oleracae* vegetables [25]. Low concentration of copper ranging from 0.01-0.05mg/100g had also been reported in eggplant varieties [30]. Copper is involved in the process of erythropoiesis, erythrocyte function and regulation of red blood cell survival. However, high concentration in the system can lead to diarrhea, epigastric pain and discomfort, blood in the urine, liver damage, hypotension and vomiting [31].

Table 2: Mineral compositions of *Brassica oleracae* var. *capitata L.*

Parameters	Composition (mg/100g)
Sodium	176±1.16
Potassium	678±2.65
Calcium	28.9±1.51
Manganese	0.67±0.02
Copper	0.05±0.003
Iron	2.15±0.10
Zinc	2.11±0.04
Phosphorus	26.92±0.47

Values are mean ± SEM, n=3

Vitamins content : The vitamin A content of 7.14±0.13µg/100g shown in TABLE 3 is higher compared to 5.5µg/100g reported in the same vegetable, 0.9µg/100g in cauliflower, and 6.0µg/100g in turnip, but lower when compared to 85.9µg/100g in broccoli, 35.8µg/100g in Brussels sprout, and 765.8µg/100g in Kale [19]. *Brassica oleracae* var. *capitata L.* is a very good source of vitamin A contributing 11% of the recommended dietary allowance of 800µg/100g [19]. Studies have revealed that the consumption of foods rich in β-carotenoids (pro-vitamin A) is associated with a lower risk for various epithelial cancers [32]. The content of folate (vitamin B9) 86.30±0.61µg/100g is higher compared to 29.9µg/100g reported in the same vegetable, 85.9µg/100g in cauliflower and 14µg/100g in turnip, but lower when compared to 113µg/100g in broccoli, 93.6µg/100g in Brussels sprout, and 120µg/100g in Kale [19]. Folate is an essential vitamin which acts as a coenzyme in many single carbon transfer reactions in the synthesis of DNA, RNA, and protein components [33]. It reduces the risk of neural tube defects and may be linked with the lowered risk of vascular disease and cancer [34]. *Brassica oleracae* var. *capitata L.* has been reported to be a good source of folate [33], contribution 21.58% to the recommended dietary allowance of 400µg/100g [19].

Vitamin C content of 56.37±5.21mg/100g is higher when compared to 37.4mg/100g [19], 51mg/100g [35], 55±0.06mg/100g [18], and 48mg/100g [17] for the same vegetable, but lower when compared to 120mg/100g in broccoli, 90mg/100g in Brussels sprout, 110mg/100g in Kale, and 61.5mg/100g in cauliflower [19]. It is also higher when compared to some cultivated vegetables in Nigeria (*Xanthosoma sagitifolium*-32.80mg/100g, *Lasianthera Africana*-32.61mg/100g and *Heinsia crinita*-22.95mg/100g [36]. High levels of vitamin C have been reported in broccoli, Chinese cabbage, cauliflower and cabbage [37]. Vitamin C functions as a primary antioxidant in the body [38]. Consumption of foods high in vitamin C is associated with a reduced risk of colon cancer. *Brassica* vegetables have been reported to be significantly better sources of vitamin C than fruits such as apple, banana, carrot, and raspberry [19], with *Brassica oleracae* var. *capitata L.* contributing 70.5% of the recommended dietary allowance of 80mg/100g per day.

Table 3: Vitamin compositions of *Brassica oleracae* var. *Capitata L*.

Parameters	Composition (per 100g)
Folic acid (µg)	86.30±0.69
Vitamin A (µg)	7.14±0.13
Vitamin C (mg)	56.37±5.21

Values are mean ± standard error of mean (SEM) of triplicate determinations.

Anti-nutrient factor : The result of anti-nutrient analyses of *Brassica oleracae* var. *capitata L*. in shown on TABLE 4 below. The tannins content of 2.84±0.60mg/100g is higher when compared to 1.50mg/100g in green cabbage, 1.57mg/100g in red cabbage, 1.57±0.36mg/100g in Chinese cabbage [39], but lower compared to 7.40±0.14mg/100g in *Balanite aegyptiaca* 'desert date' and 4.83±0.15 mg/100g in *Vitex donianan* 'black plum' [40]. High levels of tannins were reported in some locally cultivated fresh green vegetables in Nigeria with values ranging from 0.13g/100g to 0.28g/100g [41]. Tannins impose an astringent taste in foods thereby affecting palatability. They have been reported to possess anti-nutrient effects by forming complexes with essential nutrients including enzymes of the digestive tract, thereby suppressing the availability and utilization of essential nutrients [40]. However, tannin compounds have been reported to posses antibacterial [42], antiviral and antiparasitic effects [43]. The oxalate content of 19.67±0.88mg/100g is lower compared to 225±6.60mg/100g in green cabbage, 265.06±13.70mg/100g in red cabbage, and 265±13.70mg/100g in Chinese cabbage [39], but higher when compared to some locally cultivated vegetables in Nigeria (*Pterocarpus mildbreadii* 'Oha'- 0.92mg/100g, *Gongronema ofericanum*'Ukazi'-1.56mg/100g, *Ocimum viride* 'Nchuanwu'-2.70mg/100g, *Piper guinenses* 'Uziza'-1.48mg/100g, *Amaranthus spinosus* 'Inene'-2.10mg/100g, and 1.88mg/100g in *Gongronema ratifola* 'Utabanzi') [44] The content of phytate 22±0.81mg/100g is lower when compared to 27.83±0.40mg/100g in green cabbage, 30.36±0.90mg/100g in red cabbage, 27.83±0.40mg/100g in Chinese cabbage [39], and in some common cereals such as maize-348mg/100g, millet- 104mg/100g, and Soya beans-808mg/100g [45]. Phytate and Oxalate are anti-nutritional factors which are present in various fruits and vegetables, with high concentrations discovered to cause great effects on mineral bioavailability in foods [46].The Cyanide concentration of 15.74±2.03mg/100g is lower when compared to 82.50±2.60mg/100g in green cabbage, 82.50±2.80mg/100g in red cabbage and 75.63±1.60mg/100g in Chinese cabbage [39]. Excessive ingestion of cyanogenic glycosides can be very poisonous as it interferes with electron flow in the mitochondria-electron transport chain, thereby inhibiting energy generation. The concentrations of anti-nutrients (tannins, oxalate, phytate and hydrogen cyanide) obtained in this study are lower than the lethal dose, hence, may not elicit toxic effect when consumed.

Table 4: Anti-nutrients composition of *Brassica oleracae* var. *Capitata L*.

Parameter	Composition (mg/100g)
Tannins	2.84±0.60
Phytate	22.00±0.81
Cyanide	15.74±2.03
Oxalate	19.67±0.88

Values are mean ± standard error of mean (SEM) of triplicate determinations.

IV. CONCLUSION

Brassica oleracae var. capitata L. possess significant amount of vitamins, minerals and dietary fibre, with low fat and calorie contents, revealing it as a vegetable of promising nutritional value. Its ability to accumulate high concentrations of metals in its edible leaf can be exploited in pharmaceutical industries to make capsules or tablets that can supply considerable amount of the recommended daily intake of these elements, with the advantage of using a natural plant source. It can also be exploited in industries for the removal of toxic and heavy metals found in high concentration in contaminated soils.

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