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Proximate Analysis of Selected Vegetables Sold in Yankaba Market Kano State, Nigeria

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ABSTRACT

This research examines the proximate contents of broccoli, cauliflower, curly kale, and red cabbage sold in Yankaba Market Kano State, Nigeria. Samples of these vegetables were procured from the market and analysed for proximate (moisture, protein, fat, ash, and fibre) contents. The proximate compositions were determined using the Association of Official Analytical Chemists (AOAC) method. The proximate analysis results reveal that the moisture content of the vegetable samples ranged from 11.73 to 82.52%, protein from 1.70 to 24.32%, fat from 0.25 to 1.09%, ash from 1.33 to 7.31%, dietary fibre from 2.11 to 17.30%, and carbohydrate from 9.83 to 38.56%. All the vegetables were low-fat and nutritious, but the levels of nutrients vary. The study discovered that the vegetables from the Yankaba market contained some appreciable amount of essential nutrients needed to maintain good nutritional status that will benefit consumers.

Keywords: Vegetables; proximate composition; Yankaba

INTRODUCTION

In underdeveloped nations, there is a relatively high frequency of malnutrition, particularly protein deficiency and vegetables are one of the world's most abundant sources of nutritious food. Consumption of vegetables as food is reported to be the quickest and easiest way of providing adequate supplies of vitamins, minerals, and fibre, among other food components (Akan et al., 2009). They are the edible parts of plants that are consumed wholly or in parts, raw or cooked as part of a main dish or salad. A vegetable includes leaves, stems, roots, flowers, seeds, fruits, bulbs, tubers and fungi (Uwaegbule, 1989; Uzo, 1989). Vegetables are rich in protein, minerals, and vitamins, and they contain an abundance of essential amino acids. Therefore, vegetables can be a good supplement to cereals (Laţo *et al.,* 2012). Onunogbu, (2002) reported that vegetable fats and oil lower blood lipids thereby reducing the occurrence of disease associated with damage to the coronary artery.

Broccoli (Brassica oleracea L. var. italic) is an edible green plant in the cabbage family whose large flowering head is consumed as a vegetable. It contains vitamins A, C, and riboflavin, which are all important nutrients. It is also abundant in iron and calcium, is a non-fattening meal, and has a variety of therapeutic benefits (Mishra and Mukherjee, 2012). The second vegetable Cauliflower (Brassica oleracea L.) is a member of the Cruciferous family. The stalk and surrounding thick, green leaves of aborted floral meristems are often discarded, while just the head (the white curd) is consumed. Whereas its leaves, which are typically discarded as trash, are a high source of iron and -carotene and can thus be used in a variety of value-added products (Kowsalya and Sangeetha, 1999). Cauliflower is low in calories, abundant in vitamin C, and an excellent source of fibre and folic acid. The third vegetable Curly Kale *(Brassica oleracea* L. var. *acephala*) is a leafy green vegetable belonging to the cabbage family Brassicaceae that contains a large amount of health-promoting phytochemicals (Satheesh

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and Workneh, 2020). It is one of the most nutritious vegetables, particularly rich in dietary fiber, protein, minerals, and antioxidant compounds (Lenka *et al.,* 2018).

The last vegetable Red cabbage (Brassica oleracea var. capitata f. rubra) is a biennial, herbaceous, dicotyledonous flowering plant that is a member of the Brassicaceae family (order Brassicales). It has dark reddish-purple foliage. According to reports, red cabbage leaves contain physiologically powerful anthocyanins that have the ability to reduce dyslipidemia and hepatic damage caused by the injection of exogenous cholesterol (Al-Dosari, 2014). It has been shown to have anti-inflammatory (Lin et al., 2008), antibacterial (Park *et al*., 2004), anticancer (Fahey et al., 1997), antioxidant (Kataya and Hamzam, 2008), antihyperglycemic (Roman-Ramos et al., 2008), and antimicrobial properties.

Other nutritional components included in vegetables include carbohydrates, fat and oils, lipids, protein, amino acids, water, sugar, energy value, etc (Dan *et al.,* 2013). Comparative proximate minerals and antinutrient analysis of selected Nigerian leafy vegetables show that the vegetables are good sources of protein, energy and fiber (Ajayi *et al.,* (2018), Similar reports on this include: Ogbede *et al.,* (2015), Santhi *et al.,* (2016) Bux Baloch *et al.,* (2015), Satheesh and Workneh Fanta (2020), Malghani *et al.,* (2022), Naz *et al.,* (2018), Ajayi *et al.,* (2018), Madhu and kochhar, (2014), Udousoro and Ekanem, (2013) and (Akan *et al.,* 2009). The objective of this study is to evaluate the nutritional values of four leafy vegetables sold in Yankaba market Kano state, Nigeria.

MATERIALS AND METHODS

All the solvents and reagents used were of analytical grade. Distilled water was used for solution preparation and all glass wares were washed, cleaned, and dried in an oven at 105^{o}C.

Sampling

Four (4) different leafy vegetables were selected (viz.; broccoli, cauliflower, red cabbage and curly Kale). The vegetables were purchased from Yankaba market in Kano city, Nigeria.

Sample Preparation

The collected plant leaves were washed under running water, then rinsed with distilled water. The samples were then cut into small pieces using knife and was spread on a cleaned laboratory bench for two weeks in the Analytical Chemistry laboratory of Bayero University, Kano. The dried leaves were later pounded into powder with laboratory ceramic mortar and pestle. The powdered sample was then used for determination of the various parameters.

Proximate Analysis

Moisture Content

Moisture was determined by the AOAC method (2000) (Burham, 2017). An empty, clean and dry crucible (W_1) was weighed on weighing machine and weight was recorded. 5gm sample was placed in a crucible (W_2) and kept in an oven at 105^{0}C up to constant time (4-6 hours). The crucible was transferred to a desiccator and allowed to cool and then weighed (W_3). Moisture was calculated using the following formula:

$$MC\ (\%) = \frac{W_2 - W_3}{W_2 - W_1} \times 100$$

Where: MC = Moisture content
W_1 = weight of crucible
W_2 = weight of crucible + sample
W_3 = weight of crucible with dry sample

Ash Content

Ash content of the sample was determined according to the method of AOAC (2000). 5gm sample (residue from moisture analysis) was placed in a crucible and kept in Muffle furnace at 550o C for 3 hours. The crucible is removed from the furnace to a desiccator

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and allow to cool, then weighed (W_4). Ash content was calculated as follows:

$$AC\ (\%) = \frac{W_4 - W_1}{W_2 - W_1} \times 100$$

Where: AC = Ash content
W_1 = weight of crucible
W_2 = weight of crucible + sample
W_3 = weight of crucible with dry sample
W_4 = weight of crucible with ash

Crude Protein Content

The crude protein was determined by using the micro-kjeldahl method according to AOAC (2000) as follows:

Digestion: 0.5 grams of the sample was weighed and placed in small digestion flask. Digestion catalysts (selenium powder) is added to the flask, 3.5cm^3 of concentrated H_2SO_4 was added into the flask, ensuring that it covers the sample completely. The content of the flask was then heated on digestion apparatus (digests the sample) for two hours till it turns into a clear solution. The tube was then removed from the digester and allowed to cool.

Distillation: The digested sample was transferred to the distillation unit and 15cm^3 of 40 % NaOH was added. The ammonia was received in 100cm^3 conical flask containing 10cm^3 of boric acid plus 3-4 drops of methyl red indicator. The distillation was continued until the volume reached 50cm^3.

Titration: The content of the flask was titrated with HCl. The titration reading was recorded. The crude protein was calculated using the following equation:

$$CP\ (\%) = \frac{(T - B) \times N \times 14 \times 100 \times 6.25}{WS \times 1000}$$

Where: CP = Crude protein
T = Titration reading
B = Blank titration reading
N = Normality of HCl
WS = Weight of sample
1000 = To convert to mg
6.25 = Protein factor

Crude Fat Content

Fat content was determined according to the method of AOAC (2000) using Soxhlet apparatus. An empty clean and dry extraction round bottomed flask was weighed. Five gram of sample was weighed and placed in a clean extraction thimble and covered with cotton wool. The thimble was placed in extractor. Extraction was carried out for 8hours with petroleum ether. The heat was regulated to obtain at least 15 siphoning per hour. The residual ether was dried by evaporation. The flask was placed in an oven at 105℃ till it dried completely and then cooled in a desiccator and weighed. The fat content was calculated using the following equation:

$$FC\ (\%) = \frac{W_2 - W_1}{W3} \times 100$$

Where: FC= Fat content
W1= Weight of extraction flask
W2= Weight of extraction flask with fat
W3= Weight of sample

Crude Fibre

Crude fiber was determined according to AOAC (2000). Five grams of defatted sample was treated successively with boiling solution of H_2SO_4 and then KOH. The residue was then separated by filtration, washed and transferred into a crucible then placed into an oven adjusted to 105 ℃ for 3 - 4 hours. The crucible with the sample (W_1) was weighed and ashed in a muffle furnace at 500^{0}C and weighed again (W_2). The crude fiber was calculated using the following equation:

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$$FC\ (\%) = \frac{W_1 - W_2}{\text{Weight of sample}} \times 100$$

Where: CF= Crude fiber
W1= Weight of crucible with sample before ashing
W2= Weight of crucible with sample after ashing

Carbohydrate Content

Carbohydrate content was determined by difference. The sum of moisture, fat, protein and ash contents was subtracted from 100 to obtain the total carbohydrate by difference.

Carbohydrate (%) = 100 - (Ash % + moisture % + CP % + fat % + fiber %).

RESULTS AND DISCUSSION

The results for proximate analysis are summarized in Table 1

Table 1: Proximate analysis

S/N	Parameters	Broccoli	Cauliflower	Curly kale	Red cabbage
1	Moisture content (%)	70.65	75.11	67.75	82.52
2	Ash content (%)	1.94	1.33	3.95	1.98
3	Crude protein (%)	8.12	3.10	3.23	1.70
4	Crude Fat (%)	0.84	0.67	1.09	0.25
5	Crude fiber (%)	7.90	2.11	8.11	3.72
6	Carbohydrate (%)	10.55	17.68	15.87	9.83

Moisture

Moisture (%) is a widely used parameter in the processing and testing of food. It is known that products that have low fat values normally have high moisture contents. Broccoli has moisture content of 70.65%, cauliflower 75.11%, curly kale 67.75% and red cabbage 82.52%. Moisture content higher than found in present work were reported as 98.85%, 92.05% and 87.93% respectively by Udousoro and Ekanem, (2013) Campas-Baypoli *et al.,* (2016), Ogbede *et al.,* (2015),. However, Ajayi *et al.,* (2018), Madhu and kochhar, (2014) reported lower moisture content of 11.02% and 1.2% respectively for broccoli, cauliflower, curly kale and red cabbage. The observed value implies that broccoli, cauliflower, curly kale and red cabbage may have a short life since microorganisms that cause spoilage thrive in foods having high moisture content and also is indicative of low total solids Emebuka and Ayinka, (2011). This result is within the recommended dietary allowance for moisture >20.5% (WHO, 2006). There was no significant difference between the moisture content of the studied samples ($P>0.05$).

Protein

Protein is an important part of diets that is used in body building and repair of tissues. Leafy vegetables are cheapest source of plant protein Hameed *et al.,* (2015). Udousoro and Ekanem, (2013) considers plant food providing more than 12% of its calorific value from protein as a good source of protein. The high protein content, however, does not present it as a good source of protein as the quality of a protein is dependent on its ability to supply all the essential amino acids in the required amount. The protein content in this study was found to be 8.12% in broccoli, 3.10% cauliflower, 3.23% curly kale and 1.70% red cabbage.All the results falls within the range of values reported by Santhi *et al.,* (2016), Ashfaq, (2018), Satheesh and Workneh Fanta, (2020) as 13%, 1.87%,1.21%, respectively. Lower values of 4.98% and 8.7% respectively were reported by Hameed *et al.,* (2015) and Wadmare *et al.,* (2019). However, value higher than obtained in this work was reported from literature by López-Cervantes *et al.,* (2013) as 27.29. Variations in protein content can be attributed to different environmental conditions. In addition, protein content is also sensitive to

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rainfall, light intensity, length of growing season, day duration, temperature and agronomic practice Malghani *et al.,* (2022). There was no significant difference between the protein content of the studied samples (P >0.05).

Ash

Ash content represents the amount of mineral elements present in the vegetables (Dan *et al.,* 2013). High ash content in a leafy vegetable would imply high mineral content, hence very nutritious but it could be the reverse if it contained toxic metals which also contribute to the ash percentage in leafy vegetables Udousoro and Ekanem, (2013). Therefore, high ash content is not necessarily a conclusive factor regarding the health benefits of vegetables. The ash content ranges from 3.95% curly kale,1.98% red cabbage,1.94% broccoli% and the least 1.33% cauliflower. Higher ash values of 14.67% and 8.26% was reported from literature by Malghani *et al.,* (2022) and Bux Baloch *et al.,* (2015) which are higher than values obtained in present study. The values obtained in this work are in agreement with 1.3%, 1.13% and 4.34% reported by Wadmare *et al.,* (2019), Naz *et al.,* (2018) and Agarwal *et al.,* (2017) but lower to 0.70% reported by Meiners *et al.,* (1976),. There was no significant difference between the ash content of the studied samples (P >0.05).

Crude Fat

Dietary fat is a major determinant of palatability of food. It has also been reported that vegetable fats and oil lower blood lipids, hence contribute to reduction in the occurrence of diseases associated with damage of coronary artery Udousoro and Ekanem, (2013). The fat contents in broccoli, red cabbage, curly kale and cauliflower were found to be 0.84%, 0.25%, 1.09%, 0.67% respectively. These results were in fair agreement with with 0.89%, and 1.62% reported by Ajayi *et al.,* (2018) Santhi *et al.,* (2016) from literature. Values higher than obtained in this work were reported by Campas-Baypoli *et al.,* (2016), López-Cervantes *et al.,* (2013), Udousoro and Ekanem, (2013) as 6.3%, 9.36% and 2.42% respectively. The values obtained (0.25-1.09) for fat in these vegetables endorsed the results of many authors, which showed that leafy and green vegetables are poor sources of fat, as reported by Malghani *et al.,* (2022). The low crude fat sources observed in the vegetable leaves make them good for human health. Moreover, it is significant to remember that a diet containing 1-2% of total caloric energy as fat is believed to be sufficient for humans. In contrast, excess fat consumption leads to cardiovascular diseases such as atherosclerosis, aging, and cancer Malghani *et al.,* (2022) . Thus, these green vegetables with low fat levels may benefit those suffering from obesity and other related disorders and can be used to reduce weight. There was no significant difference between the fat content of the studied samples (P >0.05).

Crude Fibre

Crude fiber which refers to the indigestible plant material or the indigestible portion of food which acts by changing the nature of the contents of the gastrointestinal tract, thus affecting how other nutrients and chemicals are absorbed. Fibre in leafy vegetables plays a number of roles in the body. Fibre is known to cleanse the digestive tract, remove potential carcinogens from the body, as well as keep blood sugar levels under control. It is known to provide bulking, thereby easing defecation and prevents the intake of excess starchy food Ajayi *et al.,* (2018). The crude fibre content in broccoli, cauliflower, curly kale and red cabbage, were found as 7.90%, 2.11%, 8.11% and 3.72% respectively this was in agreement with 8.3% and 7.8% reported by Agarwal *et al.,* (2017), Satheesh and Workneh Fanta, (2020). The values of 1.08%, and 2.8% lower than values obtained in this work have also been reported by

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Udousoro and Ekanem, (2013). Fabre in human diet helps to prevent over absorption of water and the formation of hard stools which can result in constipation. Dietary fiber is associated with reduced diabetes risk. There was no significant difference between the fiber content of the studied samples (P >0.05).

Carbohydrate

Carbohydrates are the primary source of energy in the body**.** The main function of carbohydrates is to provide the body with fuel and energy that is required for daily activities and exercise. It is generally known that in humans, carbohydrates are utilized as major sources of biological energy through their oxidation in the cells. They also function as organic precursors for the biosynthesis of many cell components. The Carbohydrate content in broccoli, cauliflower, curly kale and red cabbage, were found as 10.55%, 17.68%, 15.87% and 9.83% respectively these results were similar with findings by Santhi *et al.,* (2016) and Malghani *et al.,* (2022) as 7.71% and 15.24%, respectively. Higher findings as 37.16%, 42.44% and 72.04% respectively were also reported by Ajayi *et al.,* (2018), Bux Baloch *et al.,* (2015). Agarwal *et al.,* (2017) which are higher than findings in this work. The human body needs constant supply of energy to function properly, and lack of carbohydrate in the diet may result in tiredness or fatigue, poor mental function, and lack of endurance and stamina Udousoro and Ekanem, (2013). There was no significant difference between the carbohydrate content of the studied samples (P >0.05).

CONCLUSION

The present study examined the proximate contents of broccoli, cauliflower, curly kale, and red cabbage sold in Yankaba Market Kano State, Nigeria. The analysis results reveal that the moisture content of the vegetable samples ranged from 11.73 to 82.52%, protein from 1.70 to 24.32%, fat from 0.25 to 1.09%, ash from 1.33 to 7.31%, dietary fibre from 2.11 to 17.30%, and carbohydrate from 9.83 to 38.56%. Furthermore, their inclusion in our daily routine could suffice the basic needs of the body in terms of minerals and fiber content besides protection from various free radicals induced malfunctions. Alongside, consumption of these vegetables frequently keeps the body hydrated owing to the presence of higher water content. Such nutritious, approachable, and cost-effective vegetables should be encouraged by the consumers. In the nutshell, the study revealed that leafy vegetables contained some appreciable amount of essential nutrient molecules and mineral elements needed for the maintenance of good nutritional status and they compete favourably with commonly consumed vegetables.

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