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Comparative Analysis of the Nutritional Commposition of Hukleberry (Solanum Scabrum) and Spinach (Amaranthus Hybridus)

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Abstract **Original Research Article**

This research aims to conduct a comparative analysis of the nutritional composition of spinach (Amaranthus hybridus) and huckleberry (Solanum scabrum). Spinach and huckleberry are two popular plant-based food sources known for their potential health benefits. The comparative analysis focus on evaluating and contrasting the levels of key nutrients present in spinach and huckleberry. Conducting proximate, phytochemical and mineral analysis on but leaves would help in understanding their nutritional profiles and comparing them can provide valuable insights into their respective nutritional values and potential health advantages. This research involves collecting fresh samples of spinach and huckleberry from the farms. The samples were processed and analysis was carried out. Some analytical techniques such as proximate analysis, spectrophotometry, and chromatography were employed in order to determine the nutritional composition. The results observed on the proximate analysis of the two leaf species revealed that Solanum scabrum contain 38.35 ± 1.05% Carbohydrate, 71.5 ± 1.70% Moisture content, 2.56 ± 0.32% Ash content, 15.65 ± 0.33% Protein, 6.40 ± 0.49% Fat and 8.66 ± 0.15% Crude fiber, while Amaranthus hybridus contain 50.01 ± 0.65% Carbohydrate, 30.92 ± 1.36% Moisture content, 9.40 ± 0.90% Ash, 8.56 ± 0.23% Protein, 4.25 ± 0.10 %Fat and 12.56 ± 0.23% Crude fiber. The results observed on the phytochemical analysis of the two leaf species revealed that Solanum scabrum contain 7.64 ± 0.09mg/100g alkaloids, 1.79 ± 0.03mg/100g tannins, 1.35 ± 0.04mg/100g saponins, and 4.36 ± 01mg/100g flavonoids while Amaranthus hybridus contain 6.9 ± 0.06mg/100g alkaloids, 0.96 ± 0.07mg/100g tannins, 1.50 ± 0.01mg/100g saponins and 2.35 ± 0.04mg/100g flavonoids. The results observed on the mineral analysis of the two leaf species revealed that Solanum scabrum contain 58.75 ± 0.1mg/100g Calcium, 2.10 ± 0.09mg/100g Zinc, 42.87 ± 0.55mg/100g Potassium and 13.30 ± 0.25mg/100g Iron while Amaranthus hybridus contain 43.95 ± 0.35mg/100g Calcium, 3.54 ± 0.06mg/100g Zinc, 52.32 ± 1.54mg/100g Potassium and 12.28 ± 0.16mg/100g Iron respectively. All these results indicate that the studied leafy vegetables if consume in sufficient amount would contribute greatly to the nutritional requirement for human health but in comparison Solanum scabrum is of more nutritious value than Amaranthus hybridus.

Keywords: Huckleberry, Proximate, Spinach, Phytochemicals, Spectrophotometry, Chromatography.

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INTRODUCTION

The name 'huckleberry' is a rare vegetable leaf found in the northern and southern part of Nigeria which is scientifically called *Solanum scabrum*. Huckleberry (*Solanum scabrum*) commonly named as Kumbi in the northern part of Nigeria is eatable vegetable and contains both large amount of iron, calcium and other essential vitamins and minerals (Lewis, 2014).

Kumbi is native to central and South-Eastern Cameron. It is an annual plant which grows to the height of up to 30cm. Kumbi may survive over winter in temperate region. The leaves are alternate, simple, ovate to triangular which are variable in size ranging from 2-30cm long and 1-15cm in breadth, with larger leaves height on the flowing stem. The flowers are inconspicuous yellow-green, 34mm diameter

maturing into a small, hard, dry lumpy fruits cluster 5-10cm across containing several seeds (Rady, 2010).
Huckleberry is well known for its nutritional qualities and has always been regarded as a plant with remarkable ability restores energy, increase vitality and improve the quality of blood. The reason why Kumbi leaves would produce such a result is primarily because it is rich in iron (Lewis, 2014). Iron plays role in the function of red blood cells which helps in transporting oxygen around the body, energy production and DNA synthesis (Fullerton, 2007)
The name 'spinach' is a common eatable vegetable leaf found in the northern and southern part of Nigeria which is scientifically called *Amaranthus hybridus* as authored by Linn is a robust annual herb which belong to the family Amaranthaceae. It is a popular plant known for its nutritive value. Its protein and carbohydrate contents as well as mineral elements are quite high (Lehman, 1989). The vegetable has been rated equal to or superior, in taste to spinach and is considerably higher in calcium, sodium, iron and potassium, *Amaranthus hybridus* leaf protein contains more lysine than the best high lysine corn and more methionine than soybean meal (Elias *et al*., 1997).
Amaranthus spp. belongs to the Amaranthaceae family and there are 60 recognizable species (Matenge *et al*., 2017). Findings from studies conducted on indigenous vegetables revealed that *Amaranthus spp*. vegetables have high antioxidant properties; this is despite having low proximate composition on fresh basis (Baang *et al*., 2015). In addition, other researchers have reported that *Amaranthus spp*. contains crude protein and fat contents of 3.2 and 0.3%, respectively. The leaves are boiled and in some cases groundnut flour is added and is usually consumed as relish. In Nigeria, Amaranthus leaves combined with condiments are used to prepare soup (Mepha *et al*., 2007). In Congo, their leaves are eaten as spinach or green vegetables. These leaves boiled and mixed with a groundnut sauce are eaten as salad in Mozambique and in West Africa (Martin *et al*., 2019). Amaranthus has been shown to contain many compounds that had both health and industrial benefits (He and Corke, 2003). Despite the use of this plant for such purposes, there is little information on the nutritional and chemical composition of Amaranthus leaves. This work is therefore aimed determine the proximate, phytochemical and mineral composition of the Huckleberry (*Sulanum scabrum*) and spinach (*Amaranthus hybridus*) leaves.

Collection and Preparation of sample

Collect an adequate amount of representative leaf samples from the plant of interest were collected. The collected leaves were cleaned to remove any surface dirt or impurities, using soft rag or hands to gently clean the leaves. Then the leaves were air dried by spreading them in a single layer on a clean surface or using drying racks. It was then placed in a well-ventilated area away from direct sunlight until they became brittle. Once the leaves are completely dry, it was homogenized into a fine powder. The powdered leaf sample was transferred into a clean, airtight container and labeled accordingly. It was then taken for analysis.

Proximate Analysis

Determination of Moisture Content

A crucible (moisture dish) was washed and dried in an oven at 105^{o}C for 2 minutes, and quickly transferred into a desiccator, cooled and weighted as (w1). About 5g of the sample was weighted and transferred into the crucible and the total weight was recorded as (w2). The crucible containing the sample was then transferred into the oven and then dried at 105^{0}C for about 1 hour. It was then removed and cooled in a desiccator. After cooling the crucible (containing the dried sample) was then weighed. The step was repeated until a constant weight (w3) was obtained. The percentage moisture was calculated as follows

$$\% \text{ moisture} = \frac{W2-W3 \times 100}{W2-W1}$$

Where
W1= weight of empty crucible
W2=weight of crucible +weight of sample before drying
W3=weight of crucible +weight of sample after drying

Determination of Ash Content

A crucible dish was pre-treated in a muffle furnace at a temperature of 55^{0}C for 1 hour and then it was removed and cooled in a desiccator and weighed. About 10g of dried sample was weighed into the crucible and was decarbonizes. It was then transferred into a muffle furnace and the temperature was increased to 550^{0}C for 5 hours until the residue was completely charred. The heating was discontinued and the crucible was curved from the furnace and allowed to cool in the desiccator. The crucible and sample were weighed again; the percentage of ash present in the sample was calculated using Ronald and Ronald (1991) formula

$$\% \text{ ash} = \frac{W2-W3 \times 100}{W2-W1}$$

Where
W1= weight of empty crucible
W2=weight of crucible + sample before ashing
W3=weight of crucible +sample after ash

Determination of Fat (Lipid) Content

35g of the sample was weighed and then transfer into an extraction of known weighed. The opening of the thimble was ploughed with cotton wool and was weighed. The thimble was placed into the Soxhlet extractor and continuously extracting using ethyl ether as the extracting solvent for hours, after the thimble containing the residue was dried in an oven at 130^{0}C for 30 minutes and was cooled in a desiccator. It was weighed again. The percentage fat was calculated using Ronald and Ronald (1991)

$$\% \text{ fat} = \frac{W2-W3 \times 100}{W2-W1}$$

Where
W1= weight of empty thimble
W2=weight of thimble + sample before extraction
W3=weight of thimble +sample after Extraction and

Drying Test for Tannins

Determination of Crude Fibre Content

5g of the sample was transferred into a conical flask. 50ml of 0.3m H_2SO_4 was added and was boiled for 30 minutes. 20ml of 1.5m NaOH was equally added. It was then transferred into filter paper for filtration. The residue was washed for 5 minutes with distilled water before neutralization with 50ml of 0.03m Hcl. It was later rewashed for 10 times with hot distilled water before washing with 50ml Acetone to dry the residue. The crucible was dried in an oven with the sample at 140^0C for an hour, cooled and weighed and then it was later ignited in muffle furnace at 700^0C for an hour. It was then cooled and weighed. The percentage crude fibre was calculated using Ronald and Ronald (1991) method

$$\% \text{ crude fiber} = \frac{a-b \times 100}{c}$$

Where
a = weight of crucible + weight of sample drying in the oven
b = mass of crucible + sample after removal from the furnace
c = weight of sample.

Determination of protein Content

The total nitrogen was estimated by the Kjedhal method. 1g of the sample was weighed and placed in a 5000ml of Kjendal flask. 2g of catalyzed mixture (anhydrous copper sulphate and potassium sulphate) and 2ml of concentrated sulphuric acid (H_2SO_4) were introduced into the flask. The flask was placed in an electric heating mantle. The sample was heated slowly and then boiled more vigorously until there was clear digest. The sample was then allowed to cool. After cooling, the content was washed and transferred into 100ml volumetric flask and was made to the mark by adding the distilled water. The content was transferred into a distillation flask. The ammonia gas was trapped through the delivery tube to the receiving flask. 20ml of 4% boric acid was added to digest in mixture. The digest was made alkaline by adding 20ml of NaOH during the distillation. The setup was thoroughly cooked until no ammonia gas evolved. 25ml of distilled were pipette into 250ml conical flask and titrated with 1m hot to obtain the end point. The procedure was repeated for the blank sample and titration was carried out to determine the end point. The end point was reached when the color of the sample changes from yellow to pink. The percentage crude protein in the sample was calculated using the formula of Ronald and Ronald (1991) method

$$\% \text{ Nitrogen} = \frac{V2-V1 \times \text{molarity of Hcl} \times 100}{W}$$

Where
V1 =Titre value of blank
V2 =Titre value of the sample
V3 = weight of sample.
% created protein =% Nitrogen x 6.25

Phytochemical Analysis

Qualitative Determination of Phytochemical Constituents

Test for Tannins

About 0.5g of the dried powdered sample was boiled in 20ml of water in a test tube and then filtered. A few drop of 0.1% ferric chloride was added and observed for brownish-green or blue-black coloration. (Harborn, 1979)

Test for saponin

About 2g of the powdered sample was boiled in 10ml of distilled water bath and filtered. 10ml of the filtrate was mixed with 5ml of distilled water and shaken vigorously for a stable persistent froth. The frothing was mix with 3 drops of olive oil and shaken vigorously then observed for the information of emulsion (Trease and evans, 1980).

Test for Flavonoids

0.15g portion of the powdered sample was heated with 10ml of ethyl acetate over a stream bath for 3 minutes. The mixture was filtered and 4ml of the filtrate was shaken with 1ml of dilute ammonia a solution. A yellow coloration indicates the presence for flavonoids.

Test for Alkaloids

About 0.2g of each sample was warmed with 10ml of H_2SO_4 for 2 minutes. It was filtered and few drops of Trangendroffs reagent were added. Orange red precipitates indicate the presence of alkoids (Harborne, 1979).

Quantitative Determination of Phytochemical Constituents

Tannin

Analytical method for quantitative determination of tannin was according to (Amadi *et al*., 2004) and (Ejikeme *et al*., 2014). By dissolving 50 g of sodium tungstate (Na_2WO_4) in 37 cm3 of distilled water, Folin-Denis reagent was made. To the reagent prepared above, 10g of phosphomolybdic acid and 25 cm3 of orthophosphoric acid (H_3PO_4) were added. Two-hour reflux of the mixture was carried out, cooled, and diluted to 500 cm^3 with distilled water. One gram of each wood powder (sample) in a conical flask was added to 100 cm3 of distilled water. This was boiled gently for 1 hour on an electric hot plate and filtered using number 42 (125 mm) Whatman filter paper in a 100 cm^3 volumetric flask. Addition of 5.0 cm3 Folin-Denis reagent and 10 cm3 of saturated Na_2CO_3 solution into 50 cm^3 of distilled water and 10 cm3 of diluted extract (aliquot volume) was carried out after being pipetted into a 100 cm^3 conical flask for colour development. The solution was allowed to stand for 30 minutes in a water bath at a temperature of 25ºC after thorough agitation. With the aid of a Spectrum Lab 23A spectrophotometer optical density was measured at 700 nm

and compared on a standard tannic acid curve. Dissolution of 0.20g of tannic acid in distilled water and dilution to 200 cm3 mark (1 mg/cm^3) were used to obtain tannic standard curve. Varying concentrations (0.2–1.0 mg/cm^3) of the standard tannic acid solution were pipetted into five different test tubes to which Folin-Denis reagent (5 cm3) and saturated Na_2CO_3 (10 cm^3) solution were added and made up to the 100 cm3 mark with distilled water. The solution was left to stand for 30 minutes in a water bath at 25ºC. Optical density was ascertained at 700nm with the aid of a Spectrum Lab 23A spectrophotometer. Optical density (absorbance) versus tannic acid concentration was plotted.

Determination of Alkaloids

Quantitative determination of alkaloid was according to the methodology by Harborne. Exactly 200 cm^3 of 10% acetic acid in ethanol was added to each wood powder sample (2.50g) in a 250 cm3 beaker and allowed to stand for 4 hours. The extract was concentrated on a water bath to one-quarter of the original volume followed by addition of 15 drops of concentrated ammonium hydroxide drop wise to the extract until the precipitation was complete immediately after filtration. After 3 hours of mixture sedimentation, the supernatant was discarded and the precipitates were washed with 20 cm^3 of 0.1 M of ammonium hydroxide and then filtered using Gem filter paper (12.5 cm). Using electronic weighing balance Model B-218, the residue was dried in an oven and the percentage of alkaloid is expressed mathematically as

Determination of Flavonoid

Flavonoid determination was by the method reported by Ejikeme *et al*., 2014; Boham and Kocipai 1994. Exactly 50 cm^3 of 80% aqueous methanol added was added to 2.50g of sample in a 250 cm3 beaker, covered, and allowed to stand for 24 hours at room temperature. After discarding the supernatant, the residue was re-extracted (three times) with the same volume of ethanol. Whatman filter paper number 42 (125 mm) was used to filter whole solution of each wood sample. Each wood sample filtrate was later transferred into a crucible and evaporated to dryness over a water bath. The content in the crucible was cooled in a desiccator and weighed until constant weight was obtained.

Determination of Saponin

Saponin quantitative determination was carried out using the method reported by Ejikeme *et al*., 2014; Obadoni and Ochuko 2002. Exactly 100 cm^3 of 20% aqueous ethanol was added to 5 grams of each wood powder sample in a 250 cm^3 conical flask. The mixture was heated over a hot water bath for 4 hours with continuous stirring at a temperature of 55ºC. The residue of the mixture was extracted with another 100 cm^3 of 20% aqueous ethanol after filtration and heated for 4 hours at a constant temperature of 55ºC with constant stirring. The combined extract was evaporated to 40cm^3 over water bath at 90ºC. 20cm^3 of diethyl ether was added to the concentrate in a 250cm^3 separator funnel and vigorously agitated from which the aqueous layer was recovered while the ether layer was discarded. This purification process was repeated twice. 60 cm3 of n-butanol was added and extracted twice with 10 cm^3 of 5% sodium chloride. After discarding the sodium chloride layer, the remaining solution was heated in a water bath for 30 minutes after which the solution was transferred into a crucible and was dried in an oven to a constant weight. The saponin content was calculated as a percentage:

Mineral Analysis

Mineral analysis of plants using an atomic absorption spectrometer (AAS) involves several steps, including sample preparation, calibration, measurement, and data analysis. Here is a general outline of the process: The mineral elements, comprising calcium, potassium, iron and zinc were determined according to the method of Shahidi *et al*., (1999) and with some modifications. Exactly 2.0 g of each of the processed samples were weighed and subjected to dry ashing in a well-cleaned porcelain crucible at 550ºC in a muffle furnace. The resultant ash was dissolved in 5.0 ml of HNO_3/HCl/H_2O (1:2:3) and heated gently on a hot plate until brown fumes disappeared. To the remaining material in each crucible, 5.0 ml of de-ionized water was added and heated until a colorless solution was obtained. The mineral solution in each crucible was transferred into a 100 ml volumetric flask by filtration through filter paper and the volume was made to the mark with de-ionized water. This solution was used for elemental analysis by atomic absorption spectrophotometer. A 10 cm long cell was used and concentration of each element in the sample was calculated on percentage (%) of dry matter that is mg/100g sample.

Statistical Analysis

All experiments were done in duplicate and the results were expressed as mean ± SD using the Microsoft excel 2019 spreadsheet. Data were subjected to statistical analysis using IBM SPSS statistical package. A one-way analysis of variance (ANOVA) was used to compare the values of proximates, phytochemical and mineral component of the two plant species. The means were treated as significantly different at $P< 0.05$

RESULTS

Proximate Analysis of Huckleberry

Table 1 below represents the proximate analysis of huckleberry from Jalingo and Gembu. The result is in percentage (%), which indicated that huckleberry has the highest moisture composition followed by carbohydrate, protein, crude fiber, fat and ash. Statistically there was no significant difference at $P<0.05$ in the proximate content of the two vegetables.

Table 1: Proximate Analysis Result on Huckleberry from Jalingo and Gembu

	Concentration (%)					
Sample	Moisture	Carbohydrate	Ash	Protein	Fat	Crude fiber
Sample 1	72.85±0.49	38.775±0.6	2.36±0.17	15.95±0.04	6.82±0.14	8.73±0.13
Sample 2	70.15±0.49	37.58±0.4	2.76±0.08	15.35±0.1	6.48±0.61	8.60±0.12

Note: Sample 1 = Huckleberry from Jalingo Sample 2 = Huckleberry from Gembu

Proximate Analysis of Spinach

Table 2 below represents the proximate analysis of spinach from Jalingo and Wukari. The result is in percentage (%), which indicated that spinach has the highest carbohydrate composition followed by moisture, crude fiber, protein, ash and fat. Statistically there was no significant difference at $P<0.05$ in the proximate content of the two vegetables.

Table 2: Proximate Analysis Result on Spinach from Wukari and Jalingo

	Concentration (%)					
Sample	Moisture	Carbohydrate	Ash	Protein	Fat	Crude fiber
Sample 3	34.8±0.73	50.18±0.66	9.12±0.17	8.37±0.06	4.28±0.06	12.73±0.16
Sample 4	32.04±0.51	49.80±0.62	9.88±0.23	8.75±0.07	4.53±0.6	12.19±0.16

Note: Sample 3 = Spinach from Jalingo Sample 4 = Spinach from Wukari

Phytochemical Screening of Huckleberry

Table 3 below represents the phytochemical screening result on huckleberry from Jalingo and Gembu. The result is in mg/100g, all the parameter was present and it was indicated that alkaloid has the highest composition followed by flavonoid, saponin and tannin. Statistically there was no significant difference at $P<0.05$ in the proximate content of the two vegetables.

Table 3: Phytochemical Screening Result on Huckleberry from Jalingo and Gembu

	Quantitative Screening (mg/100g)			
Samples	Alkaloids	Tannins	Saponins	Flavonoids
Sample 1	7.67±0.03	0.93±0.02	1.51±0.01	4.81±0.02
Sample 2	7.75±0.02	1.04±0.02	1.49±0.01	4.84±0.02

Note: Sample 1 = Huckleberry from Jalingo Sample 2 = Huckleberry from Gembu

Phytochemical Screening of Spinach

Table 4 below represents the Phytochemical Screening Result on spinach from Jalingo and Wukari. The result is in mg/100g, all the parameter was present and it was indicated that alkaloid has the highest composition followed by flavonoid, tannin and saponin. Statistically there was no significant difference at P<0.05 in the proximate content of the two vegetables.

Table 4: Phytochemical Screening Result on Spinach from Jalingo and Wukari

	Quantitative Screening (mg/100g)			
Samples	Alkaloids	Tannins	Saponins	Flavonoids
Sample 3	5.72±0.04	1.77±0.01	1.32±0.01	2.32±0.01
Sample 4	5.56±0.01	1.82±0.01	1.39±0.01	2.38±0.01

Mineral Analysis of Huckleberry

Table 5 below represents the mineral analysis result on huckleberry from Jalingo and Gembu. The result in mg/100mg and it indicated that potassium has the highest composition, followed by calcium, iron and zinc. Statistically there was no significant difference at P<0.05 in the proximate content of the two vegetables.

Table 5: Mineral Analysis Result on Huckleberry from Jalingo and Gembu

	Concentration(mg/100g)			
Sample	Calcium (Ca)	Zinc (Zn)	Potassium (K)	Iron (Fe)
Sample 1	28.68±0.04	2.09±0.01	43.25±0.29	13.1±0.07
Sample 2	28.83±0.01	2.12±0.01	42.47±0.22	13.5±0.08

Note: Sample 1 = Huckleberry from Jalingo Sample 2 = Huckleberry from Gembu

Mineral Analysis of Spinach

Table 6 below represents the mineral analysis result on spinach from Jalingo and Wukari. The result in mg/100mg and it indicated that potassium has the highest composition, followed by calcium, iron and zinc. Statistically there was no significant difference at P<0.05 in the proximate con tent of the two vegetables.

Table 6: Mineral Analysis Result on Spinach from Wukari and Jalingo

	Concentration(mg/100g)			
Sample	Calcium (Ca)	Zinc (Zn)	Potassium (K)	Iron (Fe)
Sample 2	44.19±0.11	3.59±0.01	53.64±0.71	12.42±0.04
Sample 3	43.72±0.16	3.49±0.01	51.69±0.8	12.15±0.04

Note: Sample 3 = Spinach from Jalingo Sample 4 = Spinach from Wukari

Proximate Analysis of Both Leave Species

Table 7 below represents the comparative result on the proximate analysis of huckleberry and spinach. There is a significant (P<0.05) difference between the two plants (huckleberry and spinach), which indicated that huckleberry has high composition of moisture, carbohydrate, protein and fat but low composition of ash and crude fiber compare to that of spinach.

Table 7: Comparative Result on the Proximate Analysis of Huckleberry and Spinach

	Concentration (%)					
Sample	Moisture	Carbohydrate	Ash	Protein	Fat	Crude fiber
Huckleberry	71.5±1.91	38.18±0.85	2.56±0.28	15.65±0.42	6.65±0.24	8.67±0.09
Spinach	33.42±1.95	49.99±0.27	9.5±0.54	8.56±0.27	4.41±0.18	12.46±0.38

Phytochemical Screening of Both Leave Species

Table 8 below represents the comparative result on the phytochemical screening of huckleberry and spinach There is a significant (P<0.05) difference between the two plants (huckleberry and spinach), which indicated that huckleberry has high composition of alkaloid, flavonoids and tannins and low composition of saponins compare to that of spinach.

Table 8 Comparative Result on the Phytochemical screening of Huckleberry and Spinach

	Quantitative Screening (mg/100g)			
Samples	Alkaloids	Tannins	Saponins	Flavonoids
Huckleberry	7.71±0.05	0.98±0.08	1.5±0.01	4.84±0.01
Spinach	5.64±0.11	1.79±0.03	1.35±0.05	2.35±0.04

Mineral Analysis of Both Leave Species

Table 9 represent the comparative result on the mineral analysis of huckleberry and spinach There is a significant (P<0.05) difference between the two plants (huck leberry and spinach), which indicated that huckleberry has high composition of potassium and iron but low composition of calcium and zinc compare to that of spinach

Table 9: Comparative Result on the Mineral Analysis of Huckleberry and Spinach

	Concentration(mg/100g)			
Sample	Calcium (Ca)	Zinc (Zn)	Potassium (K)	Iron (Fe)
Huckleberry	28.76±0.11	2.11±0.02	42.86±0.55	13.3±0.28
Spinach	43.96±0.33	3.54±0.07	52.67±1.38	12.29±0.19

DISCUSSION

The proximate analysis of huckleberry (*Solanum scabrum*) and spinach (*Amaranthus hybridus*) can give us insights into its nutritional profile about the levels of major nutrients such as carbohydrate, proteins, fats, crude fiber, moisture, and ash content. Both Solanum scabrum and *Amaranthus hybridus* are rich in macronutrients. Based on the analysis carried out it have been observed that *Solanum scabrum* in Jalingo and Gembu, there was no significant (P<0.05) difference (P<0.05) between them, same as that of *Amaranthus hybridus* in Jalingo and Wukari. There is few or no work on the proximate analysis of *Solanum scabrum*. *Solanum scabrum* contain 71.5±1.91% moisture, 38.18±0.85% carbohydrate, 2.56±0.28% ash, 15.65±0.42% protein, 6.65±0.24% fat and 8.67±0.09% crude fiber., While Amaranthus hybridus contain 33.42±1.95% moisture, 49.99±0.27% carbohydrate, 9.5±0.54% ash, 8.56±0.27% protein, 4.41±0.18% fat and 12.46±0.38% crude fiber. Which signifies that *Solanum scabrum* has high amount of moisture, protein, and fat but it has low amount of carbohydrate, ash and crude fiber compare to *Amaranthus hybridus* The result obtain from the analysis *Amaranthus hybridus* was similar that of (Sani *et al*., 2021) but it contains high amount moisture, fat and protein. The considerable amounts of carbohydrate in all the vegetables studied are an indication that the leafy vegetables can be used to regulate various metabolic processes in the body as key molecules in the central metabolic pathways of the body. The degree of moisture content in a leaf is an important parameter which defines the rigidity or turgidity of the vegetable (Onuekwe, 2012). High moisture content results in rapid deterioration of vegetables and hence reduced shelf-life, the relatively high moisture contents reveal that the studied leafy vegetables need care for appropriate preservation as they would be prone to deterioration (Kwenin, 2011). Indeed, the high moisture content may induce a greater activity of water soluble enzymes and co-enzymes involved in metabolic activities of these leafy vegetables (Iheanacho and Udebuani, 2009; Agbaire, 2011). Ash Content of the leaves (2.55 and 8.65 %) is a reflection of mineral content present in the leaves which helps the body in growth and development. The body needs minerals to perform many different functions from building strong bones to transmission of nerve impulse (Mundy, 2015). All the vegetables studied contained appreciable amounts of protein which indicates that the vegetables can be used for building and repairing of body tissues, regulation of body processes and formation of enzymes and hormones (Patalinghug *et al*., 2022). The crude fiber of obtain in *solanum scabrum* is similar to that of (Laura, 2003) but in slightly lower in *Amaranthus hybridus*, which is an important part of balanced diet. It can help to prevent heart diseases, diabetes, weight gain and improve digestion. It is the key to good health,; it improves immune function, oxygen transport and maintain strong muscle tissue. The considerable amount of carbohydrate in all the vegetables studied is an indication that the leafy vegetables are also a good source of Protein, which serves as an important component of every cell in the body. The body needs protein to produce enzymes, hormones, tissues, and so on (Reich, 2013).

Phytochemical analysis involves the identification and quantification of bioactive compounds present in plants. Analyzing the phytochemical composition of huckleberry (*Solanum scabrum*) and spinach (*Amaranthus hybridus*) can help in understanding its potential health benefits. Based on the analysis carried out it have been observed that *Solanum scabrum* in Jalingo and Gembu, there was no significant (P<0.05) difference (P<0.05) between them, same as that of *Amaranthus hybridus* in Jalingo and Wukari. *Solanum scabrum* contain 7.71±0.05mg/100g alkaloids, 0.98±0.08mg/100g tannins, 1.50±0.01 mg/100g saponins and 4.84±0.01mg/100g flavonoids, while *Amaranthus hybridus* contain 5.64±0.11mg/100g alkaloids, 1.79±0.03mg/100g tannins, 1.35±0.05 mg/100g saponins and 2.35±0.04mg/100g flavonoids. Which This signifies that *Solanum scabrum* slightly has high amount of tannins, saponins, flavonoids and low amount of alkaloids compare to *Amaranthus hybridus*. The result obtain from the analysis *Amaranthus hybridus* was similar that of (Sani *et al*., 2021) Sani *et al*. (2021) but it contains high amount alkaloids and low amount of flavonoids. Which shows that *Solanum scabrum* contain high amount of alkaloids compare to *Amaranthus hybridus*, flavonoids and contain low amount of tannins and sapomins. Alkaloids play important metabolic roles and development in the system of living organisms (Edeoga *et al*., 2006). It also serves as repellent to parasites and predators. The alkaloid is known to contain antimicrobial agents which accounted for its antimicrobial activity (Usunobun and Okolie, 2016). Flavonoid is believed to contain antioxidant agents and it is reported that it reduces the oxidation of low-density lipoprotein, lower cholesterol level and triglyceride (Erdman, 2007). It is also expressed in plant in respond to microbial attack suggesting their antimicrobial property (Erdman, 2007). Saponins limit the growth and viability of cancer cell by reacting with cholesterol rich membrane of cancer cell (Prohp and Onoagbe, 2012). Pharmacologically, saponin is responsible for most cellular activities related to cell division and growth in human and has incivility effect on inflammation. Hence, the use of *Amaranthus spp*. leaves justifies the use of plant in the management of inflammation. Tannins are known to have potential antiviral activity as well as anticancer agent (Cheng *et al*., 2002).

Mineral analysis focuses on determining the presence of mineral content both trace (zinc and iron) and major (potassium and calcium) in both plant species. Analysis of mineral composition of *Solanum scabrum* and *Amaranthus hybridus* leaves in the present study confirmed the presence of this justifies the vitality of the plant leaf nutritionally especially when consumed by animals or humans. Minerals play important metabolic role in the body of animals, such activities include maintenance of acid balance in the body, production and activity of enzymes and so on (Usunobun and Okolie, 2016). Based on the analysis carried out it have been observed that *Solanum scabrum* in Jalingo and Gembu, there was no significant (P<0.05) difference between them, same as that of *Amaranthus hybridus* in Jalingo and Wukari. *Solanum scabrum* contain 28.76±0.11mg/100g calcium, 2.11±0.02mg/100g zinc, 42.86±0.55mg/100g potassium and 13.3±0.28mg/100g iron. While *Amaranthus hybridus*

contain 43.96±0.33mg/100g calcium, 3.54±0.07mg/100g zinc, 52.67±1.38mg/100g potassium and 12.29±0.19mg/100g iron, which signifies that Solanum scabrum slightly has high amount of iron and calcium, but it also has low amount of potassium and zinc compare to *Amaranthus hybridus*. The result obtain from the analysis *Amaranthus hybridus* was similar that of (Sani *et al*., 2021) but it contains high amount calcium and zinc. the presence calcium in both vegetable species played major role in formation and development of bones and teeth, coagulation of blood, contraction of muscle, normal functioning of heart and nervous system (Igbakin and Oloyede, 2009). The presence of potassium in both studied plants signifies that it plays a role conduct several functions to the body system such as regulation of osmotic pressure, conduction of nerve impulse and maintenance of acid-base balance (Usunobun and Okolie, 2016). Iit has also been reported that potassium is helpful in regulating high blood pressure. Micro-minerals such as zinc and iron are required in the body in amounts often below 100 milligrams per deciliter but lack of them or too much of it can lead to so biochemical effect on the body (FDA, 2020). The presence of zinc in both studied plants species plays an important role in nerve functioning and normal sexual development. Zinc is also vital for stimulating the activity of vitamins as well as formation of red and white blood cells (Claude and Paule, 2004). Zinc is an integral part of many enzymes in the body and also played important role in proper functioning of body immunity (Claude and Paule, 2004). Both plant species indicate a moderate amount of iron in them and iron serve as a key element that is needed in the body for processes such as DNA synthesis and oxygen transport. Iron is also a raw material that the body need in order to synthesize erythrocyte (red blood cell) through a process known as erythropoiesis (red blood cell production). Additionally, individuals with specific health conditions such as pregnant women have an increased need for iron to support the growth of the baby and the expansion of blood volume during pregnancy. Without enough iron, pregnant women are at risk for developing iron-deficiency anemia (Beard, 2001; Abbaspour *et al*., 2014), which can lead to fatigue, weakness, and other complications.

CONCLUSION

In conclusion, the proximate, phytochemical, and mineral analysis of *Solanum scabrum* (huckleberry) and *Amaranthus hybridus* (spinach) highlights their nutritional value and potential health benefits in humans. Both plants contain a considerable amount of moisture, proteins, fat, fiber, and ash makes it a valuable addition to a balanced diet and supporting various physiological functions in the human body. The presence of bioactive compounds suggests its potential as a functional food or nutraceutical with antioxidant, antimicrobial, and anti-inflammatory properties. The mineral contents are crucial for maintaining overall health, supporting bone strength, aiding in blood formation and facilitating various enzymatic activities in the body. Huckleberry (Solanum scabrum) and spinach (*Amaranthus hybridus*) have rich nutritional composition but base on this research it has being discovered that huckleberry (*Solanum scabrum*) possesses high nutritional significant compare to that of spinach (*Amaranthus hybridus*), and spinach (Amaranthus hybridus) can also be a good alternative where huckleberry (*Solanum scabrum*) is not available because huckleberry (*Solanum scabrum*) is a rare vegetable found at the north east zone of Nigeria.

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