NUTRITIONALLY AND MEDICINALLY IMPORTANT COMPOUNDS IN THE FLOWER OF *XANTHOSOMA SAGITTIFOLIUM* (L) SCHOTT (YELLOW FLESH CULTIVAR)

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Abstract
Studies on the chemical composition of the flower of Xanthosoma sagittifolium (yellow flesh cultivar) collected from two different environments (Etebi in Eket L.G.A. and Mkpatak in Essien Udim L.G.A.) in Akwa Ibom State of Nigeria were carried out using standard methods of analysis. The aim of this study was to explore the potential applications of the flower of Xanthosoma sagittifolium (yellow flesh cultivar) as a food supplement and medicament for the promotion of human health. Both samples were analyzed for their nutrients and anti-nutrient contents and phytochemical composition. The Eket sample was also analyzed for amino acid profile. The result reveals that the sample contains all the amino acids naturally present in proteins. The nutrients determined include proximate composition, vitamins and mineral elements while anti-nutrients determined include oxalates, HCN, phytic acid and tannins. The phytochemicals were cardiac glycosides, deoxy-sugars, alkaloids, terpenes, saponins and flavonoids. Both samples were significantly ($p < 0.05$) different in their nutritional values. The results reveal that the Eket sample is nutritionally superior to the Essien Udim sample. The high levels of nutrients and phytochemicals in these samples reveal medicinal/health advantage of the flower of Xanthosoma sagittifolium over other culinary leafy vegetables. This implies that the flower of Xanthosoma sagittifolium could be used as a food supplement and medicament for the promotion of human health.

Keywords*:* Proximate composition, nutrients and anti-nutrients, phytochemical analysis, vegetable, *Xanthosoma sagittifolium*

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1. INTRODUCTION

Cocoyam is an herbaceous perennial plant that belongs to the arum family, Araceae. It originated from tropical America and is cultivated in several countries of Asia and Africa as a subsistence food crop (Giacometti and Leon 1994). There are many species of cocoyam but *Xanthosoma sagittifolium* (L) Schott (*tannia)* is one of the two most edible species (Ihekoronye and Ngoddy 1985). It has a corm or main underground stem in the form of a rhizome from which swollen secondary shoots or cormels sprout. Several large leaves also sprout from the main stem, which are sagittate and erect with long ribbed petioles. Flowering is rare, but when it occurs, it starts from the later part of the rainy season and lasts through much of the dry season. Flowering is observed only in plants that have grown for longer than a year. Once started, flowering continues irrespective of season until the plant is harvested. The inflorescence consists of a cylindrical spadix enclosed in a 12-15 cm spathe. The spadix is cylindrical and slightly shorter than the spathe. The female flowers are found on the lower portion while male flowers are on the upper portion; there are sterile flowers in the middle portion. The spadices are rarely fertile and produce few viable seeds (Giacometti and Leon 1994). The growth cycle lasts for nine to eleven months. During the first six months, the corms and leaves develop; in the last four months, the foliage remains stable and when it begins to dry, the plants are ready for the cormels to be harvested. The corms and cormels of cocoyam are an important source of carbohydrate for humans. The peels from the corm have been investigated for possible use as animals' feed stock (Yahaya et al. 2013). Some cooking conditions have been developed to make the cooked corm less acridic (Akpan and Antia 2002, Akpan and Udoh 2004, Akpan and Umoh 2004). The young leaves of the plant are

occasionally used as vegetable in soup. Inspite of its importance as a staple food in many countries, cocoyam has received very little attention to enhance its production and utilization potentials (Watanabe 2002). In Nigeria cocoyam is one of the under exploited tropical root plants. It is very nutritious but its utilization is still at subsistence level and is a highly neglected crop. Cocoyam has long been used in the traditional medicine of some African countries for the treatment of various ailments such as diabetes, wounds, eye diseases, jaundice, panaries, abscess, gastrointestinal disorder and frontanelle (Ilonzo 1995, Sahnda 2012, Ukpong et al. 2014). Much work has been done on the corms and leaves of *X. sagittifolium* but information is however scarce on the flower. Therefore the basis of this research was to study the chemical composition and the potential uses of the flower of *X. sagittifolium* (yellow flesh cultivar).

2. MATERIALS AND METHODS

Samples collection and preparation

Mature flowers of *X. sagittifolium* were randomly harvested from two different locations (Etebi in Eket L. G. A. and Mkpatak in Essien Udim L.G.A.) in Akwa Ibom State between October and December 2014 and conveyed to the Department of Chemistry laboratory, University of Uyo for processing. The samples were collected from those two locations which are very distant from each other to check whether the levels of constituents are adversely affected by environmental factors since the general aim in this research is to advocate its use as a vegetable supplement. The samples were identified by Professors Margaret Bassey and Rufus Ubom, both botanists in the Department of Botany and Ecological Studies, University of Uyo, Uyo, and a voucher specimen (No. Wilson, UUH 3594) is maintained in the herbarium of that department. The samples were then dried to a constant weight in an air circulating oven pre-set at 70°C. Thereafter, the dried samples were milled into powder using the laboratory manual grinder and stored in labeled airtight polythene containers for analysis. All the reagents used for the analysis were of analytical grade. The analyses were carried out in triplicate and the mean results were calculated and reported.

Proximate composition

***Moisture content*:** Moisture content was determined using the method of (A.O.A.C., 2012). Within the time of harvesting, the fresh samples were weighed and then dried in an air oven (GallenKamp, England) at a temperature of 70°C until a constant weight was obtained. The samples were cooled in a desiccator and weighed. The moisture content was calculated as follows:

$$\text{Moisture (\% of fresh weight)} = \frac{\text{Loss in weight on drying the sample}}{\text{Initial weight of the sample}} \text{ x } 100 \quad (1)$$

***Ash content*:** Ash content was determined using the method of (A.O.A.C., 2012). The ground sample (2.0g) was weighed into a pre-weighed and dried crucible in triplicate. The weight of the crucible and its content was taken and then ignited in the muffle furnace at 550°C for 3 hours during which period the sample was completely ashed. The ash was cooled in a desiccator and weighed. The ash content was calculated as follows:

$$\% \text{ Ash} = \frac{\text{Weight of ash}}{\text{Weight of sample}} \text{ x } 100 \quad (2)$$

Crude fiber content: Crude fiber content was determined using the method of (A.O.A.C., 2012). Three steps were employed in this analysis, namely; acid digestion, alkaline digestion and ignition of the sample. The ground sample (4.0g) was defatted with petroleum ether for 2 hours and then quantitatively transferred into a 250 mL beaker. Fifty milliliters of 1.25% H_2SO_4 was added and the mixture was made up to 200mL with distilled water. The content of the beaker was boiled for 30 minutes and filtered through a Buchner funnel set up. The residue obtained was washed with hot water until it was acid

free. The residue obtained after acid digestion was quantitatively transferred into a 250mL beaker, 50mL of 1.25% NaOH was added and the solution was made up to 200mL with distilled water. The mixture was again heated for 30 min with constant stirring. The content of the beaker was filtered through the Buchner funnel set up and washed several times with hot water until it was free from NaOH. Finally, the residue was washed with 95% ethanol, quantitatively transferred into a pre-weighed crucible and dried at 100°C. The weight of the oven dried residue was noted and the residue was later ignited in a muffle furnace at 550°C for 2 hours. It was cooled in a desiccator and weighed. The crude fiber was determined from the loss in weight of crucible and its content after ignition. The following expression was used to calculate the percentage (%) fiber content.

$$\text{Crude fiber (\%)} = \frac{\text{Weight of sample after ignition}}{\text{Weight of sample before ignition}} \text{ x } 100 \quad (3)$$

***Crude lipid content*:** Crude lipid content was determined using the method of (A.O.A.C., 2012). The ground sample (5.0g) was accurately weighed into an extractor thimble. Petroleum ether (150mL, boiling point 60-80°C) was poured into a 250mL round bottom digestion flask containing some anti-bumping chips. The Soxhlet extractor into which the thimble with its content had been introduced was fitted into the round-bottom flask and an extraction apparatus was set with the flask sitting on the heating mantle. The content of the flask was heated and the extraction process was carried out for about 5 hours. The thimble now containing the defatted sample was dried in a hot air circulating oven at 50°C. The volume of the content was reduced by evaporating it to about 30mL and then poured into a dried pre-weighed beaker. The flask was rinsed with a little quantity of ether back to the beaker. The beaker was heated on a steam bath to drive off the excess solvent. The beaker was cooled in a desiccator and then weighed. The % lipid content was calculated as follows:

$$\text{Crude lipid (\%)} = \frac{\text{weight of extract}}{\text{weight of sample}} \text{ x } 100 \quad (4)$$

***Crude protein*:** Crude content was determined using the Kjeldahl method (A.O.A.C., 2012) which involves digestion, distillation and titration. The sample (1.0g) was accurately weighed into a standard 250mL Kjeldahl (digestion) flask containing 0.5g of catalyst mixture (containing sodium sulphate, copper sulphate and selenium oxide in the ratio of 10: 5: 1), some anti-bumping chips and 5mL of concentrated sulphuric acid. The Kjeldahl flask was placed on the digestion rack and heated gently to prevent vigorous charring and frothing for one hour. The flask with its content was then subjected to vigorous heating for about 3 hours until a clear bluish solution was obtained. After digestion, the solution was cooled, transferred quantitatively into a 100mL standard flask and made up to the mark with distilled water.

A 20.0mL aliquot of the digest was pipetted into a semi micro Kjedahl-Markham distillation apparatus and treated with an equal volume of 40% NaOH solution. The ammonia evolved was steam distilled into a 100mL conical flask containing 10mL solution of saturated boric acid to which two drops of the double indicator solution were added. The tip of the condenser was immersed into the boric acid double indicator solution to avoid the escape of ammonia. The distillation was continued until about two thirds of the original volume was distilled. The tip of the condenser was rinsed three times with distilled water before the next determination. The distillate was titrated with 0.1 M HCl until a purple-pink end point was reached. The crude protein was obtained by multiplying the % of nitrogen content by a factor of 6.25.

$$\text{Nitrogen content (\%)} = \frac{(\text{Sample titre} - \text{blank}) \text{x } 0.1 \text{ x } 0.014 \text{ x } 6.25}{\text{weight of sample}} \text{ x } 100 \quad (5)$$

***Carbohydrate content*:** Carbohydrate content was estimated by the difference method (A.O.A.C., 2012) by subtracting total organic

nitrogen, lipid, ash and fiber from the total dry matter.

Caloric value: The caloric value of the sample was estimated by multiplying the values of the crude protein, lipid and carbohydrate by 4, 9, and 4, respectively and taking the sum of the products. The value is expressed in kilocalories.

Anti-nutrients content

***Hydrocyanic acid* (HCN):** This was determined by the alkaline-picrate spectrophotometric method (Vogel, 1978).The ground sample (5.0g) was extracted with 5mL of water in a corked flask and was allowed to stay overnight. The solution was filtered through Whatman No.1 filter paper and the extract was used for cyanide determination. Four milliliters of alkaline picrate was added to 1mL of the filtrate in a corked test tube and incubated in a water bath for 5 minutes. A reddish brown color was developed and the absorbance was measured with a spectrophotometer (721D) at 490nm. The following expression was used to calculate the hydrocyanic content:

$$\text{HCN} = \frac{\text{Absorbance of test x Conc. of standard}}{\text{Absorbance of standard x weight of sample}} \text{ x } 100 \quad (6)$$

***Oxalates*:** The oxalate content was determined by the method of Dye (1956). The determination involves three major steps, namely; digestion, oxalate precipitation, and permanganate titration. The dried ground sample (2.5g) was weighed into a 250mL beaker and 95ml of distilled water and 5ml of 6M hydrochloric acid were added. The mixture was heated on a water bath at 50^{o}C for 2 hours. The digested sample was filtered and the filtrate diluted to 125mL with distilled water. Fifty milliliters of the filtrate (in triplicate) was taken into a 100mL beaker. Methyl red indicator was added, evaporated to 25mL and then filtered. The filtrate was treated with 5mL of concentrated ammonia and heated again to 90^{o}C. Ten milliliters of 5% $CaCl_2$ solution was added while being stirred constantly. After heating, it was cooled and left overnight.The mixture was then centrifuged for 5 min, decanted and the precipitate obtained was washed into a beaker with 20% (v/v) sulphuric acid and was diluted to 125mL with distilled water. The solution was heated in a water bath to 90^{o}C and titrated against 0.01M $KMnO_4$ solution to a faint pink color which persisted for 10 s. Equation 7 was used for the calculation of the oxalate content.

Calculation:

$$1\text{mL of } 0.01\text{M } KMnO_4 = 2.2\text{mg oxalate} \quad (7)$$

***Phytic acid*:** This was determined using the method described by McCance and Widdowson (1955). The ground sample (2.0g) was extracted with 50mL of 3% trichloroacetic acid (TCA). This was done by shaking the mixture at room temperature for 30 minutes and then filtered. The solution was transferred into a 100mL conical flask and 4mL of iron (III) chloride solution containing 2mg of $FeCl_3$ per mL in 3% TCA was added. The content was heated in a water bath for 45 minutes and centrifuged for 15 minutes. The clear supernatant was decanted and the precipitate was washed two times with 3% TCA and one time with distilled water. The precipitate was dispensed in a small volume of distilled water and 3mL of 1.5M NaOH was added with mixing. The volume was brought up to 30mL with distilled water and re-heated in a water bath for 30 minutes. The solution was centrifuged and decanted again. The precipitate obtained was dissolved in 40mL of 3.2M HNO_3 and then transferred into a 100mL standard flask. The flask with its content was cooled to room temperature and the solution diluted to volume with distilled water. The absorbance was measured at 500nm in a spectrophotometer (721D). Standard solutions of phytic acid were also prepared for the calibration curve. The phytic acid content was calculated as follows:

$$\text{Phytic acid} = \frac{\text{Absorbance of test x concentration of standard}}{\text{Absorbance of standard x weight of sample}} \text{ x } 100 \quad (8)$$

***Tannins*:** This was determined by the method described by Kirk and Sawyer (1998).One gram of the sample was dispensed in 10mL of distilled water and shaken. The mixture was allowed to stand for 30 minutes before it was filtered through Whatman No.1 filter paper. The filtrate (2.5mL) was dispensed into a 50mL volumetric flask. Similarly, 2.5mL of tannic solution was dispensed into a separate 50mL volumetric flask. Standard solutions of tannin having concentrations of 0.2, 0.4, 0.6, 0.8 and 1.0mg/mL were also prepared. Folin Denis reagent (1mL) was added to each of the flasks, followed by 2.5mL of saturated Na_2CO_3 solution. The content of each flask was made up to 50mL with distilled water and incubated in a water bath for 90 minutes at room temperature. The absorbance was measured with a spectrophotometer (721D) at 550nm. The following expression was used to calculate the tannin content:

$$\text{Tannin} = \frac{\text{Absorbance of test x concentration of standard}}{\text{Absorbance of standard x weight of sample}} \text{ x } 100 \quad (9)$$

Vitamins composition

***Vitamin A*:** Vitamin A content was determined using the method of (A.O.A.C., 2012). Antimony trichloride (20.0g) was dissolved in 100mL of chloroform, warmed slightly on a heating mantle and then cooled in an ice bath until excess of the reagent was separated. The solution was used for the analysis. One milligram of vitamin A was dissolved in 100mL of chloroform to obtain a solution containing 10mg/mL vitamin A. The ground sample (1.0g) was extracted with 10mL of chloroform and then filtered through Whatman No.1 filter paper.The filtrate was pipetted into a test tube and a little quantity of activated charcoal was added to give a clear solution. This was tested with antimony trichloride reagent to develop a blue color. The absorbance was measured at 620nm against chloroform/antimony trichloride. Vitamin A content was obtained as follows:

$$\text{Vitamin A } \left(\frac{\text{mg}}{\text{mL}}\right) = \frac{\text{Absorbance of test x concentration of standard}}{\text{Absorbance of standard x weight of sample}} \quad (10)$$

***Vitamin C*:** Vitamin C content was determined using the method of Wilson and Guillan (1969). The ground sample (1.0g) was weighed into a beaker and 10mL of 6% trichloroacetic acid was added, allowed to stand for 30 minutes and then filtered. One milliliter of the filtrate was pipetted into a separate test tube to serve as a blank. One milliliter of dinitrophenylhydrazine-thiourea-copper sulphate reagent (DTCS) was added to each of the test tubes, then caped, mixed and incubated in a water bath for 3 hours. The test tubes were removed from the water bath and cooled for 10 minutes in an ice bath. While mixing slowly, 2mL of 12M sulphuric acid was added to each of the test tubes. The absorbance was measured in a spectrophotometer (721D) at 520nm. The following expression was used to calculate the vitamin C content.

$$\text{Vitamin C } \left(\frac{\text{mg}}{\text{mL}}\right) = \frac{\text{Absorbance of test x concentration of standard}}{\text{Absorbance of standard x weight of sample}} \text{ x } 100 \quad (11)$$

Mineral elements content

***Preparation of sample solution*:** The sample was ashed using the method of (A.O.A.C., 2012). Two grams of the sample was ashed in a muffle furnace at a temperature of 550^{o}C and then cooled to room temperature. To the ash, 20mL of hydrochloric acid solution (1:1) was added and digested on a steam bath until the volume of the solution was reduced to about 10mL. This was transferred quantitatively into a 100mL volumetric flask and made to volume with distilled water. The sample solution was stored in clean plastic bottles for subsequent use. The solution was used for the determination of all the mineral elements.

***Determination of mineral elements*:** A diluted aliquot of the sample ash solution was used for the determination of sodium and potassium using Flame Emission Spectrophotometry whereas other elements such as calcium, magnesium, zinc, iron, manganese, copper,

nickel, chromium and cadmium were determined using an atomic absorption spectrophotometer (Pye Unicam, 929). Phosphorus content in the sample was estimated by colorimetric method as described by Ademoroti (1996).

Phytochemical analysis

Five grams of the ground sample of the flower of *X. xagittifolium* was macerated with 90% ethanol for 48hours at room temperature. The solution was filtered and concentrated at 40ºC in a water bath till the solvent was completely evaporated. The extract obtained after evaporation was qualitatively analyzed for alkaloids, cardiac glycosides, deoxy-sugars, terpenes, saponins and flavonoids using the methods described by Trease and Evans (1989) and Soforwora (1993).

Amino acid profile

Amino acid profile was determined using technicons sequential multisample analyzer (Benitez, 1989). This analysis was carried out in three stages, namely; defatting of the sample, hydrolysis of the sample, and loading of the hydrolysate into the technicon sequential multisample (TSM) amino acid analyzer. The sample was defatted using chloroform/methanol of ratio 2: 1. Four grams of the sample was put in an extraction thimble and extracted for 15 hours in a Soxhlet extractor. Two hundred milligrams of the defatted sample was weighed into a glass ampoule and 7mL of 6M HCl was added. Oxygen was expelled by passing nitrogen into the ampoule (this was to avoid possible oxidation of some amino acid for example, methionine and cystine in the sample during hydrolysis). The glass ampoule was the sealed with the Bunsen burner flame and put in an oven preset at 105ºC for 22 hours. The ampoule was allowed to cool before breaking open at the tip and the content was filtered to remove the humins. It should be noted that tryptophan was destroyed by 6M HCl during the hydrolysis. The filtrate was then evaporated to dryness in a hot air oven. The residue was dissolved with 5mL of acetate buffer (pH 2.0) and stored in a plastic specimen bottle which was kept in the freezer. The amount loaded was between 5-10 microliter. This was dispensed into the cartridge of the TSM analyzer (DNA 0209) and the analysis lasted for 76 minutes. The concentration of each amino acid in the sample was obtained by comparing the integrated area of its peak with that of the standard.

Statistical analysis

All the analyses were carried out in triplicate and the result of each parameter evaluated is presented as mean ± standard deviation. Student's t- test was used to determine the variations in the two samples. The level of significance was at $p < 0.05$.

3. RESULTS AND DISCUSSION

Nutrient content

A comparison of the nutritional composition of the flower of *X. sagittifolium* (yellow flesh cultivar) collected from two different environments in Akwa Ibom State is shown on tables 1 and 2. The results of the proximate analysis reveal that the Eket sample has the overall significant ($p < 0.05$) higher levels of ash, crude protein and carbohydrate than the sample from Essien Udim. The levels of lipid in both samples compare favorably. However, the sample from Essien Udim has significantly ($p < 0.05$) higher levels of moisture and fiber than the Eket sample. The differences found between the two samples may be due to different cultivation conditions or geographical location of these plants. The results also reveal that the sample from Eket has superior proximate composition compared to the one from Essien Udim.

The results of the elemental analysis reveal that the sample from Eket has superior mineral elements composition compared to the sample from Essien Udim. This may be due to the fact that the Eket sample is cultivated in a swampy area where there is outlet of industrial waste. Industrial waste dumps and outlets are usually accumulators of metallic elements (Cortez, 2014; Oti Wilberforce and Nwabue 2013;

Singh et al., 2010) depending on source. The results generally agree with the findings by FAO (1990) that the nutritional composition of a plant varies from place to place depending on the climate, soil, crop varieties and other factors. Also, the mineral elements contents are generally higher than those reported by Ukpong et al. (2014) for the flower of the white cultivar. It is interesting to note that the level of vitamin A in both samples are low but do not significantly differ. However, the sample from Essien Udim has a significant ($p < 0.05$) higher level of vitamin C than the sample from Eket. The differences may be due to genetic variation or geographical location of these plants.

Table 1: Proximate value (% dry matter, DM) of the flower of *X. saggitifolium* (yellow flesh cultivar) collected from two different environments in Akwa Ibom State

Sample location	Moisture (wet weight)	Ash	Crude fiber	Crude protein	Crude lipid	Carbohydrate	Calorific value (Kcal/100g)
Eket	91.86 ± 1.05	17.26 ± 0.24	3.11 ± 0.91	9.30 ± 0.25	9.98 ± 0.80	60.62 ± 1.25	368.43 ± 4.68
Essien Udim	95.35 ± 0.68	14.55 ± 0.17	10.81 ± 0.04	7.93 ± 0.20	9.56 ± 0.90	57.14 ± 0.19	346.37 ± 0.49

Mean ± SD of the three determinations

Table 2: Mineral elements and vitamins contents (mg/100g) of the flower of *X. sagittifolium* (yellow flesh cultivar) collected from two different environments in Akwa Ibom State

Sample location	Mineral elements						Vitamin contents		
	Na	K	Mg	Ca	P	Fe	Zn	Vit. A	Vit. C
Eket	98.19 ±0.04	109.05 ±0.16	64.13 ±0.50	304.67 ±13.32	36.78 ±0.57	3.62 ±0.07	2.73 ±0.01	0.77 ±0.13	18.46 ±0.98
Essien Udim	84.59 ±2.89	108.80 ±1.69	59.65 ±0.64	296.50 ±0.71	32.23 ±3.35	2.12 ±0.03	1.79 ±0.02	0.68 ±0.04	82.40 ± 6.61

Table 3: Anti-nutrient composition (mg/100g) of the flower of *X. sagittifolium* (yellow flesh cultivar) collected from two different environments in Akwa Ibom State

Sample location	Anti-nutrient composition (mg/100g)			
	Total oxalate	HCN	Phytic acid	Tannins
Eket	382.80±14.46	183.80±19.84	205.43±14.46	215.76±17.15
Essien Udim	243.47±5.08	31.31±2.96	454.39±2.01	2.79±0.19

Mean ± SD of the three determinations

Anti-nutrients

The results of the anti-nutrients levels in the flower of *X. sagittifolium* are shown on table 3.

Oxalates

The results obtained for oxalates in this study reveal that the sample from Eket has a significant ($p < 0.05\%$) higher level of oxalate than the sample from Essien Udim. The variations may be due to soil type, genetic variations, seasonal or environmental condition of the samples. The results for both samples are higher than 5.01mg/100g and 0.40mg/100g reported by Eddy et al.(2012) for the corms of *C. esculenta* and *X. sagittifolium*, respectively, and 234.71% reported by Lewu et al. (2009) for the leaves of *C. esculenta*. Although the levels of oxalate in these samples are below the

lethal dose of (2-5g) instant or cumulative intake, consumption of large amounts of oxalate rich foods may be risky. However processing for example, by boiling or drying can reduce oxalate toxic levels in a food (Dye, 1956). Therefore these samples should be properly processed by boiling or drying prior to human consumption.

Hydrocyanic Acid (HCN)

The result on the level of hydrocyanic acid in the Eket sample is significantly ($p < 0.05\%$) higher than the level of hydrocyanic acid in the sample from Essien Udim probably due to the differences in the time of harvest or geographical location of these plants. The levels of hydrocyanic acid in both samples are higher than 3.330mg/100g and 1.870mg/100g reported by Eddy et al. (2012) for the corms of *X. sagittifolium* and *C. esculenta*, respectively and also higher than 0.38% and 0.30% reported by Onyeka et al. (2010) for some popular vegetables such as the leaves of tread softly (*Cnidoscolus aconitifolius)* and fluted pumpkin (*Telferia occidentalis*) in the region. The lethal dose of HCN is 35% (Oke, 1969). The HCN content of food is usually reduced during processing and by heating. These samples should be properly cooked in order to reduce theHCN content before consumption.

Phytic acid

The level of phytic acid in the sample from Essien Udim is significantly ($p < 0.05\%$) higher than the level of phytic acid in the sample from Eket. According to Lewu et al. (2009), phytic acid level in plants may vary depending on the plants variety, climate conditions, locations, irrigation conditions, soil type and the growing season of the plants. However, the phytic acid levels in both samples are higher than 41.00% reported by Lewu et al. (2009) for the leaves of *C. esculenta,* 39.21% reported by Akpan and Umoh (2004) for the corm of *X. sagittifolium*, 0.18% and 0.75% reported by Onyeka et al. (2010) for the leaves of *C. aconitifolius* and *T. occidentalis*, respectively. Hence, these samples should be properly processed before consumption.

Tannins

Tannins level in the sample from Eket is significantly high compared to the level of tannins in the sample from Essien Udim probably due to natural variations caused by different growing conditions of these plants. However, the result for the sample from Essien Udim falls within the range of (1.43- 8.2%) reported by Yahaya et al. (2013) for the peels of *X. sagittifolium.* The values for both samples are higher than 0.24% and 0.36% reported by Onyekaet al. (2010) for the leaves of *C. aconitifolius* and *T. occidentalis* which are popular vegetables, but lower than 640.12mg/100g and 459.85µg/100g for the corms of *X. sagittifolium* and *C. esculenta*, respectively (Akpan and Umoh,2004). Tannins can easily coagulate proteins and render them unavailable to the body. The binding of protein is irreversible and this affects the digestibility of proteins. The high level of tannins implies more interference with protein utilization. It is however established that most of these anti-nutrients are eliminated during processing and cooking (Akpan and Antia ,2002; Akpan and Udoh, 2004; Akpan and Umoh, 2004).

Phytochemical analysis

The results of the phytochemical analysis of the flower of *X. sagittifolium* (yellow flesh cultivar) are presented on table 4. The phytochemical constituents of the flower extract are known to be responsible for its therapeutic properties. The results reveal that the flower of *X. sagittifolium* is rich in phytochemicals such as cardiac glycosides, alkaloids and deoxy-sugars. Saponnins, flavonoids and terpenes are present in trace amounts while phlobatannins and anthraquinones are absent.

Saponins although nontoxic, can generate adverse physiological responses in the human body. They exhibit cytotoxic effect and growth inhibition against a variety of cells making them to have anti-inflammatory and anticancer properties (Iwu, 1989). Saponins are useful in

medicinal and pharmaceutical industries due to their foaming ability for the manufacture of vaccines, insecticides and synthesis of steroidal hormones in the body. They have the ability to reduce cholesterol levels in man and animals (Okwuet al. 2004). The presence of saponins in this sample may be responsible for the use of the sample in the treatment of wounds and prevention of blood loss. Pure alkaloids and their synthetic derivatives have been used as anagelsic, antispasmodic and bactericidal agents (Okwuet al. 2004). Flavonoids have anti-bacterial, anti-inflammatory, anti-allergic, anti-mutagenic, anti-viral, anti-thrombotic and vasodilatory activities. They also have the ability to scavenge hydroxyl radicals, super oxide anions and lipids peroxy radicals (Okwu et al. 2004). The flower of *X. sagittifolium* is used in traditional medicine for the treatment of microbes-causing ailments. The anti-microbial activities of this flower could be due to the presence of alkaloids, flavonoids and glycoside. Takano and Gotok (2006) stated that the synthesis of prostaglandins (an inflammatory mediator) could be inhibited by flavonoids. This feature likely contributes to the anti-inflammatory effect of the flower of *X. sagittifolium.* Although cardiac glycosides are toxic, their derivatives such as dihydroouabain are used as diuretic and emetics, and in the treatment of diseases associated with the heart like cardiac failure (Trease and Evans, 1989). Terpenes fight against malaria and cancer. They are also known to promote the wound healing process mainly due to astringent, antioxidant and antimicrobial properties which seem to be responsible for wound contraction and increased rate of epithelisation (Pesin et al., 2009). Deoxy-sugars also found in this sample are important phytochemicals which may promote the medicinal value of this plant.

Table 4: Phytochemical analysis of the flower of *X. sagittifolium* (yellow flesh cultivar)collected from two different environments in Akwa Ibom State

Sample location	Phytochemicals							
	Phloba-tannins	Saponnins	Anthraquinone	Cardiac glycosides	Flavonoids	Alkaloids	Deoxy-sugars	Terpenes
Eket	–	+	–	+++	+	++	+++	++
Essien Udim	–	++	–	++	–	++	++	+

Key: +++ = Highly present; ++ = Moderately present;
+ = Present in trace amount; – = Absent or negligible amount

Amino acid profile

The result of the amino acid profile of the flower of *X. sagittifolium* (yellow flesh cultivar)is presented on table 5. The result reveals that the flower of *X. sagittifolium* (yellow flesh cultivar) contains 9.15g/100g protein which compares well with the value reported on table 1 for crude protein. The low values of methionine, cystine and the absence of tryptophan may be due to the fact that these amino acids are labile under the condition used for hydrolysis of the defatted sample. The flower of *X. sagittifolium* (yellow flesh cultivar) contains all the amino acids naturally present in proteins. The most limiting essential amino acids are methionine and cystine while glutamic acid is the most abundant amino acid. Although the values are low when compared with that of FAO/WHO (1985) provisional pattern, it does not mean that the flower of *X. sagittifolium* (yellow flesh cultivar) may not make an important contribution to the protein of a diet in many Nigerian communities which use mainly cereals, yam and cassava as their sources of carbohydrate.

Table 5: Amino acid profile (g/100g protein) of the flower of *X. sagittifolium* (yellow flesh cultivar, Eket sample)

Amino acid	Level
Lysine	0.41
Histidine	0.21
Arginine	0.42
Aspartic acid	1.26
Threonine	0.66
Serine	0.64
Glutamic acid	1.32
Proline	0.30
Glycine	0.63
Alanine	0.41
Cystine	0.03
Valine	0.54
Methionine	0.04
Isoleucine	0.39
Leucine	0.89
Tyrosine	0.31
Phenylalanine	0.70
Tryptophan	*
Total	9.15

Mean ± SD of the three determinations

* Tryptophan was destroyed in the sample during hydrolysis.

4. CONCLUSIONS

Chemical studies reveal that the flower of *X. sagittifolium* (yellow flesh cultivar) is rich in carbohydrate, protein, lipid as well as mineral elements and contains all the amino acids naturally present in proteins. Hence, it can be used as a vegetable supplement. Phytochemical analysis reveals the presence of compounds such as alkaloids, cardiac glycosides, deoxy-sugars, terpenes, saponins and flavonoids which are reported to have healing effect on wounds and in the treatment of certain diseases as well as exhibit antimicrobial and medicinal properties. Increased cultivation of the crop for easy availability of the flower is recommended.

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