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# PHYTOCHEMICAL, PROXIMATE AND MINERAL COMPOSITION OF AFRICAN BLACK NIGHTSHADE (*Solanum nigrum* L.) LEAF AND FRUIT

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**ABSTRACT**

This research was conducted on the phytochemical, proximate and mineral elements in *Solanum nigrum* L. leaf and fruit. The experiment was carried out at the laboratory of Federal College of Forestry, Jos, Plateau State. Qualitative and quantitative phytochemicals, proximate and mineral elements including phosphorus (P), sodium (Na), potassium (K), calcium (Ca), magnesium (Mg) and iron (Fe) were analyzed. Qualitative phytochemical result showed that alkaloids, saponins, tannins, flavonoids, cardiac glycosides, proteins, phenols, coumarins and terpenoids were present in the leaf and fruit extracts. Carbohydrate was present in the ethanol leaf and fruit extracts while phlobatanins and steroids were found to be absent. Anthraquinones was absent in the aqueous leaf extract while cardiac glycosides were absent in the aqueous fruit extract. Quantitative phytochemical showed flavonoid to have the highest value of 37.72 and 40.91, while tannins recorded to lowest value of 13.83 and 14.10 in leaf and fruit respectively. The proximate composition showed high protein in the leaf and fruit (36.63% and 38.71% respectively) while other parameters are 12.80% and 11.82% (total ash), 18.44% and 16.35% (carbohydrate), 2.38% and 2.50% (crude lipid), 28.14% and 23.89% (total moisture) for leaf and fruit extracts respectively. The energy value (Kcal/mol) was 193.34 for the leaf and 192.02 for the fruit extract. Mineral elements in the leaf are 60.49 mg/100 g of P, 52.48 mg/100 g K, 273.51 mg/100 g Mg, 5.28 mg/100 g Na, 16.44 mg/100 g Ca and 13.48 mg/100 g of Fe, while the fruit contained 51.39 mg/100 g P, 48.52 mg/100 g , 261 mg/100 g Mg, 5.51 mg/100 Na, 14.83 mg/100 g Ca and 11.42 mg/100 g Fe. The various phytochemicals, proximate and mineral elements constituents could justify the significant of using *Solanum nigrum* as a medicinal and nutritional plant.

**Keywords:** Black Nightshade, Phytochemical, Proximate, Mineral composition, *Solanum nigrum*

## Introduction

Before the advent of orthodox medicine, plants have been utilized as sources of medicine for either curative, prophylactic or suppressive purposes. These medicinal uses of plants are incurred either as direct usage or through the consumption of vegetables. One of such medicinal plants is Black Nightshade (*Solanum nigrum* L.). It is commonly called Glossy Nightshade or Black Nightshade, locally referred to as *Odu* in Yoruba (Kadiri and Olawoye, 2015). Black nightshade is a short-lived traditional leafy vegetable belonging to the family of *Solanaceae*. Plants of this family are well known for ethnomedicinal and dietary uses (Pinela *et al*., 2019; Pereira *et al*., 2021). It is a natural source of phytochemicals and nutrients which are essential for the well-being of individuals (Dharini *et al*., 2020). Black nightshade has a long history of medicinal usage, dating back to the ancient Greek and China (Miraj, 2016).

*S. nigrum* consists of phytonutrients that are in different parts of the plant which serve various medicinal functions. The plant is abundant in bioactive compounds, minerals and phytochemicals such as anthocyanins, flavonoids, tannins, vitamin C, vitamin E, iron, zinc, and selenium (Alam *et al*., 2022). Its abundant anthocyanin makes it a suitable antioxidative plant which arrests reactive oxygen and nitrogen species produced during acute liver toxicity (Li *et al*., 2021). These medicinal properties have been attributed to the various secondary metabolites in the plant (Vásquez-Espinal *et al*., 2019). The plant has also been reported for its antimicrobial, cytotoxic and anti-cancer properties (Javedi *et al*., 2022).

The leaves and fruit of *S. nigrum* is consumed in the Southern part of Nigeria as a source of

nutrient. It has been reported to contain certain vital minerals such as phosphorus, iron and calcium (Javedi *et al*., 2022). Considering the numerous bioactivities reported on this plant, this work focused on the phytochemicals, proximate and the mineral elements in the leaf and seed of *S. nigrum*.

## MATERIALS AND METHODS.

### Plant Materials

The leaves and fruits of *S. nigrum* L. were obtained from Sherri Hills, Jos South Local Government Area of Plateau State. The samples were taken to the herbarium of Forestry Research Institute of Nigeria, Federal College of Forestry, Jos Branch for identification and voucher specimens were deposited at the herbarium of the institute.

### Preparation and Extraction of Plant Materials

The plant samples were rinsed under running tap water and air-dried. The dried samples were pulverized using electric blender (ModelBLG-452). Exactly 100 g of pulverized samples were percolated in 200 mL of ethanol and water for 24 hours and then filtered using Whatman No.1 filter paper. The filtrates were concentrated in a rotary evaporator (Model: RE-52A) at 40$^{o}$C and aqueous extract placed in water bath (HH-420 PEC).

### Qualitative Phytochemical Analysis

Determination of phytochemical was carried out using methods of Sofowora (1983) and Trease and Evans (1989). Phytochemical analysis carried out on the samples include alkaloids, flavonoids, tannins, terpenoids, coumarins, proteins, saponins, cardiac glycosides, phenols, carbohydrates, anthraquinones, phlobatanins and steroids.

### Quantitative Phytochemical Analysis

### Determination of Alkaloids

Quantitative alkaloid was carried out using the method of Harborne (1973) with little modifications. About 1 g of each sample was weighed and suspended in a 200 mL 10% acetic acid in ethanol and kept at room temperature for 4 hours. The content was then filtered and then concentrated on a water bath to ¼ of its volume after which concentrated aqueous $NH_4OH$ was added drop wise to obtain precipitates. The precipitate was then washed with 1% ammonia and then dried in a oven at 80$^{o}$C. the content was then weighed and the amount of alkaloid calculated in mg/g.

### Estimation of Total Tannins

The method of Swain (1979) with some modifications was employed in the determination of the amount of tannins in each of the samples. Briefly, 1 g of each of the sample was weighed and placed in a beaker, with the addition n of 20 mL of 50% ethanol, covered with paraffin and placed in a water bath at 80$^{o}$C with continuous stirring. The content was filtered (Whatman No. 1 filter paper) and then 1 mL of the filtrate was taken and 20 mL of distilled water, 2..5 mL of folin-Denis reagent and 10 mL of 17% Na2CO3 were added and allowed to stand for like 10 minutes. The sample was then taken to a spectrophotometer to take the absorbance at 760 nm wavelength. A standard curve was prepared and the amount of tannins in the sample was extrapolated from the standard curve.

### Determination of Total Saponins

The method of Brunner (1984) was used in the determination of quantitative saponin with little modification. 1 g each of the leaf and seed pulverized samples were weighed into clean beakers and 100 mL isobutyl alcohol was added with the mixture stirred on a magnetic stirrer for 5 hrs. Saturated solution of 20 mL of 40% magnesium carbonate was then added after which, 2 mL of 5% $FeCl_3$ and 50 mL distilled water were added. The samples were kept for about 30 minutes and a red colouration development was observed. A standard saponin solution, and then curve (mg/g) sample was prepared and the absorbance of the sample read using spectrophotometer at 380 nm wavelength with the result extrapolated from the standard curve.

### Determination of Total Flavonoids

The method described by Chang *et al*. (2002) was employed in the determination of total flavonoids in the leaf and seed sample. Exactly 1 g of each sample was weighed into beaker after which 1.5 mL ethanol, 0.1 mL of 10% aluminium chloride, 0.1 mL of 1 M $CH_3COOK$ and 2.8 mL of distilled water were added to each sample. The samples were kept under normal room temperature for 30 minutes after which the absorbance was taken at 416 nm wavelength. A standard quercetin, ranging from 0.2 mg – 1 mg was prepared and the concentration of flavonoids was extrapolated from the quercetin curve (mg/g).

### Determination of Total Phenols

The method described by Hagerman *et al*. (2000) was used in the determination of total phenols in the sample. Exactly 0.1 g of the leaf and seed samples were weighed into beakers and 100 mL of distilled water was added. The content was thoroughly mixed and 1 mL measured into a test tube. About 0.5 mL of 2N folin Ciocalteu reagent, 1.5 mL of 20% sodium carbonate were added and

the volume made up to 8 mL by the addition of distilled water. The content was mixed through vigorous shaking and left for 2 hours before taking the absorbance at 765 nm wavelength. A standard curve of gallic acid was prepared and used for the calibration of the total flavonoid content in the sample through extrapolation.

**Proximate Analysis**

The method of Association of Official Analytical Chemists, AOAC (1990) was employed in the analysis of proximate composition. The samples were analyzed for crude protein, crude lipid, total moisture content, total ash, carbohydrates, fibre in their percentage forms. The total energy value was calculated using the method of Greenfield and Southgate (1992).

**Determination of Mineral Composition**

Mineral elements analyzed include P, K, Mg, Na, Fe and Ca. Phosphorus concentration was analyzed using Technicon Auto-analyzer (Model: AA2), while concentrations of Na, P, K, Ca, Mg and Fe were carried out using flame atomic absorption spectrophotometer (Model: 222-2000 20D).

Determination of mineral element was carried out using the methods of Krisl *et al*. (2002). Briefly, 1 g of sample was weighed and placed into an acid-washed glass Erlenmeyer flask (125 mL capacity), 10 mL of concentrated nitric acid was added, then samples were placed in a steam bath and digested at 100°C until dry. Subsequently, 5 mL of perchloric acid was added and a glass funnel placed on top and heated until mineralization was completed. Samples were then transferred to acid-washed 100 ml volumetrics and diluted. Ca and Mg were further diluted with 1.0 % lanthanum oxide. Serial dilutions were required to bring the samples into the linear working range of the spectrophotometer for each element. Sample concentrations of each element were determined by comparing absorbency to a standard linear regression curve containing a minimum of five standard points for each element. Concentrations were corrected for sample dilution and normalized to sample weight.

**Proximate Analysis**

The method of AOAC (1990) was employed in the analysis of proximate composition. The samples were analyzed for crude protein, lipid, moisture content, ash, carbohydrates and fibre in their percentage forms. The energy value was calculated using Greenfield and Southgate (1992).

*Energy Value (Kcal/100g) = (2.62 x % protein) + (8.37 x % fat) + (4.2 x % carbohydrate)*….Equation (1) (Greenfield and Southgate, 1992)

**Determination of Mineral Composition**

Mineral elements analyzed include P, K, Mg, Na, Fe and Ca. P concentration was done using Technicon Auto-analyzer (Model: AA2), while Na, P, K, Ca, Mg and Fe were performed using flame atomic absorption spectrophotometer (Model: 222-2000 20D).

**Statistical Analysis**

Data obtained were subjected to statistical analysis using SPSS, Version 23. The data were subjected to One Way ANOVA using completely randomized design (CRD). Results were expressed as mean (±) S.D of three replicates. Data were taken to be significant at $p \leq 0.05$.

## RESULTS AND DISCUSSIONS

**Qualitative Phytochemical Analysis**

Phytochemical analysis showed the presence of alkaloids, flavonoids, tannins and coumarins in the leaf and fruit (Table 1). Carbohydrates was found to be present in the ethanol extract of leaf and fruit, while phlobatannins and steroids were found to be absent in the two solvent extract samples. Anthraquinones was present in the two solvent extracts except in the aqueous extract of the leaf. Phenolics, protein and terpenoids were found to be present in all the solvent extracts while coumarins was sparingly present in the two solvent extract of both the leaf and fruit samples.

**Quantitative Phytochemical Analysis**

Quantitative phytochemical result that the leaf sample contained alkaloids (23.64±0.12), flavonoids (37.72±0.18), phenols (30.20±0.35), saponins (17.61±0.04) and tannins (13.83±0.21), while the fruit sample contained alkaloids (21.50±0.51), flavonoids (40.91±0.03), phenols (26.23±0.77), saponins (15.36±0.13) and tannins (14.10±0.17) (Table 2). The result showed that leaf sample has more concentration of alkaloids, phenol, and saponins than the fruit, while the fruit contained more flavonoids and tannins than the leaf.

**Proximate Composition**

Proximate composition result is displayed in Table 3. The result showed that the leaf contained high protein (36.63 %), fibre (28.14 %) and carbohydrate (18.44 %). Total ash and moisture content were found to be moderate at 12.80 % total ash and 9.87 % moisture respectively. The leaf, however, contained low percentage of fat (2.38 %) while its total energy value occurred at

193.34 Kcal/100 g of sample. The fruit contained higher protein (38.71%), fibre (23.89 %) and carbohydrate (16.53 %). Total ash and moisture content were moderately present (11.82 % carbohydrate and 11.63 % moisture content) while fat was only 2.53 % in the fruit sample. The total energy value in the fruit stands at 192.02 Kcal/100 g of sample.

**Mineral Composition of the Leaf and Fruit of *S. nigrum* L. Extracts**

The mineral composition of the leaf and fruit extracts of is displayed in Figure 1. The leaf contained 60.49±0.72 mg of P, 52.48±0.58 K, 273.51±7.09 Mg, 5.28±0.20 of Na, 16.44±0.31 of Ca and 13.48±0.12 of Fe. In the fruit extract, 51.39±0.46 mg of P, 48.52±0.48 mg of K, 261.71±0.37 mg of Mg, 5.51±0.09 mg of Na, 14.83±0.28 mg of Ca and 11.42±0.33 mg of Fe were present.

## DISCUSSION

Plants have been used as sources of medicines for the of different diseases many years back (Bhat, 2021). *Solanaceae* family have been reported to contain important phytochemicals such as alkaloids, tannins, steroids and saponins (Amadi *et al*., 2010). In Nigeria, different parts of *S. nigrum* L. such as leaf, root, fruit, seed have been used for either prevention or treatment of various diseases. The presence of certain phytochemicals in the leaf and fruit of the plant must have been responsible for its pharmacological functions. Tannins, cardiac glycosides and flavonoids are abundant in the fruit, while saponin and phenol are abundant in the leaf. This result is similar to the result of Sambo *et al*. (2016) in which phytochemicals such as alkaloids, tannins, saponins, flavonoids and cardiac glycosides are present in the leaf of *Solanum incanum*, belonging to the family of *Solanaceae*.

High amount of protein and crude fibre in the leaf and fruit extracts makes the plant a good source of nutrients, hence, this confirms its reported usage as a nutritional edible plant (Ravi *et al*., 2009). This result is similar to the reported protein and ash content of *S. nigrum* by Afolayan and Bvenura (2016) in which 42.81% and 9.45% protein and ash were present and 36.63% and 12.80% were obtained in the leaf extract. High fibre in the leaf and fruit extracts depicts its good nutritional value. Consumption of foods rich in crude fibre increases the rate of bowel movement and therefore reduces constipation. High crude fibre in foods have been linked to possible alleviation of certain diseases like coronary artery diseases, diabetes, high blood pressure and obesity (Ionita-Mîndrican *et al*., 2022). The low moisture content in the fruit and leaf shows possible low susceptibility to bacterial and fungal attack as well as prolonged shelf-life. High moisture content creates enabling environment for bacteria and fungi to strive and also stimulates fermentation, thereby causing food spoilage (Bamidele *et al*., 2022). The result of the crude fat shows low-fat content in the leaf and fruit extracts. Fats are important biological biomolecules as they serve as stored forms of energy for the cell. They also perform important biological functions such as shock absorption and also as a component of cell membrane. However, high lipid, especially in the form of glycerol and saturated fatty acids could cause cardiovascular diseases (Li *et al*., 2022). The results of fibre, moisture content and total lipid can be compared to that of Gqaza *et al*. (2013) in which the proximate composition of leaf extract of *S. nigrum* were 26.9% fibre, 6.6% moisture and 1.8% fat which were lower than 28.4%, 8.74% and 2.8% fibre, moisture and crude fat in the leaf extract of this work.

The result of the mineral elements in the leaf and fruit of *S. nigrum* L. shows that the plant is substantially rich as a good nutritional supplement. All mineral elements analyzed were present in the leaf and fruit. Phosphorus is needed for the production of ATP, maintenance of acid-base balance in the blood and urine (Soetan *et al*., 2010). Sodium is essential for proper regulation of the electrolytes and fluid in the body. It is also necessary for the proper functioning of the nerves and muscles (Constantin and Alexandru, 2011).

## CONCLUSION

*S. nigrum* L. is an important wild plant domesticated because of its nutritional components. The plant is abundant in phytochemicals like alkaloids, flavonoids, tannins, and saponins. Its proximate composition shows high protein and fibre and low moisture content. It has abundant minerals to alleviate some diseases and could help in the proper functioning of the biological system. All these justifies the use of the plant for herbal medicine as well as its consumption as food.

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**Table 1:** Phytochemical Analysis of *S. nigrum* L. (African Black Nightshade)

| **Phytochemicals** | **Leaf Extracts** | | **Seed Extracts** | |
|---|---|---|---|---|
| | Ethanol | Aqueous | Ethanol | Aqueous |
| Alkaloids | +++ | ++ | + | ++ |
| Tannins | + | - | ++ | + |
| Saponins | ++ | ++ | + | + |
| Flavonoids | + | + | ++ | ++ |
| Carbohydrates | + | - | + | - |
| Anthraquinones | + | - | + | + |
| Cardiac Glycosides | + | + | ++ | - |
| Phlobatanins | - | - | - | - |
| Phenolics | ++ | +++ | + | + |
| Protein | ++ | + | ++ | + |
| Coumarins | + | + | + | + |
| Steroids | - | - | - | - |
| Terpenoids | + | + | + | + |

+ = sparingly present, ++ = moderately present, +++ = highly present

**Table 2:** Quantitative Phytochemicals of Leaf and Fruit of *Solanum nigrum* L.

| **Quantitative Phytochemicals** | **Leaf** | **Fruit** |
|---|---|---|
| Alkaloids | 23.64±0.12 | 21.50±0.51 |
| Flavonoids | 37.72±0.18 | 40.91±0.03 |
| Phenols | 30.20±0.35 | 26.23±0.77 |
| Saponins | 17.61±0.04 | 15.36±0.13 |
| Tannins | 13.83±0.21 | 14.10±0.17 |

Values are presented as mean (±) standard deviation of three (3) replicates

**Table 3:** Proximate Composition of Leaf and Fruit of *Solanum nigrum* L.

| **Proximate** | **Leaf** | **Fruit** |
|---|---|---|
| Total Ash % | 12.80±0.12 | 11.82±0.09 |
| Carbohydrate % | 18.44±0.35 | 16.53±0.02 |
| Fat % | 2.38±0.13 | 2.53±0.06 |
| Fibre % | 28.14±0.06 | 23.89±0.37 |
| Moisture Content % | 9.87±0.14 | 11.63±0.04 |
| Total Protein % | 36.63±0.67 | 38.71±0.73 |
| Energy Value (Kcal/100g) | 193.34±3.38 | 192.02±1.26 |

Values are presented as mean (±) standard deviation of three (3) replicates

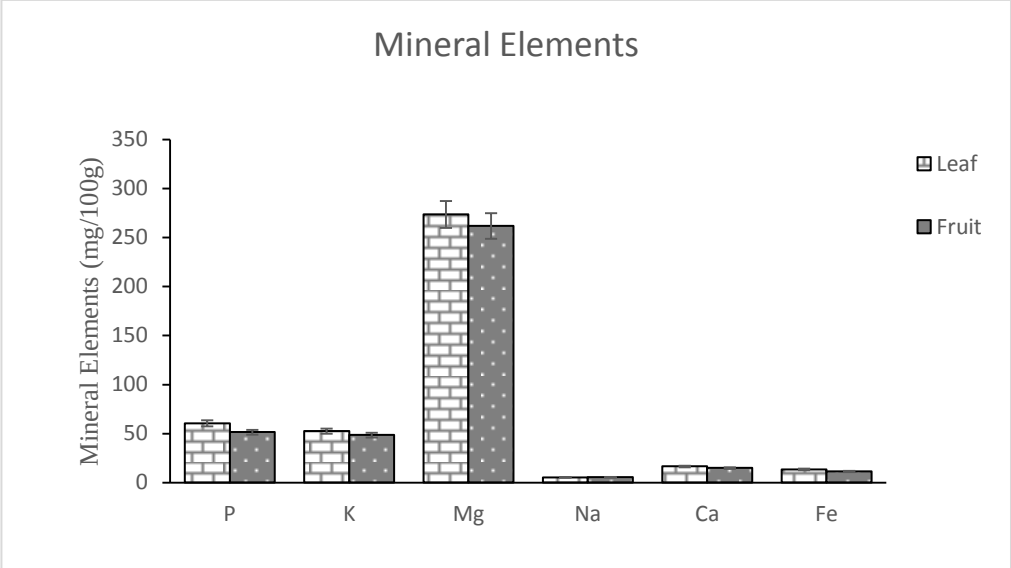


**Figure 1:** Composition of Mineral Element in the leaf and Fruit of *Solanum nigrum* L.