

Chemical Composition and Physicochemical Characteristics of *Thevetia peruviana* Seed Flour and Protein Concentrate

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Abstract

In the present study, the proximate analysis, mineral contents, amino acids and functional properties of *Thevetia peruviana* (*T. peruviana*) flour and protein concentrate were investigated. The ash, moisture, protein, fat, fiber and carbon contents of *T. peruviana* flour were observed to be 2.24%, 2.94%, 7.44%, 57.05%, 22.37% and 7.76%, respectively while 1.88%, 4.62%, 19.25%, 50.86%, 6.29% and 17.10%, respectively were recorded for the ash, moisture, protein, fat, fiber and carbon contents of the protein concentrate. Mineral analysis revealed the presence of Na, K, Mg, Fe, Mn, Cu, Pb and Zn. Lysine, histidine, arginine, aspartic acid, threonine, serine, glutamic acid, proline, glycine, alanine, cystine, valine, methionine, isoleucine, leucine, tyrosine, and phenylalanine, the highest proportion been glutamic acid (152.6 mg/g in the flour and 139.8 mg/g in the protein concentrate). The saponification value, acid value, iodine value and peroxide value of the oil are 182.20 mg KOH/g of oil, 0.85, 82.00 and 14.82 meq at active, respectively. Therefore, *T. peruviana* seeds and oil have greater potentials in medicine and as industrial raw materials.

Keywords: *Thevetia peruviana*, proximate analysis, mineral contents, amino acids, protein concentrate, functional properties

Introduction

Thevetia peruviana (*T. peruviana*) also known as milk bush, lucky nut or yellow oleander, is a small perennial green plant. It is a dicotyledonous shrub and belongs to the family *Apocynaceae*. It is commonly found in the tropics and sub-tropics regions of the world, native to Central and South America [Usman et al., 2009]. *T. peruviana* has been grown for many years as an ornamental plant in Nigeria with no economic value [Usman et al., 2009, Adebowale et al., 2012] *T. peruviana* seeds, leaves, fruit and roots are used in traditional medicine. The plant is not edible due to its ability to produce cardiac glycosides (neriifolin and peruvoside). The plant contains glycosides of neriifolin, acetyl neriifolin and thevetin, it is toxic and

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consumption of the plant has been reported in severe cardiac toxicity [Basumatary, 2015]. Ingestion of *T. peruviana* results in abdominal pain, vomiting, nausea, diarrhea, etc. Adults and children have reportedly died after consuming *T. peruviana* leaves in herbal teas [Haynes et al., 1985]. The seed of *T. peruviana* is rich in oil content (60-65%) and the cake comprises of 30-37% protein [Usman et al., 2009]. Ibiyemi et al., investigated the physicochemical properties of *T. peruviana* seed oil from three geographical locations. Parameters investigated include free fatty acid, oil yield, saponification value, unsaponifiable matter, iodine value, peroxide value, refractive index, specific gravity and viscosity (centripose). Likewise, Oluwaniyi et al., 2007 established the amino acid composition of *T. peruviana* seed cake. Several authors have also evaluated the biodiesel yielding potential of *T. peruviana* seeds [Oluwaniyi et al., 2007, Deka and Basumatary, 2011, Ana and Udofia, 2015]. The use of *T. peruviana* in biological pest control, medicine and pharmacology has been reported [Kishan et al., 2012]

Therefore, for the purpose of getting industrial utilization of *T. peruviana*, this research is aimed at carrying out detailed physicochemical characterization of *T. peruviana* flour and protein concentrate viz. proximate analysis, mineral contents, amino acids and the functional properties.

Experimental

Collection and Preparation of Sample

The mature seeds of *T. peruviana* were harvested from shrubs in Oke Ila Street, Ado Ekiti and identified at the Herbarium of the Department of Plant Science and Biotechnology, Federal University Oye, Oye Ekiti. Ekiti State, Nigeria, A voucher specimen was deposited at the Departmental Herbarium.

The seeds were screened to remove bad ones and stones. Boiling water was added to the good seeds and left until the water cooled to room temperature. The seeds were manually dehulled dried in the oven at 45 °C and dry milled to fine powder. The powdered samples were stored in polythene bag and kept in the refrigerator at 4°C until used.

The seed oils were extracted in soxhlets apparatus using N-Hexane as the extractant. Solvent was removed under reduced pressure at 30°C

Chemical Analysis

The legume flours and protein concentrates were analysed for crude protein, crude fiber, fat and ash according to AOAC, while the protein concentrate

was prepared by the method described by Akintayo et al., 2000. The metal contents sodium and potassium were determined using the EEL flame photometer. Magnesium, iron, zinc, copper, manganese and lead were determined using Perkin Elmer 230 Atomic absorption spectrophotometer. According to established analytical methods.

The amino acids were determined by the method reported by Adeyeye et al., 2008 and the functional properties of *T. peruviana* flour were determined using the methods described by Association of Official Analytical Chemist (AOAC).

Results and Discussions

The results of the proximate analysis of *T. peruviana* Flour and Protein Concentrate are presented in table 1. The ash, moisture, protein, fat, fiber and carbon contents of *T. peruviana* Flour were recorded to be 2.24, 2.94, 7.44, 57.05, 22.37 and 7.76, respectively. The protein concentrate were 1.88, 4.62, 19.25, 50.86, 6.29 and 17.10, respectively.

Table 1: Proximate analysis of *T. peruviana* Flour and Protein Concentrate

| | Flour (%) | Protein Concentrate (%) |
|------------------|-----------|-------------------------|
| Ash content | 2.24 | 1.88 |
| Moisture content | 2.94 | 4.62 |
| Protein | 7.44 | 19.25 |
| Fat | 57.05 | 50.86 |
| Fiber | 22.37 | 6.29 |
| Carbon | 7.76 | 17.10 |

The ash content signifies the mineral content in food, thus, the flour and protein concentrate with the ash content of 2.24% and 1.88%, respectively is an indication of the abundance of minerals in *T. peruviana*. The ash content also shows that the flour contains more minerals than the protein concentrate, this is evident in the result obtained on the mineral content of *T. peruviana* Flour and Protein Concentrate (table 2).

The moisture, protein, and carbon contents of the protein concentrate are higher than for the flour, whereas, the fat and fiber contents of the flour are higher. Moisture content is an index of the water activity of foods [Siyabola et al., 2013].

Table 2: Mineral content of *T. peruviana* Flour and Protein Concentrate

| | Flour (mg/100g sample) | Protein Concentrate (mg/100g sample) |
|----|-------------------------------|---|
| Na | 20.00 | 29.18 |
| K | 278.01 | 91.34 |
| Mg | 234.30 | 213.71 |
| Fe | 0.65 | 3.77 |
| Mn | 0.41 | 0.99 |
| Cu | 0.87 | 4.79 |
| Pb | ND | 0.50 |
| Zn | 0.06 | 0.16 |

ND - not detected

The results of the elemental compositions of the *T. peruviana* Flour and Protein Concentrate are given in table 2. From the result obtained for the mineral contents analysis, *T. peruviana* Flour and Protein Concentrate showed detectable levels of Na, K, Mg, Fe, Mn, Cu, Pb and Zn. Na, K and Mg were the predominant elements in the Flour and Protein Concentrate (fig. 1). This is supported by the work reported by Olatunji et al. 2011. The concentration of K was the highest (278.01mg/100g) in the flour while Mg was the highest (213.71mg/100g) in the protein concentrate. The results showed that the concentrations of Fe, Mn, Cu, Pb and Zn in the protein concentrate exceeded the WHO permissible limit (0.10 mg/L for Zn, 1.50 mg/L for Cu, 0.01 mg/L for Pb, in drinking water). Pb was not detected in the *T. peruviana* Flour. The presence of Fe, Mn, Cu, Pb and Zn makes the plant unsafe for consumption. However, these microelements are essential for plant growth.

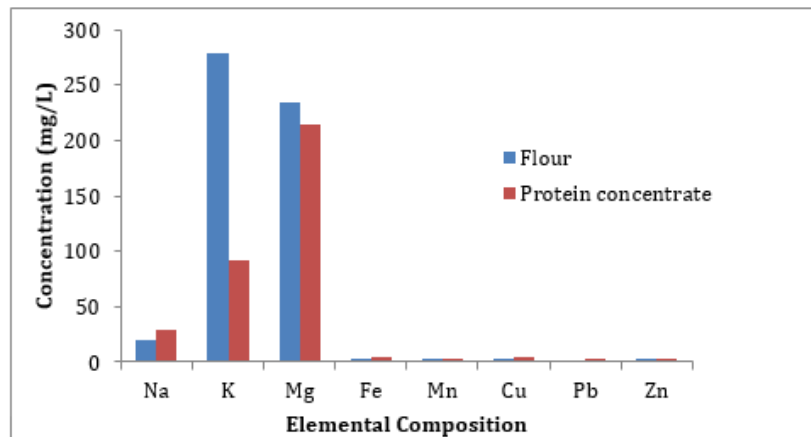


Fig. 1: Bar chart representation of the elemental compositions of the *T. peruviana* flour and protein concentrate.

The amino acid contents of *T. peruviana* flour and protein concentrate were given in table 3 while figure 2 represent a graphical representation of the data. The result of amino acid investigation showed that glutamic acid (152.6 mg/g in the flour and 139.8 mg/g present in the protein concentrate) is highest in *T. peruviana* flour and protein concentrate. This is followed by aspartic acid (100.3 mg/g in the flour and 93.2 mg/g present in the protein concentrate), whereas, the least is methionine, being 12.2 mg/g in the flour and 11.7 mg/g present in the protein concentrate. Cystine is also present at 11.7 mg/g level. The amino acid contents obtained are all higher than those reported for raw cake, acid treated and ethanol treated *T. peruviana* seed cake by Oluwaniyi et al. 2007.

Table 3: Amino Acids of *T. peruviana* Flour and Protein Concentrate

| | Conc. (mg/100g protein) | Conc. (mg/100g protein) |
|---------------|-------------------------|-------------------------|
| Lycine | 32.1 | 41.0 |
| Histidine | 26.9 | 30.0 |
| Arginine | 57.7 | 59.4 |
| Aspartic acid | 100.3 | 93.2 |
| Threonine | 40.4 | 38.4 |
| Serine | 33.6 | 36.8 |
| Glutamic acid | 152.6 | 139.8 |
| Proline | 31.7 | 32.8 |
| Glycine | 49.4 | 41.4 |
| Alanine | 36.2 | 33.5 |
| Cystine | 13.0 | 11.7 |
| Valine | 35.3 | 37.0 |
| Methionine | 12.2 | 11.7 |
| Isoleucine | 38.3 | 31.5 |
| Leucine | 69.5 | 82.3 |
| Tyrosine | 28.9 | 25.7 |
| Phenylalanine | 47.2 | 40.0 |

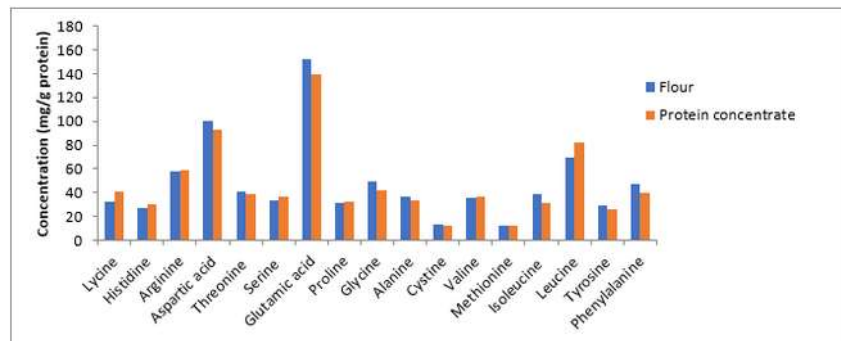


Fig. 2: Bar chart representation of the amino acids composition of *T. peruviana* flour and protein concentrate.

The use of oils for diet and oleochemicals depends on the oils physicochemical properties such as the acid value, saponification value, iodine value, etc [Usman et al., 2009]. The saponification value, acid value, iodine value, peroxide value, etc favour the use of *T. peruviana* seed oil for the production of oleochemicals.

The physicochemical and functional properties of *T. peruviana* oil and flour were presented in table 4. The saponification value (182.20 mg KOH/g of oil) and peroxide value (14.82 meg at active) are higher than for the reported *T. peruviana* seed oil by Ibiyemi et al. (2002). Saponification value is an indication of the amount of fatty saponifiable material in oil or fat. The iodine value is same as the *T. peruviana* seed oil reported by Ibiyemi et al. (2002). The iodine value of 82.00 indicates that the *T. peruviana* oil is semi drying oil. Acid value is used as an indication of the condition and edibility of oil. In the present study, 0.85 was obtained as the acid value of the *T. peruviana* oil. The water absorption, oil absorption, bulk density, swelling power, and % solubility of *T. peruviana* obtained in this study are 264.46, 290.64, 0.37, 4.96 and 45.00, respectively.

Table 4: Physicochemical and Functional Properties of *T. peruviana* Oil and Flour

| | |
|----------------------|------------------------|
| Saponification value | 182.20 mg KOH/g of oil |
| Acid value | 0.85 |
| Iodine value | 82.00 |
| Peroxide value | 14.82 meg at active |
| Water abs | 264.46 |
| Oil abs | 290.64 |
| Bulk density | 0.37 |
| Swelling power | 4.96 |
| % solubility | 45.00 |

The solubility test showed that the solubility of *T. peruviana* flour and protein concentrate increases with temperature as shown in table 5 and figure 3.

Table 5: Effect of Temperature on Solubility of *T. peruviana* Flour and Protein Concentrates

| Temp (°C) | % solubility of flour | % Solubility Protein concentrate |
|------------------|------------------------------|---|
| 60 | 2.43 | 7.20 |
| 70 | 2.90 | 7.30 |
| 80 | 6.80 | 12.00 |
| 90 | 8.20 | 14.00 |

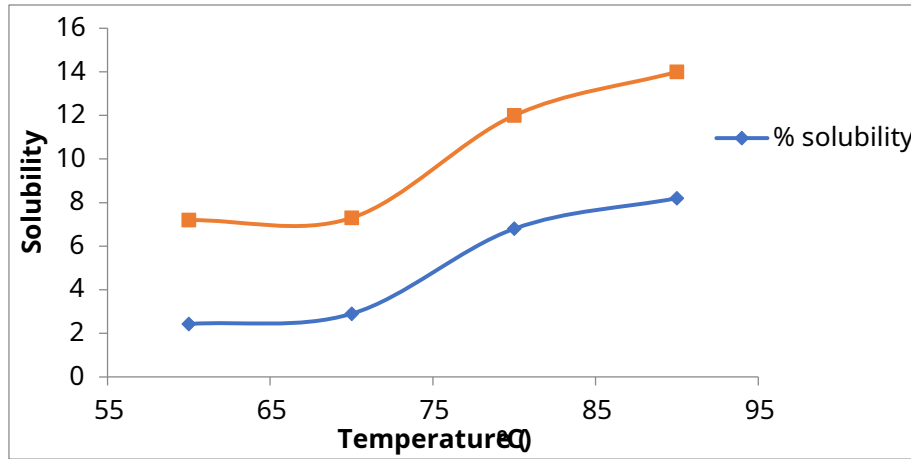


Fig. 3: Graphical representation of the effect of temperature on solubility.

Furthermore, as the temperature increases the water absorption capacity and swelling properties of *T. peruviana* protein concentrate increase (table 6 and figure 4).

Table 6: Effect of Temperature on Water Absorption and Swelling

| Temp (°C) | Water absorption (g/g) | Swelling (%) |
|-----------|------------------------|--------------|
| 60 | 2.84 | 84.21 |
| 70 | 2.92 | 89.08 |
| 80 | 4.68 | 169.24 |
| 90 | 5.16 | 172.48 |

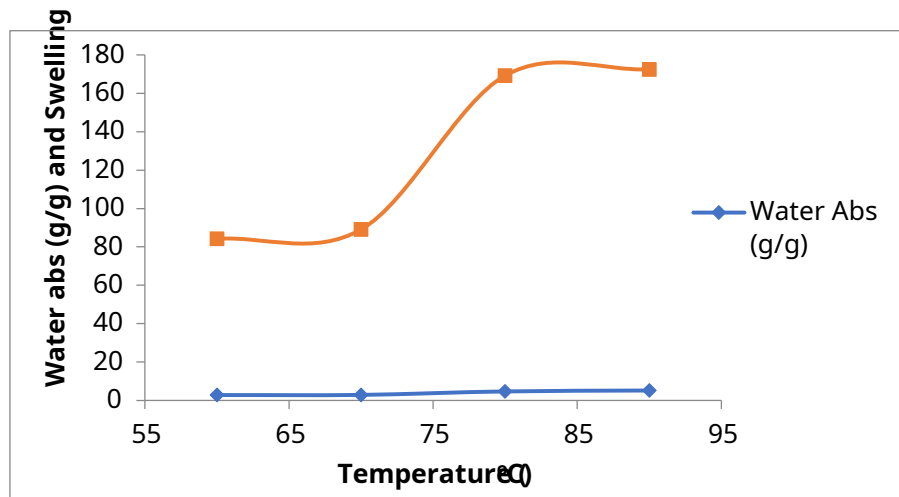


Fig. 4: Graphical presentation of the effect of temperature on swelling.

Conclusion

T. peruviana is an ornamental plant. The plant's parts contain milky juice which is poisonous. It is toxic due to the presence of cardiac glycosides. Although it is used ethno-medically in treating the external wounds, infected area, ring worms, tumours etc., the use of grinded leaves of *T. peruviana* in ethno-veterinary medicine is the evidence for its plenteous use for healing of wounds. The physicochemical characterization of *T. peruviana* flour and protein concentrate demonstrates that the seeds could be useful in non edible industrial applications. Although, the results showed that all the essential amino acids required in human and animal diet were present, overall analysis suggests that the *T. peruviana* seeds have greater potentials as industrial raw materials and medicinal plant than to be consumed as foods.

Notes

- Adebowale, K.O., Adewuyi, A. & Ajulo, K.D. (2012). Examination of fuel properties of the methyl esters of *Thevetia peruviana* seed oil. *International Journal of Green Energy*, 9: 297-307.
- Adeyeye, E.I., Adubiaro, H.O. & Awodola, O.J. (2008). Comparability of Chemical Composition and Functional Properties of Shell and flesh of *Penaeus notabilis*. *Pakistan Journal of Nutrition* 7(6): 741-747.
- Akintayo, C.O., Akpambang, V.O. & Olaofe, O. (2000). A comparative study on the functional properties of some Nigerian under-utilised legume flours and protein concentrate. *The Journal of Technoscience* vol 4: 44-48.
- Ana Godson R. E. E. & Udofia Bassey G. (2015). Characterization of oil and biodiesel produced from *Thevetia peruviana* (yellow oleander) seeds. *Int. J. Sust. Green Energy*, 4(4): 150-158.
- AOCS. (1997). *Sampling and analysis of commercial fats and oils*, American Oil Chemists Society Official Methods. AOCS Press, Champaign, Illinois, USA.
- Basumatary, S. (2015). Yellow Oleander (*Thevetia peruviana*) Seed oil biodiesel as an alternative and renewable fuel for diesel engines: A review. *International Journal of ChemTech Research*, 7(6): 2823-2840.
- Deka, D.C. & Basumatary, S. (2011). High quality biodiesel from yellow oleander (*Thevetia peruviana*) seed oil. *Biomass Bioenergy*, 35: 1797-1803.
- Haynes, B.E., Bessen, H.A. & Wrightman, W.D. (1985). Oleander tea: Herbal draught of death. *Ann. Emerg. Med.*, 14: 350-353.
- Ibiyemi, S.A., Fadipe, V.O., Akinremi, O.O. & Bako, S.S. (2002). Variation in oil composition of *Thevetia peruviana* Juss (Yellow Oleander) fruits seeds. *J. Appl. Sci. Environ. Mgt.*, 6(2): 61-65.
- Kishan, S., Kumar, A.K., Vimlesh, M., Mubeen, U.S. & Alok, S. (2012). A review on: *Thevetia peruviana*. *International Research Journal of Pharmacy*, 3(4): 74-77.

- Olatunji, O.M., Akor, A.J. & Akintayo, C.O. (2011). Analysis of some physio-chemical properties of milk bush (*Thevetia peruviana*) seeds. *Research Journal of Applied Sciences, Engineering and Technology*, 3(2): 84-87.
- Oluwaniyi, O.O., Ibiyemi, S.A. & Usman, L.A. (2007). Effect of detoxification on the nutrient content of *Thevetia peruviana* seed cake. *Res. J. Appl. Sci.*, 2(2): 188-191.
- Siyanbola, T. O., James O. O., Eromosele C. O., Akinsiku A. A., Nwinyi O. C., Edobor-Osoh A., Enebe A. O., Anake W. U. & Falomo, A. A. (2013). Physicochemical analysis, phytochemical screening and antimicrobial activities of some vegetable oils from Ogun State, Nigeria. *International Journal of Current Research*, 5(4): 992-997.
- Usman, L.A., Oluwaniyi, O.O., Ibiyemi, S.A., Muhammad, N.O. & Ameen, O. (2009). The potential of Oleander (*Thevetia peruviana*) in African agricultural and industrial development: A case study of Nigeria. *J. Appl. Biosci.*, 24: 1477-1487.