CHEMICAL EVALUATION OF THE NUTRITIVE VALUE OF *SOLANUM INDICUM* SEEDS

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ABSTRACT
The seed of *Solanum indicum* (Indian Nightshade) were analyzed to determine proximate nutrient composition, amino acid composition, selected mineral nutrients and anti-nutritional factors. Data obtained for proximate composition shows that *Solanum indicum* seeds are a rich source of lipids and protein (27.09±0.95 and 18.68±0.71g/100g respectively), but a relatively high percentage of crude fibre (39.26±1.60g/100g). Levels of macronutrients show the seeds to be a good source of sodium, potassium and iron. All essential amino acids were present with phenylanine, leucine, lysine, isoleucine and methionine present in relatively higher amounts than others compared to the FAO reference protein value. Tyrosine appears to be the limiting amino acid. Of the anti-nutritional factors analyzed, cyanide and tannic acid had higher values. The seeds can be a source of protein in livestock feed with a possibly good shelves life and the suitability of the oil considered for human consumption.

Key words: *Solanum indicum* seeds, Nutrients, Anti-nutritional factors.

INTRODUCTION

Solanum indicum (Indian Night Shade) is an annual growing plant, which belongs to the family *Solanaceae*. It is a much-branched shrub, which produces dark yellow berries (when ripe) pitted with seeds (Kirtikar and Basu, 1985). The plant grows as a weed, with tendency of overshadowing other plants (annuals) growing in close proximity. Ripe fruits of the plant are said to be sweet and sometimes eaten by children at play, particularly in Jos-South area of Plateau State, Nigeria. In Indian traditional medicine, *Solanum indicum* is used in the treatment of asthma, dry cough, chronic febrile affliction and dysuria. Water extract of the whole plant stimulated significant increase in prostaglandin E content of endometrium when few drops of the extract were administered nasally to women (Karnic and Gupta, 1980).

Reported works on several other *Solanum* species indicate that *Solanum khassianum* and *Solanum xanthocarpum* contain high level of protein rich in essential amino acids (Jaswal et al, 1984). The vitamin D activity in the leaves of *Solanum malacoxylon* was reported to be equivalent to 2.5ug/100g dried leaves (Lawson et al, 1977). Study on the effect of the aqueous suspension of the dried leaves on the uptake of calcium and on calcium-binding protein in rachitic rats and chicken showed that there was increased in mucosal calcium uptake and level of calcium binding protein in the intestines of chicks 48 hours after treatment. The nutritional quality of protein from a Nigerian leafy vegetable *Solanum* species was assessed by Fafunso and Basir (1974) in comparison to soybean protein. On the basis of data obtained for biological value, protein utilization and protein efficiency ratio, they concluded that the leaf protein was of high nutritive value.

Solanum indicum grows flamboyantly with good seeding property. In some African countries it is grown as leafy vegetable in family home gardens and contributes to household food security, and also serves as a source of income to families (Rubaihayo, 1994). This work was designed to examine the seeds of the plant for proximate nutrients and amino acids composition, selected minerals and anti-nutritional factors content.

MATERIALS AND METHODS

Ripe and dried seeds of *Solanum indicum* were collected from the field within the National Veterinary Research Institute Vom, Nigeria. The plant was identified at the Department of Botany University of Jos, Nigeria Crude lipid, crude protein (N x 6.25), crude fiber, total ash and moisture contents were determined according to AOAC (1990) procedures. Energy content of the seeds was calculated using Atwater factors of 4, 9, 4 (Osborn and Voogt, 1978). The mineral nutrients potassium, sodium, magnesium, calcium and iron were analyzed using atomic absorption spectrophotometer (Perkin Elmer model 2380), while phosphorus content was estimated by the molybdo-vanadate method (AOAC, 1990). Amino acid composition of the seeds was determined according to the method of Spackman and Moore (1958). Total oxalates and phytic acid contents of *Solanum indicum* seeds were determined according to AOAC (1990) methods, while tannic acid level was determined by the method of Joslyn (1970), The cyanide content was estimated by the modified alkaline picrate method (Ikediobi et al, 1980)

RESULTS AND DISCUSSION

The proximate composition of *Solanum indicum* seeds is given in Table 1,

Table 1: Proximate composition of *Solanum indicum* seeds

Component	Composition (g/100 dry wt.)
Crude Fat	27.09±0.95
Crude Protein	18.68±0.71
Crude Fiber	39.26±1.60
Total ash	6.41±0.53
Moisture	5.29±0.41
Carbohydrate (NFE)	7.26±4.46
Caloric value (Kcal)	347.69±13.51
	(mg/100g)
Sodium	122.95±1.40
Potassium	1309.34±1.60
Iron	23.19±1.80
Magnesium	168.42±0.98
Calcium	48.03±2.1050
Phosphorus	43.00±2.70

Tabulated values are means ± SD of three determinations.

the amino acid composition in Table 2

Table 2: Amino acids composition of *Solanum indicum* seeds

Amino Acid	Content (g/100g protein)	FAO ref. protein[a]
Lysine	3.25±0.52	4.20
Threonine	1.25±0.13	2.80
Valine	1.67±0.36	4.20
Cysteine	0.78±0.16	2.00
Methionine	1.15±0.35	2.20
Isoleucine	2.60±0.29	4.20
Leucine	4.00±0.51	4.20
Tyrosine	0.62±0.1	2.80
Phenylanine	2.71±0.38	2.80
Histidine	2.29±0.43	
Arginine	3.97±0.57	
Aspartic acid	4.94±0.48	
Serine	1.14±0.31	
Glutamic Acid	9.48±0.54	
Proline	0.66±0.13	
Glycine	1.18±0.16	
Alanine	3.25±0.38	

Tabulated values are means± SD of three determinations.
[a]FAO (1970)

Table 3; Anti-nutritional factors of *Solanum indicum* seeds

Anti-nutrient	Composition (mg/100g dry wt.s)
Phytic Acid	78.67±0.53
Oxalates	240.21±24.27
Tannins	5250±5.0
Cyanide	126.5±23.3

Tabulated values are means± SD. Of three determinations and the anti-nutritional factors in Table 3. The crude protein and crude lipid contents are high compared to those reported for cereals and grains (Oyenuga, 1968) and for some lesser-known underutilized plant seeds (Yakubu and Onwuliri, 2001). The relatively high fiber content of the seeds may serve a useful purpose if the seeds are supplemented in livestock feed as the sole source of fiber requirement in the ration. However, the high fibre content may have some adverse effect on the availability of dietary calcium, magnesium, zinc and iron. The ash content is higher than those of cereals (Oyenuga, 1968) and seeds of *Balanites aegyptiaca* reported by Samuel et al (1997). Similarly, levels of mineral nutrients potassium, sodium, magnesium and phosphorus are also higher than those reported for cereals, *Balanites aegyptiaca* seeds and seeds of the tree legume *Tamarindus indica* (Marangoni et al, 1988). These values and those for calcium and iron were however; lower than the values reported for these elements in some tropical legume seeds (Apata and Ologhobo, 1989). Chemical assessment of the seed protein quality (Table 2) showed that all the essential amino acids were present in fairly good quantities. Phenylanine, leucine and lysine had values that compare favorably with the FAO (1990) reference protein standard. The comparatively good levels of lysine and methionine would benefit supplementation with maize grain known to be deficient in these amino acids.

The total oxalate content of *Solanum indicum* seeds is much lower than the value (4800mg/100g) reported for *Kochia* hay (Rankins and Smith, 1991) and the value (9100mg/100g) reported for vegetable amaranth (Patma and Bluebell, 1989). Oxalates are considered to be anti-nutrients as well as toxins. They render calcium unavailable by binding the calcium ion to form insoluble calcium oxalate complex, which is not absorbed by the intestine. At high oxalates level the insoluble complex formed (also called kidney stones) can affect the kidneys. The content of oxalates in the seeds of *Solanum indicum* is however, below the range of values associated with incidence of urinary bladder kidney stone disease (Marshall et al, 1967) and poisoning in grazing animals (Jones et al, 1970).

Phytic acid reduces the bioavailability of trace elements and minerals. Apata and Ologhobo (1989) studied the effect of phytic acid content on bioavailability of minerals. They reported that there was a significant inverse relationship between phytic acid content and bioavailability of calcium, magnesium, zinc and iron in some tropical legume seeds. The phytic acid content of *Solanum indicum* seeds is, however, very much below the range of values (294-453mg/100g) reported for the tropical legume seeds. It is also very much lower than phytic acid content of 270mg/100g for cottonseed meal, 400mg/100g for soyabean meal and 360mg/100g for sesame meal, which are used as vegetable protein supplements (Nelson et al, 1968).

Tannic acid content (Table 3) of the seeds is higher than that of winged bean (760mg/100g) reported by Santram et al (1987) and that of *Quercus incana* (2560mg/100g) reported by Lohan et al (1980) but lower than the value of 7570mg/100g reported for *Eugenia jambolana* also by Lohan et al (1980). Tannins are known to reduce the digestibility of nutrients, usually proteins, but also carbohydrates and even lipids by binding with the substrate to be digested, inhibiting digestive enzymes or being anti-microbial (Scalbert, 1991). Pal and Negi (1978) also reported that yearling male calves fed on tannin-rich *Quercus incana* and *Terminalia arjuna* tree leaves as sole feeds showed signs of toxicity in less than one week from the start of feeding.

The high content of cyanide in the seeds of *Solanum indicum* may be of concern, because cyanide is known to be toxic. It affects cellular respiration by inhibiting cytochrome oxidase of the electron transport chain. In addition, excretion of dietary cyanide from the body in form of thiocyanate requires sulphur, which is normally derived from methionine and cysteine. Because these amino acids are essential and must be supplied in the diet, occurrence of cyanide in foods and animal feeds may increase the requirement for these amino acids. In the United States, legislation limits the concentration of cyanogens in certain species of legumes for human consumption to 20mg/100g (Liener, 1969). This value is about six times less than the content of cyanide in the seeds of *Solanum indicum*. Toxicity of cyanogenic glucosides is mainly due to the release of the bound cyanide as hydrocyanic acid by the hydrolytic activity of the glucosidase enzyme. In the absence of effective glucosidase, neither saliva nor dilute hydrochloric acid at body temperature can release significant amount of cyanide from dietary cyanogenic glucoside (Montgomery, 1964).

The proximate nutrients content and essential amino acids profile of *Solanum indicum* seeds suggest that the seeds may have potential use as vegetable protein supplement in livestock feed. The high content of the seed for tannins and cyanide may, however, be prohibitive. Tannins can be toxic and /or inhibitive to the digestion of nutrients, especially protein, depending on whether the tannin is hydrolysable or condensed. It is also not certain whether or not the theoretical amount of cyanide in the seeds of *Solanum indicum* would be released from the intact glucoside following ingestion. Further work on nutritional evaluation of the seed is therefore recommended, to ascertain its potential usefulness.

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