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Nutrient composition, protein quality and anti-nutritional factors in the seeds of *Moringa oleifera* grown in Awka, Anambra state, Nigeria

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ABSTRACT

The nutrient composition, protein quality and some anti-nutritional factors of the seeds of *Moringa oleifera* were determined using standard analytical techniques. The methods of Association of Analytical Chemists were used for the proximate analysis and vitamin determination. The mineral and amino acid content of the seed samples were estimated using atomic absorption spectrophotometer (AAS) and Technicon sequential Multi-sample amino acid analyzer (TSM) respectively. The seeds contain 33.78% fat, 28.02% proteins, 28.77% carbohydrates, 3.03% ash, 6.40% moisture and 93.60% dry matter. It contains ascorbic acid (94.74mg/100g), but lacks niacin, pyridoxine, riboflavin and thiamine. Calcium (2.84mg/100g) and sodium (129.03mg/100g), two essential electrolytes also abound in the seeds. Tannins (40mg/100g) and oxalates (51.24mg/100g) were present at high levels while saponins (9.4mg/100g), phytates (0.435mg/100g) and cyanogenic glycosides (4.59mg/100g) occur at much lower levels. Experimental studies with rats suggest that despite the appreciably high protein (28.02%) and fat (33.78%) contents of the seeds, it does not support growth. Rats fed compounded meal containing 35.7% of *Moringa* seed ration for 21 days presented with drastic reduction in growth rate with mean body weight declining from 55.77 ± 2.61g to 36.87 ± 1.52g. The implication is that either the protein content of the seeds is not digestible or that the anti-nutritional factors interfered with normal metabolism.

KEYWORDS

Moringa oleifera;
Nutrient composition;
Anti-nutritional factors.

INTRODUCTION

In Africa where protein energy gap remains an overbearing problem, plant regimens rich in essential amino acids is in great demand. Over the decades, *Moringa oleifera* has remained an essential vegetarian diet within the West African sub-region.

Moringa oleifera is a drought- resistant, very fast growing plant and is available all year round[1,2]. It has been credited with a multitude of uses: the leaves, pods (seeds), flowers, and the growing tips of the tree are edible and nutritious[3,4]. Apart from its dietary importance, local folklore credits *Moringa* with a lot of herbal potency[4-6]. The plant belongs to the moringaceae family, with about fourteen species, *Moringa oleifera* being the best known. It is native to Sub-Himalayan parts of northern India, but is now widely distributed in the tropics and sub-tropics[2,4, 6] because it tolerates a wide range of soil and rainfall conditions.

The maximum annual rainfall requirements are over 3,000mm while the minimum is about 250mm[4]. It is resistant to drought because of the presence of a long tap root. It thrives within a temperature range of 25-35°C, but can tolerate up to 48°C in the shade and can survive a light frost. *Moringa* trees flower and fruit annually, and in some regions twice annually. During the first year, it grows up to four meters in height and produces flowers and fruits. If not cut, it can reach 12 metres in height with a trunk 30cm wide. Within three years, a tree yields 400-600 pods annually[3]. A mature tree can produce up to 1,600 pods annually. It is resistant to most pests.

Some of the uses of the plant include in alley cropping, animal forage, as domestic cleaning agent, as fertilizer, for live fencing, as medicine, and as an ornamental[3]. Given these multiple uses, it is no surprise that there is a rising interest in research, development, and utilization of the plant in many parts of the tropics such as East and Southern Africa, West Africa and South East Asia[3].

The *Moringa* seed contains natural polypeptides (anti-coagulants) and anti-microbial agents which are reportedly used in treating or purifying water for drinking in traditional setting[5,7]. Despite the wide claim on the nutritional use of the *Moringa* seeds, studies on the nutritional and bioactive potentials of this plant remain scanty. This work is therefore, aimed at documenting the nutrient and chemical compositions of *Moringa oleifera* seeds grown in Awka, Anambra state, Nigeria, in a bid to determine its usefulness and suitability as a nutritious vegetable or otherwise.

EXPERIMENTAL

Sample collection

The mature dry *Moringa oleifera* pods were collected from family gardens in Ifite, Awka, Anambra state, Nigeria. The pods were split open and the seeds removed, and then pooled together to form the bulk sample. The seeds were air-dried at 30°C (temperature) for two days and ground into fine powder using manual grinder. The milled samples were kept in screw-capped containers, stored in a deep freezer and analyzed within seven days.

Proximate analysis and mineral composition: The methods of the Association of Official Analytical Chemists[8] were used for the determination of moisture, crude protein, lipids, ash and dry matter. The mineral content was estimated using atomic absorption spectrophotometer (AAS).

Determination of amino acid profile

The amino acid profile in *Moringa oleifera* seed was determined using methods described by Speckman et al.[9] The dried and milled seeds were defatted, hydrolysed, evaporated in a rotary evaporator and then loaded into the Technicon sequential Multi-Sample Amino Acid Analyzer (TSM). The amino acid values of the sample were calculated from the chromatogram peaks.

Estimation of energy value

The calorific value was estimated in kilocalories by multiplying the percentage crude proteins, lipid and carbohydrates by the recommended factors 4, 9, and 4 respectively[10].

Vitamin analysis

The determination of the water-soluble vitamins namely niacin, pyridoxine, riboflavin, thiamine and ascorbic acid were by high performance liquid chromatography (HPLC), as described by the Association of Official Analytical Chemists[11].

Determination of the anti-nutrients

The levels of oxalates[12], phytates[13], tannins[14], saponins[14], and cyanogenic glycosides[14] were determined using the prescribed methods.

Dietary evaluation using wistar albino rats

Fifteen (15) young Wistar albino rats with average weights of 54.54g were used for the experiment. They were divided into three groups, each group containing five rats. Casilan and commercially available rat diets were used as controls while the compounded *Moringa* seed diet was the test diet. The constituents of the com-

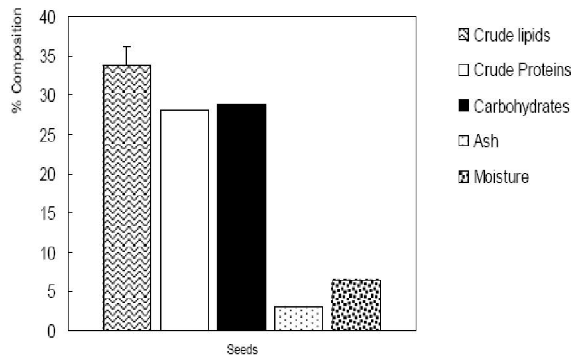

Figure 1 : The proximate composition of *Moringa oleifera* seeds (Mean ± S.E.M)

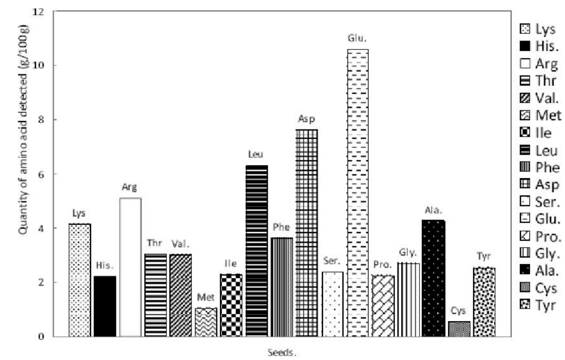

Figure 2 : The amino acid profile of *Moringa oleifera* seeds

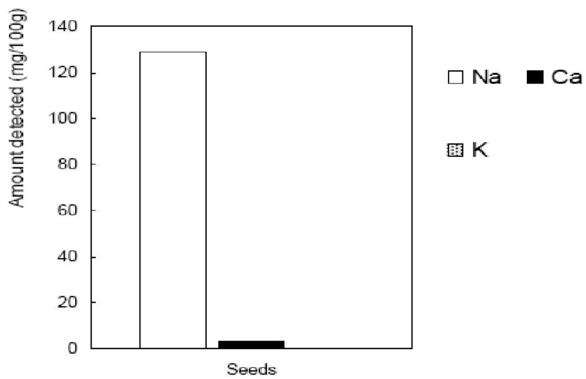

Figure 3 : The mineral composition of *Moringa oleifera* seed

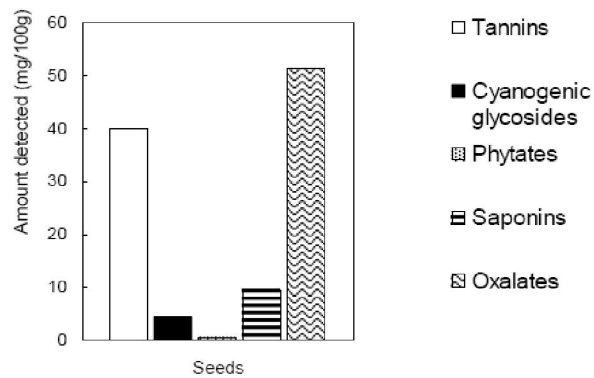

Figure 4 : The levels of anti-nutrients in *Moringa oleifera* seeds

pounded diets are shown in TABLE 1. The rats were initially fed with commercially available rat pellets for 7days (acclimatization) before the use of the compounded diets. The feeding trials were done at 10% protein level and the trials lasted for 21 days. The weights of the rats were measured every three days until the end of the feeding trials and the growth pattern determined.

RESULTS AND DISCUSSION

Figure 1 shows the proximate composition of *Moringa oleifera* seeds (Mean ± S.E.M). It contains %fat (33.78±2.41), % crude proteins (28.02±0.01), %carbohydrates (28.77), %ash (3.03±0.07), and %moisture (6.40±0.31). The energy value is 531.18 Kcal/100g.

At 28.02% the protein content of *Moringa oleifera* seeds grown at Awka has considerably higher protein than some legume seeds credited with high protein content such as *Canavalia ensiformis*, 24.48%[15], the seeds of *Gnetum africana*, 17.50%[16], and the leaves of *Amaranthus hybridus*, 17.92%[17]. The protein content compares favourably with *Piper guineeses*, 29.78%[18]. *Moringa oleifera* seed is a good source of protein since according to Pearson[19], any plant food that provides more than 12% of its calorific value from protein is a good source of protein. It is also a good source of lipid (33.78%), and carbohydrates (28.77%). The calorific energy value is 531.18 Kcal/100g.

The amino acid profile of the *Moringa oleifera* seeds is shown in figure 2. It contains all the essential amino acids with the highest being leucine (6.31g/100g protein) and arginine (5.09g/100g protein) while the lowest is methionine (1.04g/100g protein). The seed contains all the essential amino acids, just as in the leaves, as reported by Fuglie[4]. The percentage of the essential amino acids (EAA) is 48.34% while that of non-essential amino acid (NEAA) is 51.66%. In many plants, %NEAA is always higher than %EAA[17]. Analysis of variance indicates that there is no significant difference between the essential and non-essential amino acids present in the seeds, since the significance value of the results are well over 0.05. The highest amino acids are

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TABLE 1 : The composition of the compounded diets in g/kg diet (proximate composition)

Constituents	Seed diet (g)	Casilan diet (g)
Corn starch	513 (51.3%)	759 (75.9%)
Oil	100 (10%)	100 (10%)
Vit./Min. mix	30 (3%)	30 (3%)
Casilan	-	111 (11.1%)
Seed powder	357 (35.7%)	-

the acidic amino acids, glutamate (10.60g/100g protein) and aspartate (7.60g/100g protein). The high values may be due to the conversion of glutamine and asparagine to glutamate and aspartate respectively[17,20]. Leucine, a ketogenic, branch chain amino acid, is high (6.31g/100g protein) and can lead to ketoacidosis due to high synthesis of ketone bodies like acetoacetate, β-hydroxybutyric acid and acetone. These compounds lower the pH and can lead to seizures and may be fatal. The aromatic amino acids, phenylalanine (3.60g/100g protein), histidine (2.21g/100g protein) and tyrosine (2.54g/100g protein) are appreciably present in the seeds.

The mineral composition of the *Moringa oleifera* seeds is shown in figure 3. The seed contains sodium (129.03mg/100g) and calcium (2.84mg/100g), but no potassium. However, Fuglie[4] reported that the pods contain 3.1mg of potassium.

Though, Fuglie[3,4] reported that the pods contain thiamine (0.05mg/100g), riboflavin (0.07mg/100g), niacin (0.2mg/100g) and ascorbic acid (120mg/100g), only ascorbic acid (94.74mg/100g) was detected in the seeds in this particular study. That the value of ascorbic acid observed in this study (94.74mg/100g) is appreciably lower than that reported by Fuglie[4], (120mg/100g) suggests that physiographic factors of the soil may contribute to this.

The levels of the anti-nutrients are shown in figure 4. Tannins (40mg/100g) and oxalates (51.24mg/100g) are very high in the seeds of *Moringa oleifera*. The values for cyanogenic glycosides, saponins and phytates are considerably lower, 4.59mg/100g, 9.4mg/100g and 0.435mg/100g respectively. Tannins have antagonistic competition with proteins, consequently lowering the bioavalaibility of protein. Phytic acid and oxalates have complicated effects in the human system, particularly indigestion of food and flatulence[17,21].

Figure 5 shows the growth rate of rats fed with *Moringa* seed diet (test) and commercial rat pellets

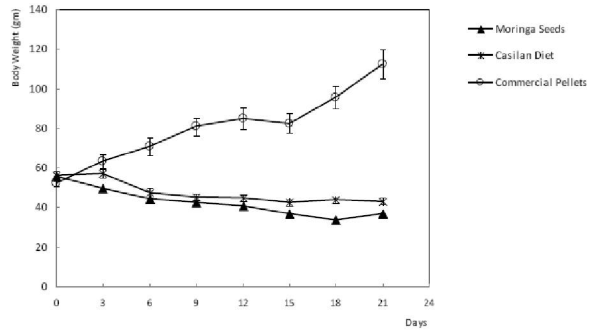

Figure 5 : The growth profile of rats fed with casilan, commercial rat pellets and meal ration containing *Moringa* seeds through a period of 21 days (each point is the mean of the growth rates ± SEM: where n=5)

and casilan diet (controls). *Moringa* seed and casilan diets did not support growth. The rats on the test diet showed a decrease in weights from 55.77 ± 2.61g to 36.87± 3.70g over a period of 21days while rats on commercial pellets (control) increased from 51.90 ± 1.38 to 112.14 ± 7.36 within the same period. The casilan diet also decreased the growth rate of the rats from 55.94 ± 2.48 to 42.89 ± 1.56. The result from the seed diet showed that, although the seeds contain high amount of proteins, it did not support growth. This may be due to the presence of some of the anti-nutrients such as tannins and oxalates[17,21]. Tannins can lower the available proteins by antagonistic competition and can therefore elicit protein deficiency. It can also prevent protein digestion by inhibiting the activation of pepsinogen and chymotrypsinogen to pepsin and chymotrypsin respectively[22]. Phytic acid and oxalates have complicated effects in the human system including reacting tightly with divalent ions such as calcium and zinc ions, thereby making them unavailable to the body[17]. However, these anti-nutrients can be removed through soaking, boiling or even frying[15,23,24].

CONCLUSION

The proximate analysis shows that the seeds are very rich in nutrients particularly proteins and fats, but when subjected to animal feeding, did not support growth. This may be due to the presence of the anti-nutrients such as tannins and oxalates which are known to interfere with protein digestion. The effects of processing on the nutritional values of the seeds should be done to ascertain the suitability as a complete nutritional supplement for both man and animals.

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