Chemical and nutritional evaluation of dietary processed and unprocessed *Prosopis africana* seed meal with pullet chicks

Chemische und ernährungsphysiologische Beurteilung von behandeltm und unbehandeltem *Prosopis africana*-Samen-Mehl durch Verfütterung an Legehennenküken

A. A. Annongu¹,² and U. ter Meulen¹


**Introduction**

In developing countries availability of conventional feed for animal nutrition is quite limited due to direct competition to human nutrition. In these countries novel crop plants have to be found which are not used by humans. *Prosopis africana* used in the present experiment may serve as one of these alternatives. *Prosopis africana* is a leguminous tree and one of the 44 species of the genus prosopis. It is a savannah tree found in semi-arid and arid regions of the world (KEAY, 1989). However, the disadvantage of prosopis is the high content of anti-nutritive factors. Scientific data on direct or processed use of *Prosopis africana* seeds and its nutritive values is lacking. Available data or information deals mainly with the use of prosopis pods and leaves (LYON et al., 1988). In some African countries, Nigeria inclusive, prosopis seeds are used for making “local maggi, by subjecting the seeds to 24 h boiling at 100 °C. But also several applications of prosopis pods in nutrition of farm animals have been documented. DRAPER (1944) used *Prosopis juliflora* pod flour to replace maize and wheat in nutrition of sows and chickens and reported positive results. BRYANT et al. (1984) documented the successful use of ozone-treated prosopis pod flour for cattle. Contrary to these reports, Sudanese goats fed prosopis pods in diets suffered linear decrease in live weight gain and dressing percentage.

GOHL (1981) reported a bitter taste and poisoning of livestock following ingestion of green pods. Feeding ruminants on an exclusive diet of prosopis pods resulted in malnutrition, jaw and tongue infection (NAS, 1979).

Prosopis is reported to contain many anti-nutrients, including protein inhibitors, toxic heat stable principles (BOOTH and WICKENS, 1988; BELLITZ and WEDER, 1990; BALOGUN, 1992). In general, information on the use of prosopis seeds in nutrition of monogastric animals is very limited. Based on the present status of knowledge on using *Prosopis africana* in poultry diets the objectives of the present experiment have been to determine the content of anti-nutritives in *Prosopis africana* and to evaluate the nutritional significance of treated and untreated, raw *Prosopis africana* seed meals in diets on performance of pullet chicks.

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**Materials and Methods**

**Source and processing of prosopis seeds**

Prosopis seeds were obtained by manually isolating the seeds from dried pods that have fallen from the trees at maturity. The seeds were milled according to day-old chicks requirement into flour and subjected to natural lactic fermentation and lye (alkali) treatments following the procedures described by ANNONGU et al. (1996, 1997). Lye was prepared from ash obtained by burning plant materials (*Parkia filicoides* pod husks) of exceptional alkalinity and purity. Measured amount of ash (kg) was dissolved in tap water (litre) and allowed to extract for a week. The resulting lye was filtered using a muslin and a standardised alkali solution of pH 11.5 was produced. The fermented PSM was soaked in the lye for 48 h after which the dough was strained and sun-dried to constant weight prior to inclusion in the diet.

**Biological evaluation with pullet chicks**

One hundred and five day-old pullet chicks of a commercial strain (Hacco black) were housed in electrically heated battery brooders and fed the experimental diets shown in Table 1.

Diets were formulated to be isonitrogenous and isoenergetic. For the experiment a single-factor design was applied. Five diets were included: a corn-soy reference diet, 10, 20, 30% raw and 30% treated prosopis seed meal (PSM). Chicks were randomly distributed to treatments and each treatment/diet had three replicate cages of 7 chicks each. Feed and water were given *ad libitum* over a 21 d feeding period. Chicks were weighed at the beginning of the trial and every week. Feed consumption, growth rate, feed efficiency (feed: gain) and survival were determined weekly.

**Chemical analyses**

Diets were subjected to Weender analysis for moisture, crude protein, crude fibre, crude ash and ether extract. Gross energy was estimated using the ballistic bomb calorimeter. Percentage nutrient composition of raw and treated PSM was determined by the established methods (AOAC, 1990). Nitrogen in raw and processed seed meal...
was determined using the automated FP-2000 nitrogen analyzer (LECO CORPORATION). Amino acid profiles of both untreated and treated PSM was carried out employing the automated EPPENDORF (BIOTRONIK) LC 3000 amino acid analyzer. Replicate samples were hydrolysed with hydrochloric acid followed by determination of amino acids in a cation exchange system. Similar samples were oxidised with performic acid followed by hydrolysis with HCL and amino acids were determined. The averages of the four determinations were used to calculate the total amino acid composition of the raw and treated PSM in g/16 g N. Soluble phenols/tannins in processed and untreated PSM were determined by gravimetric precipitation using trivalent ytterbium (REED et al., 1985). Insoluble tannins, proanthocyanidins were estimated following the n-butanol-HCL assay procedures whereby the solution of ytterbium precipitated (Yb-ppt) phenolics was taken and reacted with HCL in n-butanol. The absorbance of the tubes were read at 550 nm after completion of reactions (REED et al., 1985).

**Statistical analysis**

Data were subjected an one-way analysis variance (ANOVA). Differences between treatment means were tested for significance using the unpaired Student t-test at 1% protection level (STEEL and TORRIE, 1980).

## Results

### Chemical compounds and nutrient composition of PSM (Table 2)

Quantitative determination of soluble phenols/tannins (Yb-ppt), proanthocyanidins/insoluble tannins (BUT-A550) in raw and processed prosopis seed meal and its proximate evaluation is presented in Table 2. The concentration of both soluble and insoluble tannins in raw PSM were high relative to those in treated PSM. The treatment increased the crude protein content of PSM while it decreased the crude fibre content. Ether extract and crude ash were decreased, as well.

### Concentration of total nitrogen and amino acids in prosopis seed (Table 3)

Table 3 shows the data on the protein nature of prosopis seed. Total nitrogen in treated seed meal increased from 2.04% in raw seed to 2.50% in the treated one. The amino acids concentration of raw and treated seed meal also indicated that treatment increased the content of some amino acids. But, Prosopis seed appears to be deficient in some essential amino acids like isoleucine, total sulphur amino acids and threonine when compared with the g AA/16 g N reference pattern of FAO/WHO (1973).

### Table 2. Concentration of ytterbium precipitated phenols (Yb-ppt), proanthocyanidins (BUT-A550) and nutrient composition of raw and treated PSM

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Raw</th>
<th>Treated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total nitrogen (%)</td>
<td>2.04</td>
<td>2.50</td>
</tr>
<tr>
<td>Amino acids (g/16 g N)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Essential</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isoleucine</td>
<td>2.67</td>
<td>2.91</td>
</tr>
<tr>
<td>Leucine</td>
<td>6.86</td>
<td>6.89</td>
</tr>
<tr>
<td>Lysine</td>
<td>6.69</td>
<td>6.78</td>
</tr>
<tr>
<td>Methionine</td>
<td>0.54</td>
<td>0.57</td>
</tr>
<tr>
<td>Cystine</td>
<td>2.14</td>
<td>2.16</td>
</tr>
<tr>
<td>Phenylalanine</td>
<td>2.88</td>
<td>3.64</td>
</tr>
<tr>
<td>Tyrosine</td>
<td>2.35</td>
<td>2.75</td>
</tr>
<tr>
<td>Threonine</td>
<td>2.18</td>
<td>2.32</td>
</tr>
<tr>
<td>Tryptophan</td>
<td>0.92</td>
<td>0.94</td>
</tr>
<tr>
<td>Valine</td>
<td>5.09</td>
<td>5.14</td>
</tr>
<tr>
<td>Non-essential</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aspartic acid</td>
<td>9.04</td>
<td>9.85</td>
</tr>
<tr>
<td>Glutamic acid</td>
<td>20.12</td>
<td>20.56</td>
</tr>
<tr>
<td>Alanine</td>
<td>3.38</td>
<td>3.65</td>
</tr>
<tr>
<td>Arginine</td>
<td>9.15</td>
<td>9.88</td>
</tr>
<tr>
<td>Glycine</td>
<td>6.47</td>
<td>8.17</td>
</tr>
<tr>
<td>Histidine</td>
<td>1.80</td>
<td>1.86</td>
</tr>
<tr>
<td>Proline</td>
<td>3.71</td>
<td>4.28</td>
</tr>
<tr>
<td>Serine</td>
<td>3.98</td>
<td>4.62</td>
</tr>
</tbody>
</table>

**Notes:**

1. Yb-ppt, ytterbium precipitated phenols/tannins
2. BUT-A550, n-butanol-HCL assay, absorbance at 550 nm wave length

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Table 1. Composition of Experimental Diets (%)

<table>
<thead>
<tr>
<th>Components</th>
<th>1</th>
<th>2 Raw</th>
<th>3 Raw</th>
<th>4 Raw</th>
<th>5 Processed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yellow maize</td>
<td>59.05</td>
<td>56.20</td>
<td>44.50</td>
<td>36.05</td>
<td>36.00</td>
</tr>
<tr>
<td>Soybean meal</td>
<td>32.80</td>
<td>25.65</td>
<td>25.80</td>
<td>23.80</td>
<td>24.00</td>
</tr>
<tr>
<td>Prosopis meal</td>
<td>5.00</td>
<td>5.00</td>
<td>5.00</td>
<td>5.00</td>
<td>5.00</td>
</tr>
<tr>
<td>Fish meal</td>
<td>0.10</td>
<td>10.00</td>
<td>20.00</td>
<td>30.00</td>
<td>30.00</td>
</tr>
<tr>
<td>Palm oil</td>
<td>1.50</td>
<td>1.50</td>
<td>1.50</td>
<td>1.50</td>
<td>1.50</td>
</tr>
<tr>
<td>Bone meal</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Oyster shell</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td><em>Premix</em></td>
<td>0.30</td>
<td>0.30</td>
<td>0.30</td>
<td>0.30</td>
<td>0.30</td>
</tr>
<tr>
<td>Salt</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>Filler</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

**Nutrient content (%)**

- Dry matter: 94.30
- Crude protein: 23.70
- Crude fibre: 5.03
- Ether extract: 4.80
- Crude ash: 20.00
- G.E., MJ/Kg: 12.26

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**Notes:**

1. *Mineral-vitamin premix, Zoodry (Roche) Broiler/chicks, supplied 2.5 kg/tonne of feed: 5000.000 IU vitamin A; 1000.000 IU vitamin D3; 24.00 g vitamin E; 1.00 g vitamin K3; 1.20 g vitamin B1; 2.80 g vitamin B2; 16.00 g nicotinic acid; 4.00 g calcium D-pantothenate; 5.00g vitamin B6; 16.00 g vitamin B12; 0.40 g folic acid; 0.028 g biotin; 120 g choline chloride; 16.00 g zinc bicarbonate; 40.00 g manganese; 20.00 g iron; 18.00 g zinc; 0.80 g copper; 0.62 g iodine; 0.1 g cobalt and 0.04 g selenium.

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**References**

(1973) Reference standard

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Annongu and ter Meulen, Nutritional value of processed and unprocessed Prosopis africana seed for pullet chicks. Archiv für Geflügelkunde 1/2001
Table 4. Effects of dietary untreated and treated prosopis seed meal on performance of pullet chicks

<table>
<thead>
<tr>
<th>Dietary treatments</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feed intake (g/bird/d)</td>
<td>21.80a</td>
<td>14.50b</td>
<td>11.87d</td>
<td>10.58c</td>
<td>21.02a</td>
<td>0.40</td>
</tr>
<tr>
<td>Weight gain (g/bird/d)</td>
<td>11.70a</td>
<td>6.28b</td>
<td>5.16b</td>
<td>5.20b</td>
<td>10.70a</td>
<td>0.42</td>
</tr>
<tr>
<td>Feed : Gain</td>
<td>1.86a</td>
<td>2.30b</td>
<td>2.30b</td>
<td>2.03b</td>
<td>1.90a</td>
<td>0.09</td>
</tr>
<tr>
<td>Mortality (% in 3 wks)</td>
<td>1.03a</td>
<td>5.16b</td>
<td>6.53c</td>
<td>6.54c</td>
<td>1.56a</td>
<td>0.24</td>
</tr>
</tbody>
</table>

Treatment means in rows followed by different letters are significantly different (p < 0.01)

Chicks' performance (Table 4)

Birds offered treated PSM in diet consumed feed similar to the group maintained on the corn-soy standard diet (p > 0.01). Feed intake on 10, 20 or 30% unprocessed dietary PSM was low (p < 0.01), the consumption decreased with increasing levels of the raw PSM in diets. Growth rate measured by weight gain followed a trend similar to feed intake. Treatment of PSM before inclusion to diet resulted in a similar growth of chicks in comparison to the control diet (p > 0.01). Untreated seed meal in diets at all the inclusion levels reduced weight (p < 0.01). Feed to gain (F:G) ratios in groups fed the control and treated PSM diets were similar (p > 0.01), and superior to the groups fed the diets with unprocessed seed meal (p < 0.01). Normal mortality was recorded under the control or treated PSM diets and when occurred was due to natural causes. On the contrary, groups of chicks receiving raw PSM based diets suffered high mortality. Severe morbidity was recorded for birds fed 20 and 30% untreated PSM in diets (p < 0.01). Within three weeks in the course of the experiment, death rate rose to 60%. Morphologically, chicks offered raw seed meal diets were adversely affected. They exhibited signs of long-term emaciation and their feces formed plugs at the cloaca. This condition made difficult the discharge of waste products from the groups concerned except when the fecal plugs were removed.

Discussion

Data on the quantitative determination of soluble and insoluble phenols showed that raw prosopis seed contains high levels of both soluble and condensed phenols/tannins. High levels of tannins in feedstuffs, especially proanthocyanidins, can constitute anti-nutritional factors and might be very dangerous for the health of animals when such feedstuffs are fed directly. Condensed tannins which are typical for plant tannins are implicated in inhibiting trypsin activity. Previous reports (OLOGHOBOKAN et al., 1993) have shown that these phytotoxins are in part responsible for the poor performance of the animals. The combined treatment by anaerobic fermentation and lye (alkali) reduced drastically the concentration of the toxins. The process of fermentation resulted in toxin detoxification by microbial degradation converting the toxin to non-toxic metabolites or to compounds with enhanced activity in the animal, or the microbes converted toxins to substances with a completely different toxic property (STARTON, 1976; SMITH et al., 1964; WESTBY and CHO0, 1994). GUPTA and HASLAM (1980) found that treatment of tannins with alkali or acid resulted in their breakdown. The combined treatments in this study led to decreases in the levels of the toxins which might be of great nutritional advantage to the animals.

The results of analyses of the nutrient content of prosopis seeds showed that raw Prosopis africana seeds contained reasonable values on most of the basic nutrients. The relatively high content of crude protein among others indicates that the legume may be a good source of nutrients. However, this can only be possible if prosopis is subjected to treatments before supplementation as the inherent anti-nutrients might prevent the availability of the nutrients to the animals fed. The results on the nutrient content of prosopis obtained in this study are in agreement with earlier works (BHANDARI et al., 1979; ALLEN and ALLEN, 1981; ABDELGAABAR, 1986). Methods of treatments adopted in this study, besides detoxification, increased the level of crude protein. According to earlier reports (TONGNAL et al., 1981; PANCRES et al., 1981) fermentation enhanced the nutritional value and quality. Treatment with alkali, lye tended to reduce the high fibre content associated with prosopis seed. This is of great nutritional significance particularly to monogastrics that cannot tolerate high levels of dietary fibre (NRC, 1994). Analyses of the protein nature of Prosopis africana has indicated that the seed is very low (2%) in total nitrogen. Nevertheless, treatments increased total nitrogen content moderately. Compared with the FAO/WHO (1973) reference standard of g AA/16g N Prosopis africana is deficient in some essential amino acids. BALOGUN (1982) obtained low values of sulphur containing amino acids, methionine and cystine from analysis of raw Prosopis africana seeds. The results of the present study on sulphur amino acids confirmed this report. Based on the observed poor performance of the experimental animals receiving the raw seed meal in diet it is advisable to treat the seed meal or cake before use and to supplement the deficient essential amino acids.

Good growth performance and feed intake were obtained with treated PSM diet, comparable to the standard diet. On the contrary, feed consumption and body weight gain of chicks fed graded levels of raw PSM based diets were significantly lower relative to the results on treated PSM diet or the control. The significant depression in feed intake and weight gain elicited on diets containing raw PSM is in agreement with reports of earlier workers (ALETOR and FETUGA, 1984; RUBIO et al., 1990) who fed raw legumes to broiler chicks. The poor performance can be attributed to the presence of raw PSM anti-nutritional factors as described, previously (JAE and FLORES, 1975).

Pullets on the control and treated PSM diets were efficient in utilising their feed while poor efficiency was recorded on raw PSM diets. NITSAN et al. (1965) reported similar findings following intake of unprocessed soybean meal in diets. Very high mortality rates were observed in groups of pullet chicks receiving diets with raw PSM compared with the groups maintained on the control and treated PSM diets confirming the reports of VOHRA et al. (1966) that diets containing tannins (5%) caused 70% mortality in chicks. Hence, the very high mortality caused by diets with untreated PSM confirmed the presence of...
In conclusion, processed Prosopis africana seed has shown a relatively high feeding potential based on the nutrient composition of the treated PSM and, therefore, improved performance of the experimental animals. Optimum utilisation of the seeds in nutrition of animals will be possible if the seeds are treated properly, preferably by treatment methods that combine heat, chemical and biochemical procedures since most of the anti-nutrients in the seeds are not destroyed by heat. Final diets should also be supplemented with the deficient essential amino acids.

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The authors reserve deep appreciation for the Katholischer Akademischer Austländer-Dienst (KAAD) Bonn, for providing fellowship grant to carry out this research work in the Federal Republic of Germany.

Summary
In the present experiment the feeding value of both untreated and treated Prosopis africana seed meal (PSM) was evaluated with day-old pullet chicks. PSM was treated by natural lactic fermentation and lye (alkali). Untreated PSM was included with 10, 20 and 30% in diets, whereas, treated PSM was included with 30%. A corn-soy diet was included as a reference diet. Untreated and treated PSM were analysed for total phenols/tannins, nutrients composition, total nitrogen and amino acids contents. General performance of chicks was one of the main response criteria.

Results revealed that raw PSM contained high concentrations of soluble and condensed tannins relative to treated PSM. PSM in general, was low in total nitrogen and some essential amino acids namely isoleucine, total sulphur amino acids and threonine. Birds fed treated PSM showed good a performance level for feed intake, weight gain and feed efficiency comparable with the control (p > 0.01), while the opposite was due for the untreated PSM diets (p < 0.01). High mortality rates were observed under unprocessed PSM diets relative to the processed or standard diet (p < 0.01).

Treatment of prosopis products before inclusion in diet will allow to use Prosopis as an alternative feed component in poultry nutrition.

Keywords
Nutrition, chicken, Prosopis seed meal, feeding value, anti-nutrients, phenols, total nitrogen, amino acids, performance.

Zusammenfassung
Chemische und ernährungsphysiologische Beurteilung von behandeltem und unbehandeltem Prosopis africana-Samen-Mehl durch Verfütterung an Legehennenküken


Die Ergebnisse zeigen, dass unbehandeltes PSM einen hohen Gehalt an löslichen und unlöslichen Phenolen im Vergleich zum behandelten PSM aufweist. Im Allgemeinen ist der Gehalt an Gesamtstickstoff und einigen essentiellen Aminosäuren, wie Isoleu­cin, schwefelhaltigen Aminosäuren und Threonin, im PSM niedriger. Futteraufnahme, Gewichtsentwicklung und Futterverwertung waren bei den Tieren der Versuchsgruppe, die behandeltes PSM erhielten, vergleichbar mit denen der Kontrollgruppe (P > 0,01). Demgegenüber zeigten die Küken der Gruppen, die unbehandeltes PSM erhielten, schlechtere Leistungen (P < 0,01). Die Sterberate war in den Gruppen, die unbehandeltes PSM erhielten, im Vergleich zur Versuchsgruppe, in der behandeltes PSM eingesetzt wurde, und zur Kontrollgruppe hoch (P < 0,01).


References


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