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THE NUTRITIVE VALUE OF LEUCAENA LEAF MEAL IN DIETS FOR RATS [1]

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Three experiments with growing rats were carried out to determine the utilization of leucaena leaf meal (LLM) in monogastrics. The effect of successive increments of 0, 7.1, 14.3, 21.6 and 28.8% LLM in rat diets was studied as well as the response to supplementation with 0.35% methionine and/or 0.44% lysine and the net protein utilization (NPU) value for LLM. The incorporation of LLM at levels of up to 14.3% produced similar live weight gains as that produced in animals fed the control ration, nevertheless efficiency of feed conversion was reduced with increasing levels of LLM. Dietary supplementation with methionine increased live weight gain, but there was no significant effect from supplementary lysine. The NPU value for LLM was 40.5 which was low compared to the value of 63.2 for casein. Low protein digestibility appeared to limit the use of high inclusion rates of LLM in diets for rats.

Key Words: Leucaena, methionine, lysine, digestibility in rats.

Leucaena leucocephala is a legume native to the Yucatan Peninsula which is now found in many tropical areas. Its high protein content and capacity for nitrogen fixation have interested many researchers worldwide (see the review of Ruskin, 1977). Much information is available regarding its utilization by cattle (Jones, 1979), but there is little information regarding its utilization by monogastrics.

The principal factors limiting the use of leucaena leaf meal (LLM) in monogastric rations are the high fibre content (approximately 20% of the dry matter) and the presence of the toxic amino acid mimosine. The toxic effect in monogastrics induces weight loss, blindness, cannabalism, motor disturbances and death.

The toxic effect of mimosine can be largely eliminated by the addition of metal salts (particularly Fe and Al) to the diet, these produce a metal chelate complex with mimosine which is not absorbed from the digestive tract (El Harit et al, 1979; Acamovic and D'Mello, 1980 and 1981).

The present study was carried out to study the chemical composition of leucaena native to the Yucatan Peninsula and to determine its nutritive value to growing rats.

Materials and Methods

The experiments were carried out at the Tizimin Animal Research Centre which is a branch of the National Institute of Animal Research (Secretariat of Agriculture and Water Resources), situated at 21°23' N and 88°E, and 15 m above sea level. The climate is type AWo with an annual rainfall of 1200 mm (García 1964).

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The leucaena was harvested and dried under cover. Leaves and stems equal to or smaller than 2 mm were ground in a laboratory mill with a 1 mm screem. Proximate analysis was carried out according to AOAC (1975), as well as analysis for the protein fraction in neutral detergent fibre (Van Soest, 1964), and mimosine content (Matsumoto and Sherman, 1951). Amino acids were determined by the method of Benson and Patterson (1965) employing the modifications for tryptophan suggested by Hernández and Bates (1969).

Three experiments were carried out using young unsexed Wistar rats. All the animals were kept in a controlled environment with the temperature maintained at 22°C.

In the first experiment 40 animals were blocked according to liveweight and randomly assigned to five dietary treatments in which LLM partially replaced the casein of the control diet (Table 1). All diets were formulated to contain approximately 17% crude protein, 4.1% oil, 0.5% Ca and 0.4% P (except diet 5 which contained 0.66% Ca and 0.53% P). The ratio Ca:P in all diets was 1.2:1.0.

Table 1

Utilization of leucaena leaf meal in diets for growing rats. Composition of experimental diets (fresh basis).

	EXPERIMENTAL DIETS				
	1	2	3	4	5
Casein	12.2	9.8	7.3	4.9	2.4
LLM	-	7.1	14.3	21.6	28.8
Wheat	64.4	61.7	59.1	56.2	52.4
Maize oil	4.1	3.9	3.6	3.4	3.2
Cellulose	5.1	3.8	2.5	1.2	-
Sugar	10.0	10.0	10.0	10.0	10.0
Calcium carbonate	1.2	0.83	0.41	-	-
Potassium orthophosphate	1.76	1.67	1.63	1.55	2.02
Vitamins	0.5	0.5	0.5	0.5	0.5
Minerals	0.7	0.7	0.7	0.7	0.7
Crude Protein %	17.1	17.1	17.0	16.8	16.5
% LLM protein of total protein	0	11.1	23.5	35.7	48.0

The nutrient analysis of the LLM used in all the experiments is shown in Table 2. 32.1% crude protein was found in neutral detergent fibre. 87% crude protein was true protein.

The rats were kept in stainless steel metabolism cages, and after adaptation period of 1 week entered an experimental period of 3 weeks. Protein digestibility was measured by regression using total faecal collection from 4 animals/treatment (Rodríguez, 1980).

In the second experiment 28 rats were randomly assigned to four treatments to determine the effects of dietary supplements of methionine or lysine on rat growth.

The basal diet used in experiment 2 is shown in Table 3; the dietary treatments consisted of supplements of 0.35% D-L methionine (98%), 0.44% L lysine hydrochloride (78%) and 0.35% methionine and 0.44% lysine to the basal diet. Amino Acid supplementation was additional to the 10% crude protein

Table 2

Nutrient composition of leucaena leaf meal (fresh basis)

Dry matter	88.6%
Crude protein	27.8%
True protein	24.2%
Ether extract	3.2%
Ash	10.2%
Crude fibre	17.9%
Mimosine	0.26%

of the basal diet which was considered adequate for growth in rats. The basal diet contained 10% crude protein, 6.7% crude fibre, 4.1% oil, 0.86% Ca, and 0.67% P. The ratio of Ca:P was 1.28:1.0. The animals were managed as in experiment 1.

Table 3.

Composition of basal diet used in experiment to study the effect of dietary supplements of lysine and methionine on the growth of rats fed leucaena leaf meal.

	BASAL DIET
Leucaena leaf meal	37.3%
Maize starch	46.3%
Maize oil	2.9%
Sugar	10.0%
Phosphoric acid	2.5%
Vitamins	0.4%
Minerals	0.6%

In the third experiment the NPU of LLM was determined using the method of Sotelo and Lucas (1978). Thirty rats were assigned to three diets; a protein free control diet, control plus casein and control plus LLM.

The result were analysed by analysis of variance, comparison of means (minimum significant difference) and regresion using the methods of Lison (1968)

Results and Discussion

The amino acid composition of the LLM is shown in Table 4, and compared with the percentage value with which each amino acid meets the NRC (1978) requirements for rat growth. It can be seen that five amino acid methionine, glutamic acid, valine, histidine and lysine only cover 23, 23.3, 58, 63 and 69% respectively of the NRC requirements.

The results of the first experiment are shown in Table 5. Increasing levels of LLM in the diet produced a decrease in live weight gain although there was no significant difference between treatments for feed intake. Efficiency of feed conversion was the same for treatments 1 and 2, but signifi-

Table 4

Contribution of amino acids from leucaena leaf meal when used as the sole source of protein in a 12% crude protein diet for growing rats.

AMINO ACID	LEUCAENA LEAF MEAL (LLM)[1]	DIET[2]	DIETARY CONCENTRATION AS % OF TOTAL REQUIREMENT FOR THE RAT[3]
Methionine	0.33	0.14	23
Glutamic acid	2.30	0.93	23
Valine	0.85	0.35	58
Histidine	0.47	0.19	63
Lysine	1.18	0.48	69
Threonine	0.82	0.38	76
Arginine	1.16	0.53	88
Proline	0.82	0.38	95
Isoleucine	1.12	0.51	102
Leucine	1.84	0.84	112
Phenylalamine/Tyrosine	2.01	0.92	115
Aspartic acid	1.91	0.87	217
Alanine	1.16	-	-
Glycine	1.05	-	-
Serine	1.00	-	-

[1]LLM - 88.8% DM and 26.2% CP
[2]LLM at 45.8% of the diet and the sole source of protein.
[3]Nutrient requirements of the rat (NRC, 1978).

cantly higher ($P < 0.01$) in the other three treatments.

The digestibility of protein in the total diet tended to decrease with increasing levels of LLM in the diet (see Table 5). It is probable that the decreased live weight gain is produced by the decreased protein digestibility of those diets containing LLM. The digestibility of protein of LLM was 73.4%.

During the experiment hair loss was noted in those animals receiving LLM in the diet. This alopecia was greater as the level of dietary LLM increased. At the end of the experiment a histopathalogical examination of brain tissue slices revealed no apparent lesions.

In general terms LLM could be included at dietary levels of up to 7.1% without affecting performance, but at 14.7% inclusion rate LLM reduced the efficiency of feed conversion.

In experiment 2 it was found that methionine increased both final live weight and feed efficiency; there was no effect from supplementary lysine.

The NPU of LLM was 40.5 while that for casein in the test diet was notably greater at 63.2.

The mimosine content of LLM used in this study (0.26%) was low considering reported values of 4 or 5% for lecuaena from the same area. Other authors (Matsumoto and Sherman, 1951; Hegarty et al, 1964) have shown that wilting reduces the level of mimosine in leucaena leaves. At the levels of inclusion used in this study LLM showed no apparent toxic effect apart from hair loss.

Table 5

Growth characteristics of growing rats fed different levels of leucaena leaf meal (LLM).

DIET	1	2	3	4	5
% LLM	0	7.1	14.7	21.6	28.8
Initial live weight (g)	62 ± 7	62 ± 7	62 ± 6	62 ± 6	62 ± 5
Final live weight (g)	153 ± 30[a]	156 ± 20[a]	130 ± 23[ab]	123 ± 13[b]	114 ± 11[b]
Feed comsuption (g)	267 ± 35	285 ± 26	283 ± 42	297 ± 40	293 ± 52
Feed conversion (g)	3.0 ± 0.50[a]	3.1 ± 0.30[a]	4.9 ± 2.6[b]	4.8 ± 1.1[b]	5.8 ± 0.9[c]
Digestibility of protein (%)	93.2 ± 1.1[a]	90.9 ± 2.6[a]	88.3 ± 6.0[a]	80.9 ± 2.9[b]	78.0 ± 8.1[b]

Values with different superscripts are significantly different (P < 0.05)

Table 6

Effect of amino acid supplementation on the growth of rats fed leucaena leaf meal (LLM).

	DIET			
	Control	Control + 0.35% Methionine	Control + 0.44 Lysine	Control + 0.35% Methionine 0.44% Lysine
Initital live weight (g)	63 ± 8	63 ± 8	67 ± 7	67 ± 7.1
Final live weight (g)	90 ± 14[a]	110 ± 11[b]	91 ± 8[a]	115 ± 11[b]
Feed consumption	340 ± 23[a]	343 ± 24[a]	322 ± 26[a]	338 ± 36[a]
Feed conversion	18.2 ± 12.8[b]	8.1 ± 0.4[a]	14.1 ± 2.1[b]	7.3 ± 1.1[a]

Values with different superscripts are significantly different (P < 0.05)

The amino acid composition of LLM was similar to that reported by D'Mello and Fraser (1981) for material harvested in Malawi and Thailand, the only differences being the lower levels of lysine, alanine and glutamic acid in the LLM used in the present study.

The results of the first experiment indicate that LLM could be incorporated into rat diets at levels of up to 14.7% without affecting live weight gain. The poor digestibility of the protein is one of factors limiting the use of LLM at dietary levels greater than 14.7%. This poor digestibility can be explained by the fact that 32.1% of the total protein is found in the cell wall, and the cell wall of this type of forage being basically comprised of cellulose is not available to the rat.

The poor availability of protein is evident from the low NPU value of 40.5 and the low digestibility value for crude protein (73.4%).

The second factor limiting the increased use of LLM in rat diets is the low methionine content of the leaf protein; this deficiency was apparent in experiment 2.

A third factor limiting the use of this forage is its low energy value for monogastrics. The energy dilution effect on diets incorporating high levels of LLM could be overcome by the addition of oil or fat to the diets.

It should be noted the presence of only 0.26% mimosine in the LLM produced no toxic effects in the experimental animals. Therefore it is possible that with the low level of mimosine the addition of ferrous sulphate to the diet is not necessary as it would be for other strains of high mimosine leucaena.

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