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"LEUCAENA LEUCOCEPHALA": A NEW FORAGE FOR FARM ANIMALS IN EGYPT.3- IN VITRO AND IN VIVO EVALUATION OF RATIONS CONTAINING DIFFERENT LEVELS OF LEUCAENA HAY BY SHEEP

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SUMMARY

Two experiments were carried out to evaluate leucaena hay as ruminants feed. In the 1st experiment, a basal diet was formulated to contain 70% concentrate feed mixture, 15% berseem hay and 15% rice straw. Eight combinations in which leucaena hay replaced from the concentrate feed mixture (on DM basis) at 10% increments were tested for in vitro dry matter (IVDMD) and organic matter (IVOMD) disappearance. The highest values of IVDMD (54.0%) and IVOMD (50.5%) were recorded for a mixture of 0% concentrate feed mixture + 70% leucaena hay + 15% berseem hay + 15% rice straw, while values recorded for the combinations containing from 10 to 60% leucaena hay were nearly similar. There were positive associative effects in IVDMD and IVOMD values of the different combinations used except for those containing 0 and 10% leucaena hay which showed negative associative effects.

In the 2nd experiment, feed intake, nutrients digestibility and nitrogen balance were determined for 3 experimental rations containing different levels of leucaena hay using 9 mature Ossimi male sheep (3 animals/ ration). Leucaena hay contributed 0,30 or 50% of the total rations in place of the concentrate feed

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mixture on SV basis. Absolute DM intake recorded for animals given ration containing 50% leucaena hay was significantly ($P<0.05$) lower compared with the other two groups. However, there were no significant differences among the three groups with regard to DM or SV intakes expressed as g DM or SV/kg $W^{0.75}$. All nutrients digestibility and values of TDN, SV and DCP were increased as the level of leucaena hay in the rations was increased. All animals in the three experimental groups were in positive nitrogen balance.

Keywords: Lecucaena hay, sheep, ration and digestibility

INTRODUCTION

In Egypt, there is a severe competition between animals and human on arable land unit. This is due to the limited cultivated land in the Nile Valley. This competition diminishes the probabilities of horizontal expansion of cultivable land unit animals. So, it is very important to look round for green forage that can bear on semi-arid conditions. These conditions are there in the desert land out of the Nile Valley. It was found that leucaena plant can bear the alkaline and acid land conditions. It also can be grown intensively under the conditions of semi-arid and tropical areas.

There are very few reports on the digestibility and feed intake of leucaena when fed to ruminants. Values of 50 to 71% for dry matter digestibility were reported in the literature for leucaena (Singh and Mudgal, 1967; Upadhyay et al. 1974; Jones, 1979 and Abo El-Nor, 1987). Certain reports indicated that leucaena can be fed safely to cattle and buffaloes to the extent of 30-40% of the green forage (Jones et al. 1978 and Hiremath, 1981).

A previous study (Abo El-Nor, 1987) indicated that leucaena could replace berseem hay in dairy goats rations. This proved the high ability of this plant to give high yield of milk production from Egyptian goats compared with feeding on berseem hay. Therefore, the objective of the present study was to minimize the cost of the ration by replacing the concentrate feed mixture by leucaena hay. The effect of replacing the concentrate feed mixture by different levels of leucaena hay in rations for sheep on feed intake, in vitro and in vivo

nutrients digestibility and nitrogen balance was studied in this work.

MATERIALS AND METHODS

Leucaena plants were cultivated at the Experimental Station of the National Research Centre, Kalubia Governorate during July,1987. The first cut was taken after 4 months from planting, followed by four cuttings which were taken every two months.

The plants of each cut were stacked to be sun dried (up to about 90% DM). During the drying period (10 days), the plants were shuffled up side down every two days to make a fine hay. After sun drying, leucaena hay was chopped to about 5 cm length and then stored under good condition till the beginning of the nutritional evaluation. All hays prepared from the five cuts were mixed together to be used it in in vitro and in vivo evaluation. Two experiments were carried out in this study to evaluate leucaena hay as ruminants feed.

Experiment (1): In Vitro work:

A basal diet was formulated to contain 70% concentrate feed mixture, 15% berseem hay and 15% rice straw.

Eight combinations in which leucaena hay replaced from the concentrate feed mixture (on DM basis) at 10% increments (Table 2) were tested for in vitro dry matter (IVDMD) and organic matter (IVOMD) disappearance using the two stages technique of Tilley and Terry (1963); modified by Norris et al., (1976). The different eight tested combinations of concentrate: leucaena hay: rice straw: berseem hay were, respectively (%): (I) 70:0:15:15, (II) 60:10:15:15, (III) 50:20:15:15, (IV) 40:30:15:15, (V) 30:40:15:15, (VI) 20:50:15:15, (VII) 10:60:15:15 and (VIII) 0:70:15:15. In vitro DM and OM disappearance were also determined for concentrate feed mixture, leucaena hay, berseem hay and rice straw samples and the IVDMD and IVOMD values for the different tested combinations were calculated to predict the associative effect.

Rumen contents were collected from rams fed on berseem hay diet approximately four hours after morning feeding and transferred directly to the laboratory in separate warnned oxygen-free plastic jugs. Rumen content

was then strained through two layers of cheese cloth and the obtained liquor was used for the in vitro studies.

Experiment (2): In Vivo work:

Digestibility and nitrogen balance trials were carried out with Ossimi sheep to determine nutrients digestibility, nutritive values and N-balance of rations containing different levels of leucaena hay.

Three experimental rations were tested in this experiment. Berseem hay and rice straw were used in equal parts as a basal ration in the three experimental treatments and each contributed 15% from the SV of the total ration. The control ration (T_1) consisted of 15% berseem hay, 15% rice straw and 70% concentrate feed mixture (on SV basis). In rations 2 (T_2) and 3 (T_3), leucaena hay contributed 30 and 50% of the total rations in place of the concentrate feed mixture on SV basis, respectively. The concentrate feed mixture used consisted of undecorticated cotton seed meal 25%, wheat bran 35%, yellow corn 30%, rice bran 4%, molasses 3%, limestone 2% and sodium chloride 1%. The chemical analysis of the concentrate feed mixture, leucaena hay, rice straw and berseem hay are presented in Table (1).

Table (1): Chemical composition of dietary ingredients (on dry matter basis).

Items		Concentrate feed mixture	Berseem hay	Rice straw	Leucaena hay (leaves+branches)
Moisture	(%)	11.1	6.3	9.9	8.5
Dry matter	(%)	88.4	93.7	90.1	91.5
Ash	(%)	11.3	11.5	16.7	7.8
Organic matter	(%)	88.7	88.5	83.3	92.2
Crude protein	(%)	18.3	13.4	4.5	23.9
Ether extract	(%)	3.9	3.8	1.4	6.1
Crude fibre	(%)	18.3	14.3	42.2	18.0
Nitrogen free extract	(%)	48.2	57.0	35.2	44.2
Phosphorus	(%)	0.590	0.160	0.070	0.723
Sodium	(%)	0.210	0.630	0.240	0.494
Calcium	(%)	0.570	1.680	0.750	3.193
Potassium	(%)	1.330	1.780	0.040	2.864
Magnesium	(%)	0.600	0.410	0.290	0.228
Copper	mg/kg	8.000	16.000	10.000	48.087
Iron	mg/kg	19.000	21.000	11.000	42.497
Zinc	mg/kg	0.012	0.022	0.006	13.115
Manganese	mg/kg	74.000	30.000	11.000	43.060
Starch value	(%)	52.0*	32.0**	21.7**	54.0***
Digestible protein	(%)	10.2*	9.0**	0.0**	20.1***

* From Salman (1991), ** From Abou-Raya(1967), *** From Abo El-Nor (1987)

Nine mature Ossimi male sheep of about 3 years age were divided into three groups with 3 animals each, their average body weight in groups I,II and III were 50,51 and 48 kg, respectively. The three animal groups were randomly alloted to receive one of the three experimental rations. The animals were individually confined in metabolic crates. The digestibility trials consisted of 28 days of which the first 21 days were considered as preliminary period followed by a period of 7 days for total collection of faeces and urine.

The offered daily feed from concentrate, leucaena hay, rice straw and berseem hay were assessed to cover the maintenance requirements for each animal from starch value (SV) and digestible protein(DP) according to ARC (1965) recommendations.

The experimental animals were fed individually. The concentrate feed mixture and leucaena hay were offered once daily at 08.00 and 09.00 hr., respectively. The rice straw and berseem hay were also offered once daily at 10.00 after accessing the animals to fresh water which was available for the animals all the day period. The animals were weighed at the beginning and at the end of the experiment.

During the collection period, faeces and urine were quantitatively collected from each animal once daily at 07.00. Residues of feedstuffs if any, were also recorded.

Dry matter CP, CF, EE and ash of the dietary ingredients, faeces and feed residues and urinary nitrogen were determined according to A.O.A.C. (1980) procedures. Nitrogen free extract was obtained by difference. Minerals of the dietary ingredients were determined as mentioned by Jackson (1958) using atomic absorption spectrophotometer (IL-S-12).

Statistical analysis:

Data obtained were statistically analysed according to Snedecor and Cochran (1980). A simple one-way classification analysis followed by Duncan's multiple- range test for testing the significance between means were used.

RESULTS AND DISCUSSION

Experiment (1): In Vitro work:

Results concerning (IVDMD) and (IVOMD) of different combinations of concentrate feed mixture, leucaena hay, berseem hay and rice straw are shown in Table (2) and Fig.(1). It is found that IVDMD values of the different combinations containing from 0 to 60% leucaena hay were nearly similar (Table 2), they ranged between 49.9 to 52.5%. However, the mixture containing 70% leucaena hay showed the highest value of IVDMD (54%). Data of table (2) showed approximately similar values of IVOMD for mixtures containing from 10 to 60% leucaena hay. However, it is of interest to notice that the lowest and highest values of IVOMD were recorded for mixtures containing 0 and 70% leucaena hay, resp. Differences between the different combinations were not significant neither for IVDMD not IVOMD. Similar results have been reported by Abo EL-Nor,(1987) who found that the mixture of 75% leucaena forage +25% concentrate feed mixture showed higher IVOMD value (53.7%), than those of the mixtures of leucaena forage and concentrate feed mixture at ratios of 50:50% (41.8%)o 25:75% (41.9%),resp

The present results indicate also that there were positive associative effects in IVDMD and IVOMD of the different combinations used except for those containing 0 to 10% leucaena hay which showed negative associative effects (Table 2) .

Results of Table(2) indicated that IVDMD and IVODM values of 100% leucaena hay were better than those of 100% berseem hay or 100% rice straw. This result may be explained on the basis of the higher protein content of leucaena than that of both berseem hay and rice straw. The lower values of IVDMD and IVOMD for 100% leucaena hay than 100% concentrate feed mixture may probably be due to the influence of tannic acid found in leucaena as antinutritional factor on the degradability of leucaena hay (Jones, 1979 and Gupta and Chopra, 1985). Similar results have been reported by Abo El-Nor (1987), who found that IVDMD and IVOMD values of the concentrate feed mixture were greater than those of leucaena forage (71.7 and 68.0% vs. 44.7 and 40.5%). He also found that values of IVDMD and IVOMD of berseem hay were somewhat lower than those of leucaena forage being 37.0 and 28.5%, respectively.

Table 2. In Vitro dry matter and organic matter disappearance for concentrate feed mixture, leucaena hay, rice straw, berseem hay and different combinations from them.

Treatments	In Vitro dry matter disappearance, %			In Vitro organic matter disappearance, %		
100% concentrate feed mixture (CFM)			63.1a			60.6a
100% leucaena hay (LH)			47.6a			43.5a
100% berseem hay (BH)			41.1c			36.9b
100% rice straw (RS)			32.1b			30.9b
	Determined	Calculated	Associative effect unit percentage	Determined	Calculated	Associative effect unit percentage
70%CFM+0%LH+15%RS+15%BH	51.3a	55.0	-3.7	44.9a	52.9	-8.0
60%CFM+10%LH+15%RS+15%BH	51.9a	53.4	-1.5	48.2a	51.1	-2.9
50%CFM+20%LH+15%RS+15%BH	52.5a	51.9	+0.6	50.0a	49.4	+0.6
40%CFM+30%LH+15%RS+15%BH	52.0a	50.3	+1.7	48.9a	47.7	+1.2
30%CFM+40%LH+15%RS+15%BH	50.3a	48.8	+1.5	48.2a	46.0	+2.8
20%CFM+50%LH+15%RS+15%BH	49.9a	47.2	+2.7	47.1a	44.3	+2.8
10%CFM+600%LH+15%RS+15%BH	50.2a	45.7	+4.5	48.2a	42.6	+5.6
0 %CFM+70%LH+15%RS+15%BH	54.0a	44.1	+9.9	50.5a	40.9	+9.6

a,b,c Means in the same cloumn with different letters are significantly ($P<0.05$) different.

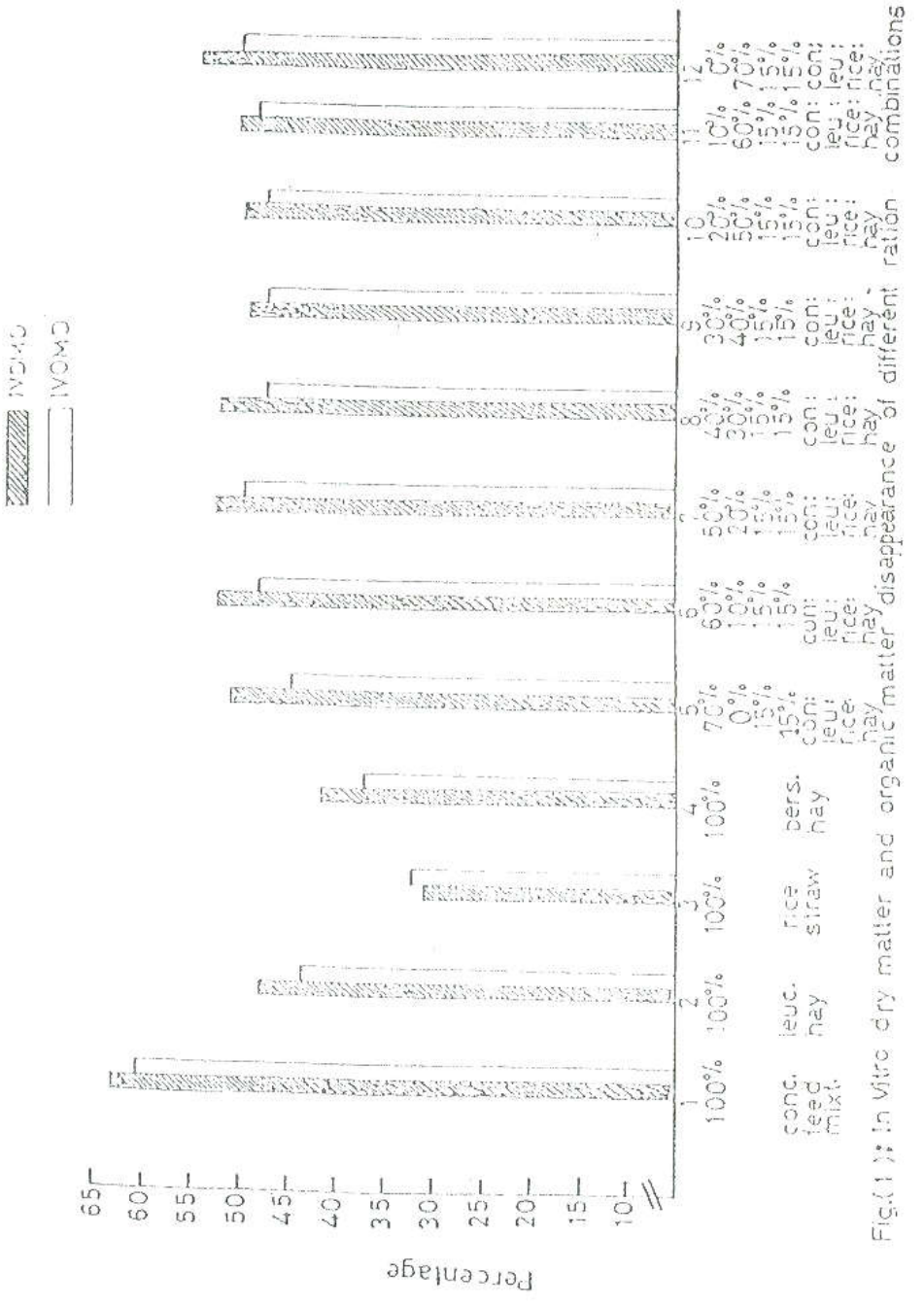

Fig. 1 :* In Vitro dry matter and organic matter disappearance of different ration combinations.

Experiment (2): Feed intake and nutrients digestibility:

Mean values of DM intake, SV intake, nutrients digestibility, nutritive values and N balance for sheep given rations containing different levels of leucaena hay are presented in Table (3). Absolute DM intakes recorded for animals fed ration 3 were significantly ($P<0.05$) lower than those recorded for animals given rations 1 or 2. Also, absolute DM intake values recorded for group (1) were somewhat lower than those observed for group (2). These differences in absolute DM intakes may be attributed to the variation in the live body weight of the animals among the three tested groups. Although, there were no significant differences among the three groups with regard to g DM intake/$w^{0.75}$, yet there was a tendency however, for decreased intake by animals given ration containing 50% leucaena hay. This may be due to the palatability factors.

Table (3): Mean values of DM and SV intake, nutrients digestibility, nutritive values and N-balance recorded on sheep given rations containing rice straw, berseem hay, concentrate feed mixture and 30% or 50% leucaena hay.

Parameter	Control	30% leucaena	50% leucaena
DM intake:			
g/animal/day	1003.3a	1043.3a	916.5b
g/$w^{0.75}$/day	53.4	54.9	50.4
SV intake:			
g/animal/day	469.5	529.0	498.6
g/$w^{0.75}$/day	25.0	27.8	27.4
Nutrients digestibility (%):			
DM	63.5a	63.6a	69.6b
OM	62.2	63.0	68.1
CP	71.9A	73.2A	77.4B
CF	46.8	48.6	52.0
EE	77.1a	86.4b	88.7b
NFE	71.4	73.7	74.8
Nutritive value (%,DM basis):			
TDN	60.7A	64.9B	68.8C
SV	46.8A	50.7B	54.4C
DCP	11.2A	12.2A	14.1B
N-balance:			
N intake, g/animal/day	25.0	27.9	26.7
N blance, g/animal/day	+ 4.8	+ 5.0	+ 4.1
N blance, % intake	19.2	17.9	15.4
N blance, % digested	26.7	24.5	19.8

a,b means in the same row with different letters are significantly ($P<0.05$) different.

A,B,C means in the same row with different letters are significantly ($P<0.01$) different.

There were no significant differences among the three experimental group with regard to SV intake expressed as g/animal/day or g/kg $w^{0.75}$. However, animals given rations containing 30 or 50% leucaena hay showed higher SV intake than those given ration containing 0% leucaena hay (control).

In general, it is of interest to notice (Table 3) that digestibility coefficients of DM, OM, CP, EE and NFE were increased as the level of leucaena hay in the rations was increased. The differences between treatments were not significant regarding OM, CF and NFE. Similar results were obtained by Gupta and Raheja (1986), who found that increasing the level of leucaena from 0 to 100% in place of concentrate feed mixture increased nutrients digestibility. However, Akbar (1983) found that when leucaena replaced 25 and 50% of the concentrate feed mixture no significant differences were detected either in CP nor in EE digestibility.

It is clear from the present results that the values of in vivo DM and OM digestibility (Table 3) of the different experimental combinations appear to be higher than those of IVDMD and IVOMD (Table 2). Similar results have been reported by Hulman and Owen (1977) and Abo El-Nor (1987).

The results obtained indicated also that as the level of leucaena hay was increased, the TDN, SV and DCP of the rations were significantly ($P<0.01$) increased. Disagreement results were recorded by Akbar and Gupta (1985) who found non significant differences among rations containing 0, 25 and 50% leucaena hay for TDN, DCP and SE.

All animals in the three experimental groups were in positive nitrogen balance. Although, there were no significant differences among the three groups with regard to nitrogen balance in terms of g/animal/day or expressed as% from nitrogen intake or nitrogen digested, yet there was a tendency however, for decreased nitrogen balance expressed as % from nitrogen intake or nitrogen digested with increasing the level of leucaena hay in the ration. Johri et al., (1983) found that there was a highly positive nitrogen balance in goats when fed on different levels of leucaena (50, 75% and 100%).

During the present study, no adverse effects on the health and weight of the animals were observed. There was no loss hairs in sheep. Similar results were

reported by Gray (1968) with cattle, Johri et al., (1983) and Abo El-Nor (1987) with goats. On the contrary, Joshi and Upadhyay (1976) reported loss of wool in sheep.

The present study demonstrated the possibility of using leucaena hay in rations for sheep up to 50% of SV of the ration in place of the concentrate feed mixture at maintenance level. Further work is needed to study the effect of using different levels of leucaena hay in ration for growing or lactating animals on their performance.

REFERENCES

Abo El-Nor, S.A.H., 1987. Studies on the nutritive value of leucaena in rations for ruminants. M.Sc. Thesis Ain Shams Univ.

Abou-Raya, A.K., 1967." Animal and Poultry Nutrition". Dar El-Maarif, Cairo. (Arabic Text Book).

Akbar, M.A., 1983. Studies on the subabol (leucaena leucocephala) as a source of protein supplement for buffalo- calves. M.Sc. Thesis, Haryana Agric. Univ., Hisor.

Akbar, M.A. and P.C. Gupta, 1985. Subabol (leucaena leucocephala) as a source of protein supplement for buffalo-calves. Indian J. of Anim. Sci. 55:54.

A.O.A.C., 1980. "Official Methods of Analysis" 13th ed. Association of Analytical Chemists. Washington, D.C., U.S.A.

A.R.C., 1965. The nutrient requirements of farm livestock. No. 2. Ruminants Tech. Rev. and Summaries Agric. Res. Council. London.

Gray, S.G., 1968. A review of research on leucaena leucocephala. Tropical grasslands. 2:19.

Gupta, B.K. and A.K. Chopra, 1985. Leucaena leucocephala (Subabul). A multipurpose fodder plant livestock adviser, 10:5.

Gupta, B.K. and R.K. Raheja, 1986. Lipid, mineral and other nutritional components of subabol (leucaena leucocephala) seeds. Ind. J. of Anim. Nutrition, 34:233.

Hiremath, N.B.,1981. Subabul (leucaena leucocephala). A wonder plant, Indian J. Dairyman, 33:351.

Hulman, B. and E. Owen, 1977. Acacia (leucaena leucocephala) as a protein and forage source in beef cattle diets containing high levels of molasses /urea. M. Phil. 1. Thesis Univ. of Reading, England (National Academy Press, 1984).

Jackson, M.L., 1958. Soil chemical analysis. Prentice-Hall, Inc. Englewood Cliffs, N.J.

Johri, C.B., S.K. Bansal and G.S. Rai, 1983. Nutritional potential of leucaena leucocephala in goats. Indian J. Anim. Sc. 53:1343.

Jones, R.J. 1979. The value of leucaena leucocephala as a feed for ruminants in the tropics. World Anim. Rev. 31:13.

Jones, R.J., C.G. Blunt and B.L. Nurberg, 1978. Toxicity of leucaena leucocephala: The effect of iodine and mineral supplements on penned steers fed a sole diet of leucaena. Australian Vet. J. 54:387.

Joshi, D.C. and R.B. Upadhyay, 1976. Leucaena leucocephala an ever green protein-rich tree fodder and the possibility of using it in the dietary of animals. 1. Sheep. Indian Vet. J. 53:606.

Norris, K.H., R.F. Barnes, J.E. Moor and J.S. Shenk, 1976. Predicting forage quality by infrared reflectance spectroscopy. J. Anim. Sci. 43:889.

Salman, F.M.M., 1991. Nutritional evaluation of processed waste materials in rations for ruminants. Ph.D. Thesis, Ain Shams Univ. Fac. of Agric., Egypt.

Singh, H.K. and J.D. Mudgal,1967. Chemical composition and nutritive value of leucaena glauca (wite popinac). Indian J.Dairy Sci. 20:191.

Snedecor, G.W. and W.G. Cochran, 1980. Statistical Methods. 7th Ed. Allied Pacific, Bombay.

Tilley, J.M.H. and R.A. Terry, 1963. A two stage technique for the In Vitro digestion of forage crops. J. Brit. Grass, Soc. 18:104.

Upadhyay, V.S., A. Rakib and P.S. Pathak,1974. Nutritive value of leucaena leucocephala (Lam.). Indian Vet. J. 51:534.

" نبات الليوكينا كعلف جديد للحيوانات المزرعية فى مصر " ٣- التقييم الغذائى لعلائق الاغنام المحتوية على نسب مختلفة من دريس نبات الليوكينا

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اجريت تجربتين لتقييم دريس نبات الليوكينا كمادة علف يمكن ان تدخل فى علائق المجترات. ففى التجربة الاولى تم تقدير معامل هضم المادة الجافة والمادة العضوية معمليا باستخدام الكرش الصناعى لثمانى مخاليط احتوت على نسب متدرجة من دريس الليوكينا (صفر ، ٢٠ ، ٣٠ ، ٤٠ ، ٥٠ ، ٦٠ ، ٧٠٪) وذلك بالاضافة الى العلف المركز ودريس البرسيم وقش الارز ، وقد اوضحت النتائج ان اعلى قيم لمعامل هضم المادة الجافة والمادة العضوية سجلت للمخاليط المحتوية على ٧٠٪ دريس الليوكينا حيث كانت ٥٤,٠ ، ٥٠,٥٪ على التوالى ، بينما كانت القيم المسجلة للمخاليط المحتوية على دريس الليوكينا بنسب من ١٠ الى ٦٠٪ متقاربة وكان هناك تأثير مشترك موجب لجميع المخاليط المحتوية على صفر او ١٠٪ دريس الليوكينا حيث كان هناك تاثير مشترك سالب.

خلال التجربة الثانية استخدم ٩ ذكور اغنام اوسيمى تامة النمو فى تقدير كمية المأكول ومعاملات الهضم لثلاثة علائق تجريبية احتوات على دريس الليوكينا بنسب تمثل صفر ، ٣٠ ، ٥٠٪ من معادل النشا الكلى للعلائق التجريبية بدلا من مخلوط العلف المركز (٣ حيوان / عليقة) وقد اوضحت النتائج ان كمية المادة الجافة المأكولة من العليقة المحتوية على ٥٠٪ دريس الليوكينا كانت اقل معنويا بالمقارنة بالعلائق الاخرى بينما لم تكن هناك فروق معنوية فى كمية معادل النشا المأكول بالنسبة للعلائق التجريبية الثلاث . ومن ناحية اخرى لم تظهر فروق معنوية بين العلائق التجريبية الثلاث سواء بالنسبة لكمية المادة الجافة المأكولة او معادل النشا المأكول والمحسوبة لكل وحدة من حيز الجسم التمثيلى.

تحسنت معاملات هضم جميع المركبات الغذائية والقيم الغذائية المقدرة في صورة مركبات مهضومة كلية ومعادل نشا وبروتين خام مهضوم بزيادة نسبة دريس الليوكينا فى العلائق التجريبية . سجلت جميع الحيوانات المغذاه على جميع العلائق التجريبية ميزان ازوت موجب ولم تكن هناك فروق معنوية بين المعاملات المختلفة بالنسبة لقيم ميزان الآزوت .