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Effect of Supplementation of Urea, Natural Proteins or Protected Protein of Plant or Animal Origin on the Utilization of Poor Quality Roughages. II. Lamb Performance.

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THIRTY-TWO Rahmany male of 6 month-old were alloted into 8 equal groups. The animals received wheat straw rations without nitrogen (N.) supplementation or with a supplement of urea, untreated casein (UCAS), formaldehyde treated casein (FCAS), urea + FCAS, untreated decc rtecated cottonseed meal (UCSM), formaldehyde treated decortecated cottonseed meal (FCSM) or urea + FCSM. The experimental period lasted for 12 weeks, The results showed that highest feed intakes were recorded for lambs given wheat straw supplemented by FCSM or FCAS in the presence of urea or the absence of it. Intermediate intakes were recorded for animal given wheat straw supplemented by UCSM, UCAS or urea only.Lowest feed intakes were recorded for Lambs given wheat straw only.

Animals given wheat straw without N-supplementation lost weight and the mortality rate of this group was high. The addition of 2% urea only, UCAS or UCSM caused a remarkable increase in daily gain. Supplementation of wheat straw diet with FCAS or FCSM greatly increased daily gain ($P<0.05$) compared with that recorded for the groups given urea, UCAS or UCSM, The inclusion of urea with FCAS or FCSM significantly improved lamb performance compared with most other treatments, Animals given wheat straw supplemented by urea + FCAS showed the best feed efficiency value Poorest feed efficiency value was recorded for the animals given wheat straw supplemented by urea only.

The present study demonstrated clearly the potentiality of using urea, natural or protected proteins in improving intake and utilization of poor quality roughages by sheep,It also showed the superiority of animal protein on plant protein in this respect.

Preston (1981) stated that feeding strategies in tropical developing countries must be based on concepts different from those in developed temperate countries Most of the available agriculture waste materials should be properly used as animals feeds, to ensure maximum livestock production from minimum land

and resources available. Various approches have been attempted to improve utilization of these agriculture waste materials especially poor quality roughages by ruminants.

Protected proteins have recently been considered as one of the most important supplements for raising the nutritive value, increasing food intake of poor quality roughages and improving animal performance (Ferguson *et al.*, 1967 ; Sharma *et al*, 1972 ; Fichney *et al.*, 1973 ; Kempton and Leng, 1979 and Kempton *et al.*, 1977 and 1979. In a previous work (Soliman *et al.*, 1985) supplementing wheat straw by urea, unprotected or protected protein sources improved greatly nutrients digestibility and nitrogen utilization by growing lambs. The present work is therefore designed to examine the effect of urea, natural or protected proteins of animal or plant origin, on feed intake and the performance of growing lambs given wheat straw as the main feed.

Materials and Methods

Feeding trials were carried out with growing Rahmany lambs. A basal ration of wheat straw was used to study the effect of supplementation with urea, unprotected or protected protein sources (plant or animal origin, given alone or in combination, on daily gain, food intake and efficiency of feed utilization of lambs given these rations.

Animals

Thirty-two Rahmany male lambs, of about 22 kg live weight and 6 month-old, were purchased from the Ministry of Agriculture (Sakha Station, Kafr El-Sheikh, Egypt) and transported to the Experimental Farm Station of the Fac. of Agric. Ain Shams Univ., Shoubra El-Kheima Cairo. They were kept in the experimental farm station under veterinary medical care for a preliminary period of 15 days during which they received berseem hay plus the Co-op concentrate mixture at the rate of 300 g concentrate/head/day and the hay was given ad-lib.

Management

At the end of the preliminary period (15 days),the animals were divided according to their body weights in 8 groups of four lambs each, and within groups assigned at random to receive one of eight experimental rations. Each group was kept in a separated brick made pens. The animals were weighed weekly during the growth trial before the morning meal. The growth trial lasted for 12 weeks. The animals were offered their diets ad-lib twice daily in equal parts at 8·00 and 17·00. The amount of rations offered was adjusted every 4 weeks to ensure that the rations were in excess of the voluntry intakes of the animals. Water and salt blocks were available freely to the animals.

Representative samples of rations offered were taken every day for DM determinations. Residual rations were weighed every day during the experimental period, and representative samples were taken for DM determinations (according to A.O.A.C. procedures, 1970). Feed intake was calculated (on DM basis) as the difference between rations offered and residues.

Experimental rations

Eight different experimental rations were tested in this experiment. They were based mainly on chopped wheat straw given ad-lib as a basal ration. A supplement of co-op feed mix. was given at the rate of 100 g DM/animal/day to each animal. Supplements of urea, formaldehyde treated or untreated casein or decortecated cottonseed meal (D.C.S.M.) or combinations of them were added to the basal ration according to the treatment as shown below.

Ration No

1. Wheat straw (basal ration).
2. Wheat straw + 2% urea (20 g urea per kg wheat straw) spray.
3. Wheat straw + untreated casein which calculated to supply the same amount of nitrogen derived from urea as in ration II.
4. Wheat straw + casein treated with 1% formaldehyde (protected casein) calculated to supply the same amount of nitrogen derived from urea or untreated casein (rations II and III).
5. Wheat straw + 2% urea + protected casein similar to that in ration III.
6. Wheat straw + untreated D.C.S.M calculated to supply an amount of nitrogen equal to that of 2% urea.
7. Wheat straw + 1% formaldehyde treated D.C.S.M. (protected D.C.S.M.) calculated to supply an amount of nitrogen equal to that of 2% urea.
8. Wheat straw + 2% urea + protected D.C.S.M. similar to that of ration VII.

Ground co-op-feed mix. consisted of 37% undecortecated cottonseed meal, 25% ground yellow corn, 15% rice germ meal, 3% molasses, 15% wheat bran, 5% lime stone and minerals El-Sabe Tanta feed mill co. was added to the 8 experimental rations at a level of 100 mg DM/head/day.

Urea was dissolved in a proper volume of water then sprayed on wheat straw mixed properly and left to dry in the sun for two days. Sodium sulfate was dissolved in the urea solution at the rate of 10% sulfur of the nitrogen supplied by urea.

The amounts of co-op-feed mix. and protected or unprotected protein sources were added to diluted cane molasses (calculated to provide 2% of the weight of wheat straw) to ensure good mixing and the mixture was mixed again with wheat straw according to the treatment.

Methods used for casein and D.C.S.M. protection

Casein was treated with formaldehyde according to the procedure of Ferguson *et al.*, (1967). Decortecated cottonseed meal was sprayed witha formaldehyde solution (40 %) calculated to provide 1 gm formaldehyde/ 100 gm protein. The treated D.C.S.M. was stored for 7 days in plastic bags in room temperature before being used. (See Soliman *et al* 1985).

Statistical analysis

Data obtained for daily gain were statistically analyzed according to Snedecor and Cochran (1967).

Results

General

Two animals died in the last 4 weeks of the experiment, from the group given the control diet (wheat straw), because their feed intakes were very low and their body weight losses were very high. The remaining animals in this group although lost weight during the trial yet they completed the experimental period and this will be discussed in more details in the discussion. A part from this all other animals completed the experiment with no health problems.

The experimental period which lasted for 12 weeks was divided into two periods mainly the first 6 weeks of the experiment and the last 6 weeks of it. Results concerning, feed intakes, daily gains and feed efficiency values were therefore calculated for the two periods and over the entire experimental period, and the data recorded are presented in Table 1 and 2

1. *Feed intakes*

1.1. *First experimental period*

During the first experimental period absolute DM intakes (g/ animal day), for the eight groups of lambs ranged from 640 to 1120 g/ animal / day. Highest DM intakes were recorded for animals given wheat straw sprayed with 2.0 % urea and supplemented by formaldehyde treated casein (FCAS) or cottonseed (FCSM) meal (Treatments 5 and 8), followed by those given wheat straw (No urea) supplemented with FCAS or FCSM (Treatments 4 and 7) and was lowest for those given wheat straw only, wheat straw supplemented by urea or untreated casein (UCAS) or untreated cottonseed meal (UCSM) (Treatments 1, 2, 3, and6).

A trend similar to that recorded for absolute feed intakes was recorded for intakes/ $Kgw^{0.75}$ except for groups given wheat straw only or supplemented by FCAS, which showed somewhat higher values.

1.2. *Second experimental period*

During the second experimental period, highest absolute DM intakes were recorded for groups given wheat straw supplemented by FCAS or FCSM or either supplements by urea (treatments 5, 8, 4, and 7), followed by those given wheat straw supplemented by urea, UCSM or UCAS (Treatments 2,6, and 3) and was lowest for the control group (Table 1). These results showed that absolute feed intakes improved for all groups of animals during the second experimental period compared with the first one except for the control group in which feed intake was greatly depressed during this period. The magnitude of improvement was greatest for lambs given diets 2 and 3, intermediate for those given diets 4, 7 and 5 and was lowest for those given diets 6 and 8.

TABLE 1. Dry matter intakes of growing lambs given wheat straw supplemented by urea or untreated or formaldehyde treated cottonseed meal or casein.

Treatment number	First experimental Period (1st 6 , weeks)		Second experimental Period (2nd 6 weeks)		Entire experimental Period (12 weeks)	
	g/Animal/day	g/W $^{0.75}$day	g/Animal/day	g/W$^{0.75}$day	g/Animal/day	g/W$^{0.75}$day
1. Wheat straw	734	76.9	400	46.2	567	61.6
2. Wheat straw + urea	643	57.5	895	80.1	769	68.8
3. Wheat straw + untreated casein	760	64.6	929	79.0	845	71.9
4. Wheat straw + treated casein	970	79.2	1148	93.7	1059	86.4
5. Wheat straw + urea + treated casein . .	1046	79.6	1216	92.5	1131	86.1
6. Wheat straw + decortecated cottonseed meal (D.C.S.M)	756	64.7	850	72.8	803	68.8
7. Wheat straw + treated D.C.S.M.	853	73.5	1011	87.2	932	80.3
8. Wheat straw + urea + treated D.C.S.M.	1119	93.2	1129	94.0	1124	93.6

A trend similar to that recorded for absolute intakes was recorded for DM intakes / kgW $^{0.75}$ during the second experimental period.

1.3. *Entire experimental period*

Data recorded for absolute DM intakes over the entire experimental period (Table 1) was a reflection to those recorded during the first and second experimental periods, being highest for lambs given wheat straw supplemeneted by FCSM or FCAS in the presence of urea or the absence of it (Treatments 8, 5, 4 and 7). Intermediate intakes were recorded for animals given wheat straw supplemented by untreated CSM or CAS (Treatments 6and3), followed by those given wheat straw supplemented by urea. Lowest feed intakes were recorded for lambs given wheat straw only (control group).

2. *Daily gains*

Data concerning changes in body weight gains along with feed efficiency recorded during the different experimental periods for lambs given the different nitrogen supplements are presented in Table 2,

2.1. *First experimental period*

The results showed that lambs given the control ration (Treatment 1) lost weight (-35 g/ day) during this period. The addition of 2.0 % urea only (Treatment 2), caused a remarkable increase in daily gains from -35 to + 56 g/ day. Inclusion of either UCAS (Treatment 3) or UCSM (Treatment 6) greatly increased daily gains from - 35 g/ day (Treatment 1) to + 75 or + 71 g/ day (Treatments 3 & 6). Daily gains of the group given the casein supplement were however somewhat higher than that of the group given the cottonseed meal supplement.

Supplementation of wheat straw diet (basal ration) with FCAS or FCSM greatly increased daily gains (Treatments 4 & 7). This increase exceeded that recorded for the groups given the UCAS or UCSM (Treatments 3 & 6). The improvement achived with protection of casein was higher than that achived with protecting cottonseed meal (43 vs 23 %) over the non-protected materials.

The inclusion of urea with protected casein (Treatment 5) or cottonseed meal (Treatment 8) caused a remarkable increase in daily gains which mounted to 40 % for casein and 37 % for cottonseed meal over the groups given protected proteins only.

When these results were compared with the daily gains recorded for group given wheat straw supplemented by urea only it was evident that the inclusion of FCAS or FCSM caused an improvement of 168 % and 113 % over the urea supplemented wheat straw group. Treated casein was more effective than treated cottonseed meal in this respect.

TABLE 2. **Average daily gain and feed efficiency (F.C.) recorded during the different experimental periods for growing lambs given rations containing different nitrogen supplements.**

Treatment number	First period		Second period		Whole period	
	ADG	F.e*	ADG	F.e*	ADG	F.e*
1. Wheat straw	—35	—	—71	—	$-53^{A,B}$	—
2. Wheat straw + urea	56	8.7	78	8.7	$67^{B,b}$	8.7
3. Wheat straw+untreated casein	75	9.9	91	9.8	$83^{B,b}$	9.8
4. Wheat straw+treated casein	107	11.0	125	10.9	$116^{B,c}$	11.0
5. Wheat straw+urea+treated casein	150	13.3	164	13.5	$157^{C,a}$	13.9
6. Wheat straw+decortecated cottonseed meal (D.C.S.M.)	71	9.4	81	9.5	$76^{B,b}$	9.5
7. Wheat straw+treated D.C.S.M.	87	10.2	101	10.0	$94^{B,c}$	10.1
8. Wheat straw+urea+treated D.C.S.M.	119	10.6	123	10.9	$121^{B,c}$	10.8

a,b Means with different superscripts are significantly ($P<0.05$) different.
A,B,C Means with different superscripts are significantly ($P<0.01$) different.
* g. gain/100g DM intake.

2.2. *Second experimental Period*

The group given the control ration continued to loose body weight during this period. Body weight losses recorded during this period was twice as much as that recorded during the first period.

Daily gains recorded for the other 7 groups followed a trend similar to that recorded during the first period. There was however, a general improvement daily gains during this period compared with the values recorded during the first period. The magnitude of improvement was greatest for the group given urea supplemented wheat straw, intermediate for groups 3, 4, 5, 6 and 7 and was least for group 8 (urea + FCSM).

2.3. *Whole exp erimental period*

Daily gains recorded during this period was a reflection to that recorded during the first and second experimental periods. Statistical analysis showed that differences between the control group and all other groups were statistically significant ($P<0.01$).

Differences between the groups given urea only or either UCAS or UCSM (Treatments 2, 3, & 6) were not statistically significant. Differences between groups 4, 7 and 8 (FCAS, FCSM or FCSM + urea) and all other groups were statistically significant ($P<0.05$).

Animals given wheat straw supplemented by urea and FCAS showed the highest daily gains compared with the other groups ($P<0.05$ & $P<0.01$).

3. *Feed efficiency*

As the group given the control wheat straw diet lost weight during the *1st*, *2nd* and over the entire experimental period, therefore no feed efficiency values were calculated for this group.

3.1. *First experimental period*

Animals given wheat straw supplemented by urea and FCAS (treatment 5) showed the best feed efficiency value, followed by those given treated or untreated casein or cottonseed meal or those given FCSM + urea. Poorest feed efficiency value was recorded for the group given treatment 2 (urea supplemented wheat straw only).

3.2. *Second experimental period*

Results recorded for feed efficiency during this period followed a trend similar to that recorded during the first experimental period. No dramatic or nearly very little changes were recorded in the feed efficiency values during this period compared with the first period.

3.3. *whole experimental period*

Values recorded for feed efficiency over the entire experimental period were nearly similar to those recorded during the *1st* or *2nd* experimental periods and followed similar trends.

Differences in feed intakes, daily gains and efficiency of feed utilization were statistically significant ($P<0.05$) throughout the different experimental periods.

Discussion

As the trends recorded for feed intakes, daily gains and efficiency of feed utilization during the two experimental periods were nearly similar, the discussion, therefore will be limited to the data recorded over the entire experimental period only.

The present results showed clearly that un-supplemented wheat straw when given as the main feed to growing lambs resulted in low feed intakes, body weight losses and high mortality rate. Similar results have been reported by

kempton and Leng (1979) for lambs and Dolberg *et al.*, (1981) for cattle. This was expected since many workers (Balch, 1950; Campling *et al.*, 1962; Van Soest, 1964; Baile and Forbes, 1974; Jackson, 1977; Kempton and Leng, 1979, Preston, 1981; Dolberg *et al.*, 1981 and Ørskov, 1982) have shown that low energy density, low nitrogen content along with high fiber contents of poor quality roughages are the main constraints limiting their use as main diets for ruminants. This was substantiated by the low value obtained for nutrients digestibility and N-balance recorded for lambs given this diet (Soliman *et al.*, 1985). The decreased animal performance may have been related to the possibility that N-requirements for rumen micro-organisms may have not been met on the un-supplemented wheat straw treatment.

Effect of urea supplementation

Urea supplementation to wheat straw, (Treatment 2) significantly improved feed intakes and daily gains. Similar results have been reported by Campling *et al.*, (1962); Hemsley and Moir (1963); Kempton and Leng (1979) and Kempton *et al.*, (1979) for animals given low quality roughages supplemented by urea. The improved animal performance with urea supplementation may have been due to the possibility that the requirements of N for rumen microbes have been at least partially or completely met Krause and Klopfenstein, 1978; Kempton and Leng, 1979 and Soliman *et al.*, 1983). This assumption was substantiated by the improved feed intake and daily gains, recorded for this treatment compared with the control treatment.

Effect supplementation by untreated casein or D.C.S.M.

The results obtained in this experiment showed that supplementation by casein or D.C.S.M. slightly improved lamb performance over that recorded for urea supplementation. This improvement was slightly higher for the casein than the D.C.S.M. supplement. The improved animal performance associated with natural protein rather than urea was not clear. Hume (1970) showed that microbial yield was considerably greater when casein was the main dietary N source compared with urea. Maeng and Baldwin (1976) showed that the replacement of 25 % of the dietary urea N by a mixture of amino acids doubled microbial biomass. The results of Hume (1970) and Maeng and Baldwin (1976) may explain the improved animal performance with casein or cottonseed meal supplementation.

The slight improvement in animal performance with casein compared with cottonseed meal supplementation may be considered as an indicative to certain essential amino acid requirements by the rumen micro-organisms. Apart from other essential amino acids, casein contains higher concentrations of sulfur containing amino acids than D.C.S.M. (See Schaible, 1970), and this may explain the improvement in animal performance for the casein group over the D.C.S.M. group. The possibility that differences in the type of branched chain fatty acids produced from deamination of casein or D.C.S.M. in the rumen and required by rumen micro-organisms, may have also been responsible for the slight differences obtained between the two supplements, can not be ruled out (Ørskov, 1982).

Effect of supplementation by formaldehyde treated casein or D.C.S.M.

Supplementation with protected casein or D.C.S.M. significantly increased lamb performance in terms of feed intakes, daily gains and feed efficiency over those given urea or unprotected casein or D.C.S.M. Similar results have been reported by Reis and Schinkel (1963); Ferguson *et al.*, (1967); Peter *et al.*, (1971); Sharma *et al.*, (1972); Faichney *et al.*, (1973); Faichney and Davies (1973); Reynolds *et al.*, (1978); Kempton and Leng (1979) and Kempton *et al.*, (1979). This has been explained on the basis of improved N-status of the animals (Egan and Moir, 1965; Egan, 1966; Weston, 1971; Faichney and Weston, 1971; Weston, 1973; Faichney, 1974; Egan, 1977 and Kempton and Leng, 1979).

The slight improvement recorded for the group given protected casein over those given protected D.C.S.M. may have been partially related to differences in the extent of protection achived for the two protein sources. According to the method used for casein protection (Ferguson *et al*, 1967) formaldehyde treated casein was only slightly degradable (4·0 % after 24 hr. of incubation *In-Vitro*), while that of D.C.S.M. reached 60 to 75 % after 12 and 24 hrs. of incubation. Although both methods may not accuratly be indicative to the actual degradability of both protein sources (Grummer and Clark 1982), they still can be used as a guide line to the extent of degradability of both protein sources. In other words, it is possible to speculate that degradability of treated casein was lower than that of D.C.S.M. It follows that more casein protein may have reached the abomasum and the small intestine compared withD.C.S.M (Crooker *et al.*,1983)and this may have been responsible for the improved animal performance with protected casein over that achived with protected D.C.S.M. In this case the improved animal performance with protected casein may well be the resultant of differences in the amino acid profile resulting from partial degradation in the rumen and digestion in the small intestine of both protein sources.

Effect of supplementation with both urea and protected proteins

The results obtained in this study showed the superiority ofthis treatment over all other treatments studied. Similar results have been reported by Egan and Moir (1965); Kempton and Leng (1979), Kempton *et al.*,(1979) and Stock *et al.*, (1981). This was probably related to the possibility that addition of urea may have satisfied the microbial need for N on one hand and protected proteins may have satisfied at least partially the need of the host animal for proteins on the other hand. The superiority of casein over D.C.S.M. in supporting animal performance in the presence of urea may have been due to differences in amino acids composition between the two sources as discussed earlier.

Finally, the present results demonstrated clearly the potentiality of using urea, natural or protected proteins in improving intake and utilization of poor quality roughages, by sheep. It also showed the superiority of animal protein

on plant protein in this respect. These results are of great importance in the light of the recent trends adopted towards making best use of the available farm by-products as animal feeds in Egypt (See El-Shinnawy and AbouRaya, 1983 ; Hathout and El-Nouby, 1983 and Abou El-Naga, 1983).

Techniques such as urea supplementation, liquid supplements of urea-molasses, alkali treatment with urea (followed by storage) or ammonia with its different forms on farm or factory levels and/or other supplementations such as energy, natural or protected proteins should be considered if best use of farm by-products is to be achived.

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تأثير استخدام الاضافات من اليوريا أو البروتينات الطبيعية غير المحمية أو المحمية ذات الأصل النباتى أو الحيوانى عـــلى الاستفادة من الخشنة الفقيرة ٠
٢ ــ الأداء الانتاجى للحملان ٠

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أجريت هذه الدراسة باستخدام ٢٣ من ذكور الحملان الرحمانى النامية عمر ٦ أشهر ، وقد قسمت هذه الحيوانات الى ثمانية مجاميع متساوية فى العدد ، وغذيت حيوانات المجموعة الأولى (المقارنة) على عليقة تحتوى على تبن القمح دون أى اضافات نيتروجينية ، وغذيت المجاميع الأخرى على نفس العليقة مع اضافة أحد الاضافات التالية : يوريا فقط ، كسب قطن مقشور غير معامل ، كسب قطن مقشور معامل بالفورمالدهيد ، يوريا + كسب قطن مقشور معامل بالفورمالدهيد ، كازين غير معامل ، كازين معامل بالفورمالدهيد ، يوريا + كازين معـامل بالفورمالدهيد وقد استغرقت هـــذه التجربة ١٢ أسبوعا ٠ وأوضحت النتائج أن أعلى كمية غذاء ماكول سجلت للحملان المغذاة على عليقة تبن القمح المضاف اليها الكازين المعامل أو الكسب المعامل سواء عند اضافة اليوريا للعليقة أو عدم اضافتها ، بينما كانت كمية المـاكول متوسطة عند تغذية الحملان على علائق تحتوى على اضافة من الكازين غير المعامل أو الكسب غير المعامل أو اليوريا فقط ، وسجلت الحيوانات المغذاة على عليقة المقارنة أقل كمية غذاء ماكول ٠

حدث انخفاض كبير فى وزن الحيوانات المغذاة على عليقة المقارنة وكانت نسبة النفوق عالية فى هذه المجموعة ٠ أدت اضافة اليوريا فقط أو الكازين غير المعامل أو الكسب غير المعامل الى زيادة واضحة فى معدلات نمو الحملان بينما أدت اضافة الكازين المعامل أو الكسب المعامل الى زيادة كبيرة ومعنوية فى معدلات النمو للحملان ، وكانت أعلى زيادة فى معدلات النمو عند استخدام اضافة من اليوريا مع الكازين المعامل أو الكسب المعامل ٠ أعطت الحملان المغذاة على اضافة من اليوريا مع الكازين المعامل أعلى قيم للكفاءة التحويلية للغذاء بينما أعطت الحملان المغذاة على اضافة من اليوريا فقط أقل قيم للكفاءة التحويلية للغذاء ٠

وقد أكدت هذه الدراسة بصفة عامة امكانية زيادة كمية المـاكول والاستفادة من المواد الخشنة الفقيرة بواسطة الأغنام باستخدام الاضافات من اليوريا