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EFFECT OF PROTEIN LEVELS ON KEDAH-KELANTAN HEIFERS DURING PREGNANCY AND LACTATION

I. Effect on the reproductive performance

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RINGKASAN

Artikal I melaporkan akibat peringkat protein ke atas pembiakan lembu betina Kedah-Kelantan. 27 lembu betina bunting telah dibahagikan kepada 6 peringkat makanan. 5 peringkat mengandungi 12, 15, 18, 21 dan 24% protein mentah. Peringkat yang ke enam mengandungi 18% protein mentah, bukan daripada urea tetapi semuanya didapati daripada kacang soya. Tiap-tiap lembu ini diberi makan dengan secukupnya dengan kadar 75:25 rumput Napier *(Pennisetum purpureum)* dan concentrat dengan berasaskan kepada pengambilan makanan kering. Pertukaran dalam segi berat badan, berat semasa lahir dan pertukaran makanan telah dicatitkan iaitu dalam masa kajian yang mengambil masa sebanyak 322 hari.

Dalam masa bunting, tidak ada perbezaan yang nyata didapati di antara peringkat-peringkat makanan. Ibu diberi makanan yang mengandungi lebih daripada 18% protein mentah mencapai berat badan yang berkurangan, dan berat badan turun sebelum bersalin juga selepas bersalin. Sedikit perbezaan didapati dalam masa bunting dan berat lahir anak. Perbezaan di antara bahagian temuni (foetal tissue) dan foetus juga didapati sedikit perbezaan.

Berbeza dengan amat nyata ($P<0.01$) di antara peringkat makanan didapati dalam pertukaran berat badan semasa penyusuan. Ibu diberi makanan mengandungi 12% protein mentah dan abok kacang soya dapat mempertahankan berat badan semasa penyusuan dan berbeza dengan nyata telah didapati dari ibu-ibu yang diberi makanan yang mengandungi 18, 21 dan 24% protein mentah dalam berat badan mereka semasa lepas penyusuan, darimana mereka hilang berat badan harian dan juga dalam masa penyusuan. Tidak ada perbezaan yang nyata didapati dalam pengambilan makanan dalam masa bunting dan penyusuan. Penambahan urea pada tingkat yang tinggi dalam makanan dan akibatnya atas pembiakan telahpun dibincangkan.

INTRODUCTION

Kedah-Kelantan cattle of Malaysia constitute an important genetic resource in Malaysia. Not only are they numerically important, constituting about 80% of the total cattle population, recent research on their productive capacity suggest that they have considerable potential and have in fact been underestimated. Substantial improvements in performance have been demonstrated for example, live weight increase by 134%, live weight at 24 months age by 80% and age at first service by 94% (DEVENDRA and LEE, 1975a). Body measurements and carcass characteristics also showed improvement with better nutrition (DEVENDRA and LEE, 1975b; 1975c).

In view of these interesting results, and in a continuation of research on the performance of the species, it was appropriate to extend the studies into the reproductive performance. Accordingly, the nutrient requirements during pregnancy and the performance during and after

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this period were studied. This paper, the first in three parts, reports the effect of varying protein levels in the diets of pregnant and lactating cows. The next two papers in this series will deal with preweaning calf performance and milk yield and composition.

MATERIALS AND METHODS

(a) Animals and management

Initially, thirty, 2-year old Kedah-Kelantan heifers were grazed in 2 separate fields and 2 Kedah-Kelantan bulls, one in each field, were allowed to run together with the heifers for a month. After the one month was over, the heifers were allocated to the various treatments by weight to give a uniform average initial weight. However, because some of the animals did not conceive and had to be remated, and some were found to be sterile, the number of replications became uneven. Finally, only 27 heifers were confirmed pregnant while 3 heifers were considered sterile, failing to conceive after several matings. Obesity was one of the suspected causes. Pregnancy was confirmed 2 months after mating by rectal palpation.

The animals were individually stall-fed and weighed once a week. One or two days prior to parturition, the animals were weighed and removed to the maternity pens where they remained for 4 days after parturition for colustrum feeding to the calves. The birth weights of the calves were taken about 3 hours after birth and the post partum dams were also weighed.

(b) Treatments

The experiment was a completely randomised design, having 6 treatments or diets containing 5 different levels of crude protein. The five dietary protein levels were 12, 15, 18, 21 and 24 percent. Urea was used as the main source of nitrogen. In the 6th diet which was a repetition of the third diet at 18% crude protein, soyabean meal was the sole source of nitrogen and contained no urea.

The energy content of the diets was made to meet the N.R.C. recommended levels of 2.06 Mcal/Kg. of feed (N.R.C., 1970) for postpartum nursing cows. Palm oil was added to 3 of the diets as an energy source to meet the required level. Molasses comprising mainly of soluble sugars acts as an ideal substrate for microbial growth and was added to complement urea feeding as well as to increase urea palatability (PRESTON, 1972).

(c) Diets

The composition of the experimental diets is presented in *table 1*. Napier grass *(Pennisetum purpureum)* was used to provide the major portion of the daily dry matter intake (DMI). In fact, 75% of the total DMI estimated at 3.0% of the animals live weight was provided by Napier grass and the remaining 25% from a concentrate mixture. This particular partitioning of the supply of DMI was found to be the most optimal for growth response in Kedah-Kelantan growers (DEVENDRA and LEE, 1975a; 1975b).

The concentrate diets were mixed daily. Molasses was used to dissolve the urea with minimal addition of water. Palm oil was added where necessary and this mixture was then

TABLE 1. COMPOSITION OF THE EXPERIMENTAL DIETS
(On dry matter basis)

Ingredients	Treatment					
	1 12% crude protein	2 15% crude protein	3 18% crude protein	4 21% crude protein	5 24% crude protein	6 18% crude protein with no urea
Napier Grass *(Pennisetum purpureum)*	75.00	75.00	75.00	75.00	75.00	75.00
Tapioca Chips	11.25	11.25	11.25	11.25	11.25	—
Molasses	5.00	5.00	5.00	5.00	5.00	5.00
Salt	0.50	0.50	0.50	0.50	0.50	0.50
Tricalcium Phosphate**	0.50	0.50	0.50	0.50	0.50	0.50
Copra Cake	7.35	6.25	5.15	4.05	2.95	0.50
Soybean Meal		—	—	—	—	19.00
Urea	0.40	1.50	2.60	3.70	4.80	—
Total	100.00	100.00	100.00	100.00	100.00	100.00
Palm Oil Supplementation (% of diet)		—	0.11	0.51	0.91	—
Calculated Crude Protein Content (%)	12.14	15.10	18.06	21.03	24.00	18.00
Calculated ME Content (Mcal/kg.)	2.11	2.08	2.06	2.06	2.06	2.14
Urea as % of Total Protein source	9.47	28.56	41.39	50.58	57.50	—

**Declared contents: 38.7% PO_4, 1.1% CO_3, 1.5% Flourine, 0.2% SO_4, 46.2% Ca, 0.2% Mg, 2.4% Fe, 5.8% Al, 120 ppm K, 92 ppm Mn, 55 ppm Cu, 410 ppm Zn, 0.5 ppm Co and 0.9 ppm Mo.

thoroughly mixed with the rest of the ingredients. The estimated amounts of the concentrate feed required were weighed and fed at 1200 hours each day.

(d) Analysis

Daily samples of grass and concentrate were kept for dry matter determination. These were bulked for one month and then subsampled for proximate analysis as a check for quality of feed.

Data collected were analysed for treatment differences. Wherever relevant, the correlation coefficients for related traits were calculated and tested for significance. Correction by co-variance analysis for a uniform initial liveweight was also carried out. All statistical analyses followed methods as outlined by LECLERG, LEONARD and CLARK (1966).

RESULTS

Gestational response

Out of the 27 pregnant heifers, 25 calves were weaned. One dam aborted and one calf died from severe scouring. The summary of the dams' response to the diets during the phase of gestation is given in *table 2.*

i) Gestation period and birth weight

Protein levels had no effect on either gestation period or birth weight of calves. The dams on the lowest level of crude protein responded with the longest gestation and increasing crude protein level in the diets did not decrease gestation length. The results on the birth weight of calves suggested that dams fed higher protein levels would give heavier calves. However the results were not significantly different. Soyabean feeding did not show any better effect over urea feeding.

Male calves (16.0 Kg.) were heavier than female calves (14.8 Kg.) at birth and tended to have longer gestation period (283.3 days) than female calves (281.1 days) but the results were not significantly different.

ii) Liveweight changes

No significant differences were detected between treatments for the liveweight before calving and consequently, no significant differences were found for the liveweight increase during gestation. Generally, the dams fed lower protein levels gained weight faster and therefore, reached higher liveweights before calving than dams fed higher levels. Soybean meal did not improve the average daily liveweight increase.

After parturition, it was observed that dams fed crude protein above 18 per cent weighed less than dams fed crude protein below 18 percent. When compared with their initial liveweights, all the dams lost weight after the period of gestation, indicating that the animals had stopped growing and that any weight increase was due to foetal growth and tissues.

TABLE 2. EFFECT OF FIVE DIETARY PROTEIN LEVELS ON KEDAH–KELANTAN HEIFERS DURING GESTATION

Parameter	Treatment					
	1 12% crude protein	2 15% crude protein	3 18% crude protein	4 21% crude protein	5 24% crude protein	6 18% crude protein with no urea
Number of animals	4	5	3	4	4	5
Initial liveweight (Kg.)	252.4	250.4	246.0	234.9	236.6	244.7
Gestation period (days)	283.3	282.0	282.7	280.5	281.2	281.2
Birth weight (Kg.)	14.7	14.8	15.6	15.0	15.1	15.7
Ratio of male to female calves	1:3	1:4	1:2	1:3	1:3	1:4
Liveweight before calving (Kg.)	269.9	276.5	268.8	248.3	253.3	266.5
Liveweight gain (Kg.)	17.5	26.1	22.7	13.3	16.7	21.9
Average daily gain (g/day)	114	169	147	86	108	142
Liveweight after calving (Kg.)	238.8	247.5	242.9	222.6	226.7	239.6
Weight loss in calving (Kg.)	31.2	29.0	25.9	25.4	26.6	27.0
Weight loss after gestation (Kg.)	13.6	2.9	1.8	12.3	6.4	5.1
Average daily dry matter intake (Kg.)	4.9	4.9	4.7	4.3	4.7	4.7
Feed conversion	43.0	29.0	32.0	50.0	43.5	33.1

iii) Feed intake and conversion

Increasing crude protein content did not increase the DMI of dams during gestation. The DMI for all the treatments were quite similar. Feed conversion was generally very poor.

iv) Foetal tissues

The different components of total foetal growth are listed in *table 3*. The weight of foetal tissues (placenta and fluids) was obtained by subtraction of the foetus weight from the weight lost in parturition. No significant differences were detected between treatments for any of the parameters examined. The averages of these parameters were calculated.

Just before calving, the foetus made up 5.8% of the dam's liveweight and 55.4% of the total foetal growth. These values could be used to estimate the birth weight of the calves.

Lactational response

The results of the experiment for liveweight changes and feed intake during lactation are summarised in *table 4*.

i) Liveweight changes

There were significant differences between treatments in the liveweight of dams at the end of lactation ($P<0.01$). Dams fed the lowest crude protein level weaned off heaviest and were not significantly different with dams fed at 15% and 18% crude protein (soybean meal). However, they were significantly different from the dams fed 18% (urea), 21% and 24% crude protein ($P<0.01$). It may be concluded that increasing crude protein levels above 18% of total diet, using mainly urea decreased significantly the dam's ability to maintain body weight during lactation. The results also suggested that a preformed protein source was better than a non-protein-nitrogen (NPN) source such as urea in maintaining body conditions during lactational stress.

Increasing crude protein content of diets affected significantly the average daily gain (ADG) and therefore, the liveweight losses during lactation ($P<0.01$). Dams fed high levels of crude protein lost weight faster than dams fed lower levels and the weight lost were significantly different. Dams fed 18% and 21% crude protein lost weight fastest, at the rates of 228 and 221 g/day and lost 38.3 kg and 37.1 kg respectively during lactation. The dams fed soybean meal were comparable to dams fed 12% crude protein in the their ADG and weight loss. It would appear from these results that the critical level of urea in the diet had been exceeded and adverse effects can be observed.

No significant differences were found between treatments in the total weight loss during gestation and lactation. Although the dams fed high levels of protein still lost the most weight, the weight lost did not differ significantly from the weight lost by dams fed lower levels of protein.

TABLE 3. EFFECT OF FIVE DIETARY PROTEIN LEVELS ON THE DIFFERENT COMPONENTS OF FOETAL GROWTH IN KEDAH–KELANTAN HEIFERS

Parameter (Kg.)	Treatment						Average
	1	2	3	4	5	6	
Number of animals	4	5	3	4	4	5	
Liveweight at calving	269.9	276.5	268.8	248.3	253.3	266.5	263.9 ± 10.8
Total foetal growth (TFG)	31.2	29.0	25.9	25.4	26.6	27.0	27.5 ± 2.2
Weight of foetus	14.7	14.8	15.6	15.0	15.1	15.7	15.2 ± 4.3
Weight of foetal tissues (FT)	16.5	14.2	10.3	10.4	11.5	11.3	12.4 ± 2.5
TFG as % of liveweight at calving	11.5	10.5	9.5	10.2	10.5	10.1	10.4 ± 6.3
Foetus as % of TFG	47.0	51.0	60.2	59.1	56.9	58.3	55.4 ± 5.2
Foetus as % of liveweight of calving	5.4	5.4	5.8	6.0	6.0	5.9	5.8 ± 2.9
FT as % of TGF	53.0	49.0	39.8	40.9	43.1	41.7	44.6 ± 5.2
FT as % of liveweight at calving	6.1	5.1	3.8	4.2	4.5	4.2	4.7 ± 0.8

TABLE 4. EFFECT OF FIVE DIETARY PROTEIN LEVELS ON LIVEWEIGHT CHANGES AND FEED INTAKE DURING LACTATION

Parameter	Treatment					
	1 12% crude protein	2 15% crude protein	3 18% crude protein	4 21% crude protein	5 24% crude protein	6 18% crude protein with no urea
Number of animals	4	5	3	4	4	5
Liveweight at end of lactation (Kg.)	246.0^{a}	225.3^{ab}	204.6^{bc}	185.5^{cd}	206.5^{bd}	233.6^{a}
Weight loss during lactation	14.1^{a}	21.3^{a}	38.3^{b}	37.1^{b}	23.8^{ab}	8.4^{c}
Average daily gain (g/day)	-84^{a}	-127^{ab}	-228^{b}	-221^{b}	-141^{ab}	-50^{a}
Total weight loss during gestation and lactation	16.3	25.3	38.2	46.0	30.7	21.7
Average daily DMI (Kg.)	5.3	5.4	5.3	4.7	5.0	5.2

a – d – Means in the same row with different superscript letters differ significantly ($P<0.01$).

ii) Feed intake

The feed intake of dams during lactation showed no significant differences. Dams fed less than 18% crude protein had higher feed intakes than dams fed higher levels. Although the results are not conclusive, there were indications of a depression in feed intake possibly caused by reduced palatability since urea was used as the main source of nitrogen. When the average feed intake during gestation (4.70 kg/day) was compared with the average feed intake during lactation (5.14 Kg/day), it was significantly lower (P<0.01).

DISCUSSION

Gestation length was not affected by increasing protein content in the diets. Though gestation length is more often affected by factors like breed, age, sex of calf, season and parity of dams as reviewed by ANDERSON and PLUM (1970), it had been shown to be affected by the feeding of soybean meal instead of urea (BOND and OLTJEN, 1973a). Longer gestation length of male calves had also been shown in Hariana cattle (KOHLI and SURI, 1957) and Hereford cattle (BOND and OLTJEN, 1973b). The average gestation length of 282.2 days for Kedah-Kelantan dams as recorded in this experiment is slightly shorter than that reported by DEVENDRA *et al.* (1973) for the same breed of animals and that of Bali cattle (DEVENDRA, LEE and PATHMASINGAM, 1973). Compared with other breeds, it is shorter than Afrikander cattle (295.0 days) as reported by JOUBERT and BONSMA (1957); 316.4 days for Egyptian buffaloes (GHANEM *et al.,* 1955) and longer than that of Aberdeen-Angus (272.8 days) as reported by RIFE *et al.,* (1943).

The experimental diets had no effect on the birth weight of calves. This result agrees with the finding of BOND and WILTBANK (1970) who fed levels of crude protein as high as 28.1% and found no significant effect on the survival or birth weight of calves. CLANTON and ZIMMERMAN (1970) reported only a slight increase of 1.3 kg. in the birth weight of calves from five years data of dams fed with protein supplementation. It was suggested that substantial changes in the birth weight would only occur with severe undernutrition, particularly near calving (WILTBANK *et al.,* 1962). The reason is that the additional nutrient requirement for protein and energy of the developing foetus, the enlarging uterus and its other contents during pregnancy is not large (MITCHELL, 1929; HEIGH, MOULTON and TROWBRIDGE, 1920). However, the requirement for other nutrients especially the minerals and vitamins are quite critical during pre-natal development. Work with prepartum levels of over feeding or submaintenance levels (HIGHT, 1966; TUDOR, 1972) had resulted in substantial increase or decrease in the birth weight of calves.

Although the liveweight and liveweight changes were not significantly affected by increasing protein levels, there were indications of unfavourable influence at high protein levels. The critical level appears to be around 18% of crude protein in the total diet, above which the dams fed these levels showed poorer liveweight gain, reached lower body weight before calving, lost more weight after the period of gestation and had poorer feed conversion. The cause could be the high levels of urea used in these two diets, providing more than 50% of the total protein content.

Animal response to nitrogen level is curvilinear and PRESTON (1971) stated that the results from NPN supplementation had rarely led to increased productivity of more than 10%. The addition of any extra amount of urea to diets of adult ruminants would be a wasteful process (GUPTA and MATHUR, 1972). The excess urea would be absorbed through the rumen wall in the form of ammonia, converted to urea by the liver and excreted in that form

(McDONALD, 1948). It had long been recognised that the inclusion of a readily available energy source would greatly enhance urea utilisation and nitrogen retention. In situations where energy is limiting, the diminishing response per unit of protein, with its consequent fall in apparent biological value, can be attributed to the use of protein as a source of energy (BALCH, 1968). When energy is not limiting, rumen protein production may be regulated by the amounts and forms of nitrogenous nutrients, resulting in a rectilinear response with increments of protein in diets. It is most likely then that in this study, where all the diets are isocaloric, energy is limiting in the two diets that contain high proportions of urea and that the excess urea is ultimately excreted. A high rumen pH seems to be favourable for rumen absorption of ammonia (COOMBE, TRIBE and MORRISON, 1960). If that is the case, the high proportions of urea in the diet would result in a condition where rumen pH would be high and rumen absorption of ammonia would be greatly enhanced.

Feed intake of dams during gestation was not influenced significantly by different levels of crude protein content in the diet. This is contradictory to the report by ROBINSON and FORBES (1967) who found higher feed intakes in pregnant ewes fed a higher protein level. However, hay was used in their study and adding nitrogen to low quality forages has often led to greater voluntary consumption. With low protein feeds, nitrogen content of digesta is a major factor limiting fermentation rate in the rumen and the rate at which food digesta pass through the gastro-intestinal tract. The increase in feed intake with increase in protein content is attributed to urea in feeds had been reported to cause a depression in palatability (LOOSLI and WARNER, 1958) and consequently, a reduction in feed intake (VAN HORN, FOREMAN and RODRIQUEZ, 1967; HUBER and SANDY, 1965). No reduction in feed intake was observed here even though urea supplied more than 50 percent of the ration nitrogen, probably because of the 5 percent inclusion of molasses increasing urea palatability.

No significant differences were found between treatments for the total foetal growth. Kedah-Kelantan foetus weighed an average of 55.4 percent of the total foetal growth, which is comparable with the figure of 60.0 percent given by SALISBURY and VAN DEMARK (1961) as an estimate of the birth weight of the calf pre-partum. The total foetal growth was only 27.5 kg and is considerably low compared to 68.0 kg given by SALISBURY and VAN DEMARK (1961), depending on breed and other factors. However, the results here suggest that a high total foetal growth does not necessarily mean a heavier foetus. ECKLES (1916) stated that although the uterus may increase four-fold or more in weight during pregnancy, a considerable part of this increase is in water content. A decrease in dry matter of the uterus during pregnancy was reported by YAPP (1931). Nevertheless, the figure of 55.4 percent as recorded here may prove to be useful in predicting the birth weight of Kedah-Kelantan calves. The birth weight can also be predicted as a percentage of the dam's liveweight at calving. The data of this experiment gave a figure of 5.8 percent, which may be more accurate in birth weight estimation as a significant correlation was found between birth weight and dam's liveweight at calving.

Increasing protein content of diets had significant effect on liveweight and liveweight changes of Kedah-Kelantan dams during lactation. From the results, there is evidence, though not definitive that the critical level of protein content in the diets was about 15 percent, beyond which the diets could not maintain body conditions. Dams fed above this level lost weight faster and weighed lowest at the end of lactation. As indicated previously from the gestational data, the critical level of crude protein content appeared to be about 18 percent. This shift from 18 percent to 15 percent crude protein could be caused by the higher demand for nutrients, particularly energy for milk production during lactation. It is likely that with diets containing more than 15 percent crude protein, the energy partitioned for milk production and maintenance is insufficient, resulting in body reserves and tissues being catabolised and considerable weight loss during lactation. Therefore, whereas the diet containing 18 percent crude protein was adequate to supply the gestational demand for energy, it became inadequate during lactation when the demand is higher.

The utilisation of urea or rumen ammonia by the microorganisms requires energy and CHALUPA and DAVIES (1976) gave an estimate of 22 g microbial crude protein per Mcal of rumen digested energy. The microbial protein production was considered to be regulated by energy availability in the rumen. CHALUPA and DAVIES (1976) stated that at a given level of energy consumption, the amount of microbial protein synthesised may be approximately equivalent to the animals's maintenance requirement and absorbable protein for production must be provided by rumen bypass protein. Maintenance requirements range from 20 percent to 50 percent of total requirements. There is no evidence from the results to suggest that the experimental diets were inadequate in protein content. On the contrary, the results suggest that the protein content or urea levels were too high at the given level of energy to be efficiently utilised and consequently, causing a reduction of available energy for production purposes. THOMPSON *et al.*, (1973) suggested that reproductive problems encountered when beef cows are fed urea probably results from a deficiency of dietary energy rather than urea.

Soybean meal proved to be more superior than the NPN diet and dams fed soybean weighed significantly higher at weaning and lost significantly less weight than dams fed only NPN. The response of these soybean fed dams were comparable to dams fed urea at 12 and 15 percent crude protein. The difference in response can be explained by the difference in ruminal degradation of urea and soybean. Urea is 100 percent degraded and soybean, containing proteins of lower solubilities is only 60 percent degraded (CHALUPA and DAVIES, 1976). The remaining 40 percent is more efficiently utilised by the animal host when it is digested in the lower gastro-intestinal tract. Thus, the soybean diet is more efficiently utilised for productive purposes during lactation than NPN diets in which urea supplied more than 41 percent of the total nitrogen. This finding differs from that of THOMPSON *et al.*, (1973) and BOND and OLTJEN (1973b). The urea used in the diets of THOMPSON *et al.*, (1973) supplied only 27 percent of the total nitrogen. Although BOND and OLTJEN (1973b) used high levels of urea in their diets, supplying more than two-thirds of the total nitrogen, the level of corn starch as an easily available carbohydrate source increased proportionately with urea increments. This explains why their urea fed dams and soybean fed dams performed equally well and there was no adverse effect on reproduction. It has been shown that urea can be used at very high levels, even as the only source in ruminant diets for growth, reproduction or milk production (OLTJEN, 1968; VIRTANEN, 1966). However, for effective and efficient utilisation, the mechanics of urea inclusion in ruminants' diets have to be known. An update on the use of urea in ruminal feeding is recently given by CHALUPA and DAVIES (1976).

There was a constant but non-significant increase in feed intake throughout lactation for all the different diets. The level of urea did not depress feed intake of the dams. However, the feed intake during lactation was found to be significantly higher than the feed intake during gestation. Similar findings had been reported by HUTTON, 1963; LENKEIT *et al.*, 1966; CURRAN, CAMPLING and HOLMES, 1967; MARSH, CURRAN and CAMPLING, 1971. The stimulatory effects of lactation on voluntary intake is explained partly by the increased nutrient requirements and endocrine changes which occur in lactation (FORBES, 1970) and partly by physical changes in response to an increase in an available space in the abdomen (MOWAT, 1963; CONRAD, PRATT and HIBBS, 1964; HADJIPIERIS and HOLMES, 1966).

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SUMMARY

Paper I reports the effect of protein levels on the reproductive performance of Kedah-Kelantan heifers. Twenty-seven pregnant heifers were allocated to 6 treatments, with 5 different levels of crude protein viz. at 12, 15, 18, 21 and 24%. The sixth treatment contains 18% crude protein but no urea and has only soybean as a protein source. The animals were fed to appetite individually a ratio of 75:25 of Napier grass *(Pennisetum purpureum)* and concentrate in terms of dry matter intake. Changes in liveweight, birth weight and feed conversion were measured for a total of 322 days of experimentation.

During the period of gestation, no significant differences were found between treatments for any of the parameters measured. Dams fed diets containing higher than 18% crude protein gained less weight, reached lower liveweight before calving and lost more weight after parturition. There was very little difference in the gestation length and birth weight of the calves. The different components of foetal tissues and foetus also showed little difference.

Significant differences ($P<0.01$) between treatments were found for the liveweight changes during the period of lactation. Dams fed 12% crude protein and soybean meal maintained their weight during lactation and were significantly different from dams fed 18, 21 and 24% crude protein in their liveweight at weaning, their average daily gain and their weight loss during lactation. There was no significant difference in the feed intake during either gestation or lactation. The inclusion of high levels of urea in ruminant feed and its effect on reproduction was discussed.

REFERENCES

ANDERSEN, H. and M. PLUM (1970). Gestation length and birth weight in cattle and buffaloes: A review. *J. Dairy Sci., 48* : 1224–1235.

BALCH, C.C. (1968). Problems in predicting the value of non-protein nitrogen as a substitute for protein in rations for farm animal ruminants. *Wld. Rev. Anim. Prod., 7* : 84–91.

BOND, J. and J.N. WILTBANK (1970). Effect of energy and protein on oestrus, conception rate, growth and milk production of beef females. *J. Anim. Sci., 30* : 438–444.

BOND, J. and R.R. OLTJEN (1973a). Growth and reproductive performance of bulls and heifers fed purified and natural diets. VI. Growth, oestrus, conception rate, gestation and milk production of females. *J. Anim. Sci., 37* : 141–147.

BOND, J. and R.R. OLTJEN (1973b). Growth and reproductive performance of beef females fed high urea-containing diets. *J. Anim. Sci., 37* : 1040–1047.

CHALUPA, W. (1968). Problems in feeding urea to ruminants. *J. Anim. Sci., 27* : 207–219.

CHALUPA, W. and R.F. DAVIES (1976). An update on the use of urea in ruminant feeding. *Maryland Nutr. Conf. Proc.,* 1976 : 6–13.

CLANTON, D.C. and D.R. ZIMMERMAN (1970). Symposium on pasture methods of maximum production in beef cattle: Protein and energy requirements for female beef cattle. *J. Anim. Sci., 30* : 122–132.

CONRAD, H.R., A.D. PRATT and J.W. HIBBS (1964). Regulation of feed intake in dairy cows. 1. Change in importance of physical and physical and physiological factors with increasing digestibility. *J. Dairy Sci., 47* : 54–62.

COOMBE, J.B., D.E. TRIBE and J.W.C. MORRISON (1960). Some experimental observation on the toxicity of urea to sheep. *Aust. J. agric. Res., 11* : 247–256.

CURRAN, M.K., R.C. CAMPLING and W. HOLMES (1967). The feed intake of milk cows during late pregnancy and early lactation. *Anim. Prod., 5* : 266 (Abstr.).

DEVENDRA, C., MOHD. NORDIN HASSAN, R. HODGE, T. LEE KOK CHOO and M. PATHMASINGHAM (1973). Kedah-Kelantan cattle of Malaysia. *Malays. agric. J., 49* : 25–47.

DEVENDRA, C. and T. LEE KOK CHOO (1975a). Studies on Kedah-Kelantan cattle. I. Effect of improved nutrition on growth. *MARDI Res. Bull., 3* : 68–86.

DEVENDRA, C. and T. LEE KOK CHOO (1975b). Studies on Kedah-Kelantan cattle. II. The effect of feeding increasing levels of tapioca *(Manihot utilissima Pohl)* on growth. *MARDI Res. Bull., 4* : 80–89.

DEVENDRA, C. and T. LEE KOK CHOO (1975c). Studies on Kedah-Kelantan cattle. III. Body composition and carcass characteristics. *MARDI Res. Bull., 4* : 81–90.

DEVENDRA, C., T. LEE KOK CHOO and M. PATHMASINGHAM (1973). The productivity of Bali cattle in Malaysia. *Malays. agric. J., 49* : 183–197.

ECKLES, C.H. (1916). Nutrients required to develop the bovine foetus. *Missoun Agric. Expt. Sta. Bull., 26.*

FORBES, J.M. (1970). The voluntary food intake of pregnant and lactating ruminants: A review. *Br. Vet. J., 126* : 1–11.

GHANEM, Y.S., A. ZAHER, A. ABDUL-FADL and F.A. SOHMAN (1955). Genetic causes of variation in the length of gestation of buffaloes. *Indian J. Vet. Sci., 25* : 307–311.

GUPTA, B.N. and M.L. MATHUR (1972). Utilisation of non-protein nitrogen by ruminants – a review. *Indian J. Dairy Sci., 25* : 121–128.

HADJIPIERIS, G. and W. HOLMES (1966). Studies on feed intake and feed utilisation by sheep. I. The voluntary feed intake of dry pregnant and lactating ewes. *J. Agric. Sci., 66* : 217–223.

HAIGH, L.D., C.R. MOULTON and P.F. TROWBRIDGE (1920). Composition of the bovine at birth. *Missouri Agr. Expt. Sta. Bull., 38.*

HIGHT, G.K. (1966). The effects of undernutrition in late pregnancy on beef cattle production. *N.Z. J. agric. Res., 9* : 479–490.

HUBER, J.T. and R.A. SANDY (1965). Response of dairy cows fed unlimited corn silage to three levels of urea and grain. *J. Anim. Sci., 24* : 887. (Abstr.).

HUTTON, J.B. (1963). Effect of lactation on intake (cow). *Proc. N.Z. Soc. Anim. Prod., 23* : 39–52.

JOUBERT, D.M. and F.N. BONSMA (1957). The effect of nutrition on the birth weight of calves. *Nutr. Abstr. Rev., 28* : 303 (Abstr.).

KOHLI, M.L. and K.R. SURI (1957). Factors affecting gestation length in Hariana cattle. *Indian J. Vet. Sci., 27* : 23–32.

LECLERG, E.L., W.H. LEONARD and A.G. CLARK (1966). *Field plot technique.* 2nd Ed. Burgess Publishing Company. Minneapolis, Minnesota.

LENKEIT, W., M. WITT, E. FARIES and P. DJAMAI (1966). Studies of weight changes and feed intake at the end of pregnancy and the beginning of lactation. *Nutr. Abstr. Rev., 37* 262 (Abstr.).

LOOSLI, J.K. and R.G. WARNER (1958). Distillers grains, brewers grains and urea as protein supplements for dairy rations. *J. Dairy Sci., 41* : 1446–1450.

MARSH, R., M.K. CURRAN and R.C. CAMPLING (1971). The voluntary intake of roughages by pregnant and lactating dairy cows. *Anim. Prod., 13* : 107–166.

MCDONALD, I.W. (1948). The absorption of ammonia from the rumen of the sheep. *Biochem. J., 42* : 584–587.

MITCHELL, H.H. (1929). Minimum protein requirements of cattle. *Rep. Comm. Anim. Nutr. Bull. Natl. Res. Counc.* p. 67.

MOWAT, D.N. (1963). Ph.D. Thesis, Cornell University, New York, (cited by FORBES, 1970b).

N.R.C. (1970). *Nutrient requirements of beef cattle.* Nat. Acad. Sci., Washington, D.C.

OLTJEN, R.R. (1968). Effects of feeding ruminants non-protein nitrogen as the only nitrogen source. *J. Anim. Sci., 28,* : 673–782.

PRESTON, T.R. (1971). Quantitative aspects of animal protein production from NPN in ruminants. Tracer studies on NPN for ruminants. *Proceedings of a panel. Vienna,* 11–15 Oct., 1971.

PRESTON, T.R. (1972). Molasses as an energy source for cattle. Wld. Rev. *Nutr. Diet., 17* : 250–311.

RIFE, D.C., P. GERLAUGH, L. KUNKLE, G.W. BRANDT and L.H. SNYDER (1943). Comparative lengths of the gestation periods of Aberdeen-Angus and Hereford cows carrying purebred and crossbred calves. *J. Anim. Sci., 2* : 50–52.

ROBINSON, J.J. and T.J. FORBES (1967). A study of the protein requirements of the mature breeding ewes. 2. Protein utilisation in the pregnant ewe. *Br. J. Nutr., 21* : 879–891.

SALISBURY, G.W. and G.L. VAN DEMARK (1961). *Physiology of reproduction and artificial insemination of cattle.* University of Illinois, W.H. Freeman and Co., San Francisco and London.

THOMPSON, L.H., L. GOODE, R.W. HARVEY, R.M. MEYERS and A.C. LINNERUD (1973). Effects of dietary urea on reproduction in ruminants. *J. Anim. Sci., 37* : 399–405.

TUDOR, G.D. (1972). The effect of pre and post-natal nutrition on the growth of beef cattle. I. The effect of nutrition and parity of the dam on calf birth weight. *Aust. J. Agric. Res., 23* : 388–395.

VAN HORN, H.H., F. FOREMAN and J.E. RODRIGUEX (1967). Effect of high-urea supplementation on feed intake and milk production of dairy cows. *J. Dairy Sci., 50* : 709–714.

VIRTANEN, A.I. (1966). Milk production of cows on protein-free feed. *Sci., 153* : 1603.

WILTBANK, J.N., W.W. ROWDEN, J.E. INGALLS, K.E. GREGORY and R.M. KOCK (1962). Effect of energy level on reproductive phenomena of mature Hereford cows. *J. Anim. Sci., 21* : 219–225.

YAPP, W.W. (1931). Intrauterine development in cattle. *Am. Soc. Anim. Prod., 24* : 133.