MUARIK BULLETIN, Vol. 4. pp. 49-54, 2001
Printed in Uganda. All rights reserved
© MUARIK 2001
ISSN 1563-3721

Variation in plasma luteinising hormone levels, return to oestrus and ovulation rates in sows on different planes of sorghum based rations

R.G Wahome, B.N. Mitaru and P.N. Mbugua
†Department of Animal Production,
††Institute of Dry-land Research and Utilization, University of Nairobi,
P.O. Box 29053, Nairobi, Kenya

Abstract

Twenty one gilts were fed two levels of lactation rations nested within two levels of gestation rations to evaluate the effect of level of feeding on reproductive parameters. Twelve sows were given each of two levels of feeding (High (H) and low (L)) during gestation. The H-sows were subdivided into two groups one of which received the high level (HH) while the other received the low level of feeding (HL). The L sows were similarly subdivided to form 2 groups of sows, the first of which received the level (LH) while the other received the low level (LL) of feeding, respectively. Production of porcine luteinising hormone (pLH) during lactation, and ovulation parameters, in the subsequent gestation, was assessed. Sows fed high (H) had significantly better ($P<0.05$) ovulation parameters than the low fed sows (L). The ovulation for high fed and low fed sows were 14.2 and 13.6 ova released, the ovary weights were 7.4g and 6g for high fed and low fed sows, respectively. However, gestation level of feeding did not influence the size of the corpora lutea. Lactation level of feeding had a significant ($P<0.05$) effect on ovulation (7.2 and 6.4 ova) and corpora lutea size (0.49g and 0.56g). Subsequent ovary size was not affected by level of feeding during lactation. There was an interaction between level of feeding during gestation and that during lactation with sows changing from high to low performing poorest among all the four feeding levels. Overall the previous gestation's level of feeding had an over-riding effect on these parameters mediated by its effect on plasma levels of pLH in the previous lactation. Based on results obtained its concluded that level of feeding during gestation was more likely to influence subsequent sow reproductive performance by specifically affecting ovary function as well as early embryo development.

Key words: Gestation, gilts, lactation, reproductive performance, Kenya

Introduction

Energy and protein requirements in sows can vary widely with physiological stage, reproductive performance, behaviour and housing conditions. Thus, these should be supplied in order to achieve higher average piglet birth weight, piglet survival, weaning weights and shorter weaning to oestrus interval. Extreme loss in condition leads to inability to regain condition accompanied by reproductive failure. Feed energy level has been implicated in causing failure to return to heat after weaning through an obscure mechanism. Possibilities of energy influencing luteinising hormone (pLH) concentrations early in lactation have been raised which may influence return to heat after weaning. Pig diets in Kenya mainly comprise of maize *(Zea mays)* and maize by-products. However, production of the traditional food crop sorghum *(Sorghum bicolor)* has increased and in times when maize is scarce, sorghums have been recently incorporated in pig feeds. However, it is not clear whether different planes of the sorghum-based diets have a positive influence on pLH concentrations. This trial studied the effect of varying planes of feeding sorghum-based diets during gestation and lactation on luteinising hormone levels (pLH) during early lactation, return to oestrus and ovulation rates subsequent to weaning.

Materials and methods

Gilts

A total of 21 gilts housed in individual pens, were recruited into the experiment after pregnancy was confirmed by failure to return to heat within 28 days of mating. The gilts were mated at 110 kg live weight and were observed through gestation, lactation, post-weaning period, re-breeding and a post-mating period of 28 days. The gilts were weighed weekly throughout the experiment. On recruitment to the experiment, each gilt was randomly fed either a high or low plane of a gestating sow feed (Table 1). The sows in each plane of feeding were assigned the high or low lactation feeding planes alternately as they farrowed. Weaning was done at 28 days and sow's feed allowance reduced to 2 kg daily. Heat detection was done twice daily with the aid of a boar. Sows on heat were taken to the boar for mating. Mated sows were moved to another group pen to await slaughter 28 days post-mating after confirmation of pregnancy. On slaughter, the ovaries were detached, weighed and the number of corpora lutea counted. The corpora lutea were then excised and weighed.

Diets

Two diets, one for gestation and the other for lactation, were formulated to meet NRC (1998) requirements. The composition of the diets are as shown in Table 1. Levels of feeding were instituted 28 days after mating to avoid the detrimental dietary effect on embryonic survival (Varley and Prime, 1993). Gilts on the high plane of feeding were allowed 29.9 MJ of digestible energy per day (2.1 kg) while those on the low level 14.2 MJ per day (1 kg) during gestation. Sows on the low energy level during lactation were offered an additional 0.3 kg feed for each piglet in their litter while those on the high level were offered 0.5 kg more per each piglet in the litter. Thus, for a sow having eight (8) piglets, the energy intake was 84.1 and 49.4 MJ DE per day for the high and low planes, respectively. After

Table 1. Composition of diets used in the feeding experiment.

Ingredient (%)	Diets	
	Gestation	Lactation
Sorghum	73	66
Lard	3	4.5
Bone meal	1.25	1.25
Cotton seed cake	10	15
Sunflower seed cake	11	11.5
Limestone	1	1.25
Salt	0.5	0.5
Premix	0.25	0.25
Cost (Ksh kg^{-1})	3.06	3.06
Calculated chemical composition of the diets		
Moisture (%)	10.1	9.84
DE (Kcal kg^{-1})	14.2	14.6
Crude Protein (%)	14.3	15.6
Crude Fibre (%)	5.6	6.3
Crude Fat (%)	7.2	8.4
Calcium (%)	0.8	0.79
Available Phosphorus (%)	0.37	0.36
Lysine (%)	0.59	0.63
Methionine	0.35	0.38

weaning the sows were fed 29.2 MJ (2 kg) daily on the lactation diet until they were re-bred and slaughtered, to prevent post-weaning dietary effects.

Blood sampling and pLH Assay

Each week on the weighing day, seven (7) blood samples (5ml) were collected at intervals of thirty (30) minutes from each lactating sow through an in-dwelling jugular vein cannula. The samples were centrifuged and plasma stored at –20°C until assaying for porcine luteinizing hormone (Kraeling *et al.*, 1982). The first and second antibodies for the radio-immunoassay were raised in the goat and the rabbit, respectively. The intra-assay coefficient of variation (CV) for the standards and samples averaged 1.03% and 10.96%, respectively. The sensitivity of the assay was 0.35 $\mu g\ l^{-1}$. The low and high quality control samples had CVs of 7.13% and 0.02%, respectively. All the samples were analysed in one assay to eliminate inter-assay variation.

Experimental design

A cross over design with animals nested within gestation diets was used in this study. The effect of levels of feeding effect on ovary weights, ovulation rates, conception rates, plasma pLH concentration and the length of wean to oestrus period was tested by a two way ANOVA with the interaction between the gestation and lactation levels testing the combined effect. Correlations were calculated between pLH plasma levels and other factors.

Results and discussion

The 21 gilts in the experiment farrowed and went through the lactation period successfully. However, two sows died after weaning. Apparently they never recovered from the stress of lactation. They persistently lost weight and finally succumbed to nutritional inadequacy. Three sows in the group fed low in gestation and lactation (LL), and one sow in the group fed low in lactation (HL) failed to come back to oestrus. The one sow in the HL group died before showing post-partum heat. After weaning, all the sows fed in low in gestation and high in lactation (LH) and those fed high through the two periods (HH) started cycling 18.7 and 8.3 days, respectively (Table 2). The average length of the weaning to re-mating period for the LL and HL (calculated only for the sows that came back) was 16 and 17.6 days, respectively. These differences were not significant ($P > 0.05$) though the proportion of sows re-mated successfully gradually increased (Table 2). Sows fed at high levels throughout gestation and lactation came back to oestrus earlier compared to those on the other treatments. The return to oestrus post weaning may be used in judging the feeding level whose effect is probably mediated through loss of body weight in general and body fat loss in particular (Baidoo, 1989; Whittemore and Yang, 1989; Coffey *et al*, 1994). Thus, the LL sows were unable to regain sufficient post weaning condition to enable them start cycling. The sows that had cross over planes of feeding (LH and HL) had problems adjusting hence, the high failure of conception in spite of coming back to oestrus. At slaughter, these sows were seen to have ovulated (evidenced by the presence of corpora lutea) but implantation had failed to occur. Such sows would fail to come back to oestrus after 18–23 days as expected (Wrathall, 1980) but come back after the 30th day. Since the sows were slaughtered 28 days after mating, these were presumed pregnant on slaughter.

Plasma concentrations of porcine luteinising hormone (pLH)

There was a consistent gestation feeding level effect on the plasma concentrations of pLH throughout the first three weeks of lactation. Table 2 shows the weekly means of the plasma concentration of luteinizing hormone in the first three weeks of lactation. Feeding level in gestation influenced pLH

concentration positively in the first week of gestation but not thereafter. Because of the episodic release of pLH, averages of pLH at thirty-minute intervals for each week are shown in Figure 1. The chart shows the trends observed as a result of the feeding levels in gestation. The major observation is that release of luteinising hormone (pLH) in the first week of lactation and indeed throughout the lactation is largely dependent on level of feeding during gestation. Stepwise regression of various variables of interest (Gestation feeding level, Lactation feeding level, week of lactation, ovulation rate, ovary weight, average corpus luteum weight and sample number) only gestation feeding level and ovary weight were retained in the model. The coefficient for gestation feeding level was 0.175 ($P = 0.0011$) and that of ovary weight was -0.021 ($P < 0.05$). The general coefficient was 0.791 ($P < 0.05$). These two variables explained only 8.5 % of the variation in plasma pLH concentrations ($R^2 = 0.086$). Overall plasma pLH level also had a significant correlation with ovulation rate ($r = -0.1589$; $P < 0.05$) and a marginally non-significant association with ovary weight ($r = -0.1447$; $P > 0.05$). The plasma concentrations of pLH among treatments were markedly distinct in the first week of lactation but

Table 2. Effect of level of feeding ovulation rates.

	Low	High	SEM
Response to feeding level during gestation			
Ova released	13.6	14.2	2.9
Corpus luteum wt (g)	0.51	0.49	0.1
Ovary weight	6.0	7.4	1.4
pLH Week 1	0.68	1.03	0.12
pLH Week 2	0.93	0.91	0.01
pLH Week 3	0.99	1.01	0.01

Response to lactation feeding levels irrespective of previous level during gestation			
Ova released	6.4	7.2	2.8^{S}
Corpus luteum wt (g)	0.56	0.49	0.1^{S}
Ovary weight	7.0	6.8	1.5

Interaction of feeding during gestation and lactation

	LL	LH	HL	HH	SEM
Post-weaning performance					
Number weaned	5	6	6	4	
Proportion dead (%)	20	0	17	0	
Proportion re-mated	20	100	83	100	
Conception rate	25	50	60	100	
Post-weaning wt change	5.5	5.3	-2.9	22.5	25.9
Days to re-mating	16	18.7	17.6	8.3	14.7
Ova released	11.5	14.4	13.6	15	2.9
Corpus luteum wt (g)	0.51	0.50	0.61	0.41	0.1
Ovary weight (g)	5.8	5.3	7.8	6.9	1.3
pLH week 1	0.36	0.76	1.10	0.97	0.16
pLH week 2	0.83	1.03	1.06	0.52	0.12
pLH week 3	1.11	0.87	1.20	0.98	0.07

Notes:
LL- Low level of feed in gestation and lactation
LH- Low level of feed in gestation and High in lactation
HL- High level of feed in gestation and low in lactation
HH- High level of feed in gestation and lactation
SEM - Standard error of the mean.

thereafter were within the same margins though more or less varying. The low fed group in gestation, which had lower pLH concentrations in the first week, had concentrations comparable to those of the high fed group in the second and third week.

The variation in pLH observed in the first week of lactation may have been due to difference in body fat content, difference in the rate of fat gain in gestation or difference in the rate of fat loss in the first few days of lactation. pLH stimulation has been shown to be necessary for the ovary to resume cyclicity after weaning and related pLH concentrations to the wean to oestrus interval. Edwards and Foxcroft (1983) showed that lack of pLH stimulation was responsible for a sow's lactation physiological anoestrus. Luteinising hormone (pLH) production was observed to be differentially suppressed on the basis of feeding level in this study in the first week of lactation. Suppression was not observed in the second and third week of lactation. The studies of Edward and Foxcroft (1983) had concentrated on the period around weaning and observed the build-up of plasma pLH concentration towards oestrus. In this study, variability in return to oestrus was not significant and appeared to be related to feeding level during gestation and lactation rather than on pLH concentration either in the first second or third week of lactation. A significant proportion of the sows in the low gestation feed level failed to come back to oestrus and these had lower plasma pLH concentrations indicating that dietary delays in return to oestrus observed by Kirkwood *et al.* (1987) were probably mediated through pLH release. Luteinising hormone concentration was negatively correlated with reproductive function in such other ways as ovary size and ovulation rate. Earlier studies indicated that pLH secretion is either depressed by stress in some way, or has its activity on theca- interstitial and granulosa cells suppressed (Viveiros, 1991) through high concentrations of cortisol in follicles of nutritionally stressed gilts (Tsang *et al.*, 1985). Elevated plasma cortisol levels may have had a negative effect on pLH synthesis. It must be borne in mind that 50% of sows fed low in gestation that came back to oestrus failed to conceive probably due to a less ready uterine environment. However, the mechanisms of operation by which the feeding level effects either long term or short term on the pituitary-ovary axis and to the rest of the reproductive system remain unclear. Sows fed low in gestation had lower ovary weights at slaughter than those fed high ($P<0.05$). The separate gestation feeding level influenced ovulation rate in the post-weaning oestrus. The low fed sows had fewer ova released. These also had lighter ovaries. Similar observations were made for separate lactation feeding levels. The combined gestation and lactation levels analysis showed significant ($P < 0.05$) differences among the four treatments in ovary weights. The sows fed low in gestation and lactation had about 1.5 ova fewer ($P < 0.05$) than the other combinations. The ovary weights in this study were within the ranges given by Andre *et al.* (1993). The

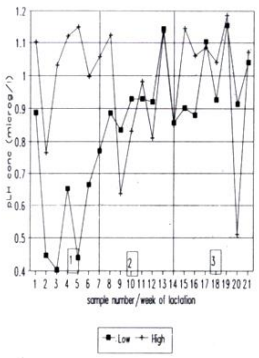

Figure1. Effect of gestation feeding level on plasma pLH concentration during the first three weeks of lactation.

ovary that releases more ova is expected to be slightly larger than its corresponding partner because of the greater number of corpora lutea that will be formed. This could be verified by the fact that the size of the corpora lutea were fairly uniform, though those of the HH group were significantly lighter than those of the other three groups. It is also evident that the left ovary over the four groups on average yielded 1.4 fewer ova but had corpora lutea of similar weight to its right partner. The significance of ovary size in reproduction is not clear. There is no evidence that size is a determinant of the endocrine function of the ovary. The corpora lutea is necessary for maintenance of the products of conception. If weight is correlated to secretion and the exact role of the products of the ovary endocrine activity during gestation were known it might help in explaining the differences in size as was suggested earlier by Adashi (1994).

Overall, this study demonstrated that gilts on a low feed plane in gestation have lower plasma pLH concentrations in the first week of lactation but not in the subsequent weeks of lactation. As a result of being underfed in gestation and probably in relation to low pLH concentrations in the first week of lactation, gilts are more likely to fail to come back to heat and also to conceive if they do come back. Such sows are more likely to have a poorer subsequent reproductive performance.

References

Adashi, E.Y. 1994. Endocrinology of the ovary. Human Reproduction. (supplement 2) 9:36-50.

Andre, C.J., Green, M.L., Clapper, J., Cline, T., Dickman, M.A. and Thomford, P.J. 1993. Influence of porcine somatotropin on endocrine and histological variables in gilts. Journal of Animal Science 71:1552-1560.

Baidoo, S.K. 1989. The effect of weight and body fat loss on the reproductive performance and endocrinological status of the lactating and weaned sow. PhD thesis, University of Alberta, Edmonton, Canada.

Coffey, M.T., Diggs, B.G., Handlin, D.L., Knabe, D.A., Maxwell, C.V., Noland, P.R., Prince, T.J. and Gromwell, G.L. 1994. Effects of dietary energy during gestation and lactation on reproductive performance of sows – a cooperative study. Journal of Animal Science 72:4-9.

Edwards, S. and Foxcroft, G.R. 1983. Endocrine changes in sows weaned at two stages of lactation. Journal of Reproduction and Fertility 73:93-107.

Kirkwood, R.N., Baidoo, S.K., Aherne, F.X. and Sather, A.P. 1987. The influence of feeding level during lactation on the occurence and endocrinology of the postweaning oestrus in sows. Canadian Journal of Animal Science 67:405-415.

Kraeling, R.R., Rampacek, G.B., Cox, N.M. and Kiser, T.E., 1982. Prolactin and luteinizing hormone after bromocryptine CB-154 treatment in lactating sows and ovariectomised gilts. Journal of Animal Science 54:1212-1220.

National Research Council, 1998. *Nutrient Requirements of Swine (10th edition).* National Academy of Sciences, Washington, DC 119pp.

Tsang, B.K., Ainsworth, L., Downey, B.R. and Marcus, G.J. 1985. Differential production of steroid hormones by dispersed granulosa and theca-interna cells from developing pre-ovulatory follicles in pigs. Journal of Reproduction and Fertility 74:459-471.

Varley, M.A. and Prime, G.R. 1993. The effect of feed intake on prolificacy and plasma progesterone concentrations in multiparous sows. Livestock Production Science 34:267-279.

Viveiros, M.M., 1991. Glucocorticoid influence on ovarian pre-selection follicles. MSc. Thesis University of Guelph, Ontario, Canada.

Whittemore, C.T. and Yang, H. 1989. Physical and chemical composition of the body of breeding sows with differing body subcutaneous fat, differing nutrition during lactation and differing litter size. Animal Production 48:203-212.

Wrathall, A.E., 1980. Ovarian disorders in the sow. Veterinary Bulletin 50:253-272.

MUARIK BULLETIN, Vol. 4. pp. 55-61, 2001
Printed in Uganda. All rights reserved
© MUARIK 2001
ISSN 1563-3721

Silage quality, intake and digestibility coefficients of tropical forages ensiled in pit silos

S.V. Sarwatt, N.A. Urio and A. Ekern†
Department of Animal Science and Production, P.O. Box 3004, Chuo Kikuu, Morogoro, Tanzania
†Department of Animal Science, Agricultural University of Norway, 1432 Aas, NLH, Norway

Abstract

A study was conducted to evaluate silage quality, intake and digestibility of maize *(Zea mays)*, sorghum*(Sorghum bicolor)* and rhodes grass *(Chloris gayana)* ensiled in pit silos using sheep. Treatments imposed were T_0 (no additive), T_1 (0.5% urea) and T_2 (3.0% molasses). Treatments were randomly allocated to 9 pit silos in a completely randomised design. After 90 days all silos were opened and the amount of spoiled and good silages were separated weighed and sampled. The pH, proportions of volatile fatty acids (VFA) and chemical composition of the silages were determined. The silages were fed to sheep to determine intake and digestibility. The pH of the silages increased ($P< 0.05$) on addition of urea compared to control, whereas molasses application generally lowered ($P< 0.05$) pH for all forages. Addition of urea significantly ($P< 0.05$) increased N content of silages and elevated ammonia N concentration. Higher ($P <0.05$) amounts of lactic acid were recorded at higher levels of molasses application. Butyric acid was observed to increase with urea addition but was significantly ($P<0.05$) depressed with addition of molasses. Crude protein (CP) contents of the silages increased ($P <0.01$) on addition of urea while water soluble carbohydrates (WSC) increased for the molasses treated silages. However, WSC content in all silages was observed to be lower than in the original forages. Both neutral detergent fibre (NDF) and acid detergent fibre (ADF) in the untreated silages were observed to be higher than in the urea treated and molasses treated silages. Voluntary forage intake ($g/gW^{3/4}$) was generally increased for both urea and molasses treatments compared to control silages. Similar trend was apparent for dry matter digestibility, but the differences between forages were not significant ($P>0.05$). The study showed that addition of molasses and urea as preservatives improved the chemical composition of the silages, voluntary feed intake and digestibility of the silages.

Key words: Additive, chemical composition, sheep, voluntary forage intake

Introduction

The making of silage in the tropics has not received much attention. The lack of scientific information on controlling fermentation of tropical forages and appropriate technology on simple methods of making silage on small scale, seem to be the most significant limiting factors in adoption of ensiling (Diamond 1973; Sarwatt *et al.*, 1989 and Mannetje't, 2000). Construction of silos is an expensive venture for small-scale dairy farmers. The pit silos have been used in some countries in Africa but there are no studies on the quality of the silage made. Most commonly conserved crops forages include the tropics maize *(Zea mays)*, sorghum *(Sorghum bicolor)* and grasses like elephant grass, pangola grass and rhodes grass as they give high yields of digestible energy. Sarwatt (1995) established 3% of molasses and 0.5% urea as the optimal preservation levels for such forages when ensiled in concrete, bucket and laboratory silos. The objective of this study, was therefore, to determine the nutritive value of the most commonly used forages when ensiled in pit silos with or without molasses

Material and methods

Forages

During the long rains of February 1986, 1987 and 1989 maize and sorghum were planted at Magadu Research Farm, Sokoine University of Agriculture. After weeding at 4 weeks of growth a triple super-phosphate fertilizer was applied at a rate of 40 kg ha^{-1}. The forages were harvested at dough stage, (about 2 months from planting) using a flail harvester. The area to be harvested was first flattened with a tractor and then harvested by the tractor pulled flail harvester travelling in the opposite direction. The rhodes grass (*Chloris gayana*) was obtained from a two year old stand harvested at anthesis also using a flail harvester. The cut forage were thoroughly mixed and fresh samples were taken, weighed and dried in a forced drought oven at 60° C for 48 hours. The dried samples were milled to pass through a 1-mm screen and sub-samples collected for chemical analysis.

Preparation of silos and application of treatments to forages

A total of 9 rectangular shaped pit silos were dug to about 1m deep measuring 1m wide and 3m long. These could hold about 600-800 kg of fresh forage. Banana leaves were laid on the ground at the bottom of the silos to protect the material being ensiled from dirt. The three treatments i.e., control T1 that had no additive,T2 containing 0.5% urea and treatment T3 containing 3% molasses, respectively were tested. The three forages and three treatments were randomly allocated to the 9 silos (3 silos per treatment). A weighed amount of cut forage (about 10 kg) was evenly spread on the bottom surface of the silos and a known amount of solution was sprayed on it using a fine nozzle sprayer. This procedure was repeated and the forage was thoroughly compacted layer after layer until the silos were filled. The forage was then covered with banana leaves before covering the silo. After 90 days, the silos were opened and the resulting silage sampled. The good silage was filled in plastic bags and kept in a cold room (-4°C) ready for feeding trials. Similar procedure was repeated in 1987 and 1989.

Intake and digestibility studies

Nine male adults black head persian sheep of an average weight of 27.8 kg were used. The sheep were dewormed with Panacur (Fenbendazole, Hoescht) before the trial began. During intake sheep were offered silage at a level of 10% above the normal requirement for 10 days, after a preliminary period of 7 days of acclimatization. Feed was offered every morning at 8.00h and in the afternoon at 15.00h. Before offer of a new ration, refusals were collected and weighed. During the digestibility study, the animals were offered 20.5 g dry matter of silage per kg live body weight taken prior to the start of the trial. The daily rations were fed to the sheep in two equal meals at 09.00h and 14.00h. Feed samples were taken for each silage and bulked with previous feed samples for the same silage. The bulked samples were stored in a deep freezer at -4°C and used for crude protein and dry matter determination. Feed residue for each sheep was collected at 08.30h in the morning weighed and composite sub – samples bulked and stored in a deep freezer for further chemical analysis. Faecal measurements were done at 10.00h daily. Composite sub – samples (20% of the total faecal output) was bulked for each collection period and stored in the deep freezer. The remaining 80% of the total faecal collection was dried using a forced draught oven at 100°C for 24 hours to determine moisture content, and then bulked for chemical analysis. A solution that was made from 74.9 g of $CuSO_4$ and 56 ml of concentrated H_2So_4 brought to a volume of one litre with distilled water was used for preservation of faecal samples.

Chemical analysis

Chemical composition of the forages and silages were determined according to (AOAC, 1980). The pH recording was done on the day of opening the silo using a pH metre (Model 219-MK 2: Pye Unicam). The ammonia nitrogen of silages from frozen samples were determined by the routine Kjeldahl method (AOAC, 1980). The dry matter of the silages were determined by freeze drying method (Larsen and Jones, 1975). The Volatile fatty acids (VFA's) were determined according to the procedure of Playne (1985). Water soluble carbohydrates (WSC) were determined according to Thomas (1977). Neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) were determined by the method of Goering and Van Soest (1992).

Experimental design and statistical analyses

For statistical analyses a completely randomised design was used. Data obtained were analysed using the general linear model (GLM) Statistical Analysis System (SAS 1985). The treatment and forage means were compared using probability of difference SAS (1985).

Results

Chemical composition of forages and silages

The chemical composition of forages at the time of harvest and ensiling are presented in Table 1. There were minor variations in DM content of forages between years. Although both maize and sorghum were harvested at dough stage, the mean dry matter content was 4-5% units than the mean dry matter of maize. Dry matter content of rhodes grass harvested at anthesis stage of growth was similar to that of sorghum. Sorghum had slightly higher CP content than maize, while the lowest value was observed for rhodes grass. The mean fibre and lignin fractions were higher for rhodes grass than the rest of the forages. Rhodes grass had the lowest water-soluble carbohydrates compared to maize and sorghum. The chemical composition of the silages is presented in Table 2. The DM content was significantly ($P<0.05$) different between treatments. The molasses treated silages exhibited significantly ($P<0.05$) highest DM values while the control had the lowest values. As expected urea treatment significantly ($P<0.01$) increased total CP and decreased concentration of WSC as compared to both control and molasses treated silages. However, the WSC content in all silages was observed to be lower than in the original material. Both the NDF and ADF in the untreated silage were observed to be higher than in the urea treated and molasses treated silages.

Table 1. The mean chemical composition (in g kg^{-1} DM) of maize, sorghum and rhodes grass at harvest and ensiling.

Parameter	Maize	Sorghum	Rhodes grass
Dry matter	281.0	328.9	323.4
Crude protein	77.6	81.0	65.3
EE	13.6	13.8	14.6
Ash	105.6	114.7	92.4
Neutral detergent fibre	640.3	665.1	647.9
Acid detergent fibre	385.6	377.6	355.5
ADL	68.8	77.7	76.6
Water soluble carbogydrates	103.3	95.1	18.6

Fermentation characteristics of the silages

Fermentation products of the silages are shown in Table 3. The pH was significantly (P 0.05) lowered by molasses treatment and increased by addition of urea. Also urea significantly (P <0.05) increased concentration of ammonia – N expressed as percent of total N. Addition of molasses, generally reduced ammonia N but the difference in concentration was not different (P >0.05) from untreated controls. Lactic acid was consistently increased (P<0.01) for molasses-treated silages. The same pattern was generally observed for alcohol and acetic acid but less pronounced for acetic acid. Butyric acid was higher (P <0.05) in urea treated silages than in untreated or molasses treated silages. Levels of butyric acid were very small with lowest concentration in molasses treated silages. However, butyric concentrations were generally higher in rhodes grass than in maize and sorghum silages.

Voluntary intake and digestibility of silages

The voluntary feed intake and digestibility coefficients for the different types of silages are presented in Table 4. While the intakes were significantly affected by treatments, lowest intakes were observed for untreated silages, intermediate for urea treated silages and was highest for molasses treated silages.

Table 2. Mean chemical composition (g/kgDM) of maize, sorghum and rhodes grass with or without urea or molasses.

Forage	Trt*	DM	CP	EE	Ash	NDF	ADF	ADL	WSC
	T_0	283.0a	76.8a	13.7	97.7a	658.1a	415.0a	77.1	46.2a
Maize	T_1	285.3a	147.9b	13.8	104.0b	636.0b	413.5a	78.0	16.5b
	T_2	299.2b	77.4a	14.0	114.9c	600.6c	359.6b	77.3	22.7c
SEM		0.65	0.82	0.12	2.6	3.1	6.7	1.7	1.8
	T_0	322.6a	79.1a	13.1	96.1a	707.7a	413.1a	85.6	45.9a
Sorghum	T_1	333.9b	152.6b	13.0	98.0a	687.1b	404.3ab	83.5	18.8b
	T_2	331.2b	79.9a	13.1	109.6b	643.0c	379.4	77.3	23.3c
SEM		2.20	0.57	0.18	2.40	4.40	6.50	1.20	2.10
	T_0	312.2a	48.6a	14.2	110.3a	694.1a	385.3a	90.0	16.8a
Rhodes grass	T_1	314.5a	98.4b	14.6	114.2a	655.6b	394.4b	85.0	15.0b
	T_2	321.6b	59.7	15.1	125.7b	610.c	367.5c	79.0	18.4c
SEM		0.87	0.59	0.20	7.10	3.0	1.0	2.60	3.60

*Treatment (Trt) = T_0 = Control, T_1 = 0.5% urea and T_2 = 3% Molasses.

Table 3. Fermentation products of silages from the pit silos with or without urea or molasses.

Forage	Trt*	pH	NH_3N g/kg of total N	Lactic acid	Acetic acid	Propionic acid	Butyric acid	Alcohol
	T_0	4.48a	67.4a	48.9a	27.5a	6.6	0.7a	27.5a
Maize	T_1	5.54b	309.7b	54.7b	42.5b	8.8	1.5b	41.6b
	T_2	4.32c	44.9a	64.5c	34.2a	8.3	0.3c	63.4c
SEM		0.10	7.7	1.2	0.7	0.64	0.07	0.97
	T_0	4.49a	62.6a	44.6a	20.3a	5.4a	0.9a	20.9a
Sorghum	T_1	5.07b	286.9b	49.1b	33.0b	7.6a	1.4b	35.7b
	T_2	4.34c	54.1a	58.4b	25.6c	7.9a	0.4c	56.3c
SEM		0.16	6.4	0.95	1.9	0.44	0.08	0.37
	T_0	5.47a	65.0a	22.0a	16.2a	3.0a	2.7a	12.1a
Rhodes grass	T_1	6.53b	408.4b	38.2b	26.9b	4.9b	3.2a	29.3b
	T_2	4.55c	48.0a	47.1c	23.8a	7.0c	1.5b	46.2c
SEM		0.18	1.4	2.6	1.2	0.21	0.1	0.7

*Treatment (Trt) = T_0 = Control, T_1 = 0.5% urea and T_2 = 3% Molasses.