Journal of Animal and Veterinary Advances 9 (24): 3098-3103, 2010
ISSN: 1680-5593
© Medwell Journals, 2010

Effects of Supplementary Nutrition in Yearling Saanen Kids on Sexual Behaviors and Reproductive Traits

[1]Abdulkadir Orman, [2]Cagdas Kara, [1]Ersin Topal and [1]Ender Carkungoz
[1]Department of Zootechnics, [2]Department of Animal Nutrition and Nutritional Diseases,
Faculty of Veterinary Medicine, University of Uludag, 16059 Gorukle, Bursa, Turkey

Abstract: The present study was conducted to improve sexual behaviors in yearling kids mated for the first time by supplementing the feed additive containing multiple nutrients. In addition, the aim of this study was to evaluate the effect of supplementing multiple nutrients on litter size in yearling kids. Eighteen yearling Saanen kids (34.40±4.10 kg), aged 7-8 months and two sexually experienced Saanen bucks (53±2.80 kg), aged 2 years were used. The animals were sorted by body weight and litter size of their mothers in previous years and assigned to one of the two groups (control; CG and experimental; EG) in the study. Each group consisted of 9 animals. The daily ration of the animals in EG was added 30 g animal^{-1} the feed additive for 5 days before mating period. Despite the fact that there were no statistically differences for sexual behaviors, the number of kids born, kidding and multiple birth percentages between groups ($p>0.05$), the results showed that supplementing combination of nutrients improving animal health and reproduction had a positive effect on kidding and multiple percentages.

Key words: Supplementation of multiple nutrients, sexual behaviors, litter size, kidding, percentage mating period, supplimentation

INTRODUCTION

In domestic ruminants and most mammals, female sexual behaviors are distinguished in three components as attractivity, proceptivity and receptivity. Attractivity refers to the female's value as a sexual stimulus whereas proceptivity consists of appetitive activities shown by females. Receptivity includes the behaviors exhibited by the female that allow intravaginal ejaculation (Beach, 1976; Tilbrook *et al*., 1990). Three components of sexual behavior are important for successful mating to ocur (Beach, 1976).

In ruminants, sexual behaviors are triggered by an increasing concentration of estradiol secreted by the developing follicle at the end of the follicular phase (Pillon *et al*., 2003). Some nutrients such as cobalt, selenium, manganese, zinc and β-carotene are affected on synthesis of ovarian steroids playing a major role in controlling sexual behavior (Hurley and Doane, 1989; Corah and Ives, 1991; Basini and Tamanini, 2000; Pillon *et al*., 2003).

Intensity and quality of sexual behaviors exhibited by females are associated with both age and experience (Gelez *et al*., 2004). Young females have a shorter estrus and a lower quality of sexual behavior partly because they seem unable to attract and stimulate males (Edey *et al*., 1978; Rosciszewska, 1985). It hypothesized that identification of unexperienced yearling kids in estrus by sexual partners may be more easy through increasing intensity of sexual behaviors.

Litter size or number of kids in the litter was defined by Alexandre *et al.* (1999) as total number of born kids per kidding and per goat. Maximising potential litter size is provided by maximising ovulation rate and ensuring successful embryonic and fetal development (Martin *et al*., 2004).

It has been widely documented that many nutrients play important roles in litter size, ovulation rate, embryonic and fetal survival (Hidiroglou, 1979; Hurley and Doane, 1989; Smith and Akinbamijo, 2000; Kosior-Korzecka and Bobowiec, 2003). Vitamin supplementation (such as vitamin A and E) may improve litter size and embryonic survival (Whaley *et al*., 1997; Smith and Akinbamijo, 2000). Supplementation including energy and/or amino acids increases ovulation rate (Downing *et al*., 1995, 1997) and copper, iodine, manganese, selenium and zinc influence embryonic and fetal survival (Hostetler *et al*., 2003). It hypothesized that supplementation of a mixture of nutrients can be more useful than supplementation of a single nutrient on

Corresponding Author: Cagdas Kara, Department of Animal Nutrition and Nutritional Diseases, Faculty of Veterinary Medicine, University of Uludag, 16059 Gorukle, Bursa, Turkey

sexual behaviors and litter size because there are many mechanisms and variables affecting sexual behavior and litter size. The present study was conducted to improve sexual behaviors in yearling kids mated for the first time by supplementing the feed additive containing multiple nutrients. In addition, the aim of this study was to evaluate the effect of supplementing multiple nutrients on litter size in yearling kids.

MATERIALS AND METHODS

Study area and animals: The study was carried out at Uludag University Applied Research Center For Veterinary Faculty Unit in Bursa where place within the north west Turkey, 40°North latitude, 29°East longitude and at an altitude of 120 m above sea level. All animals were handled according to the EU directive number 86/609/EEC concerning the protection of animals used for experimental and other scientific purposes.

Eighteen yearling Saanen kids (34.40±4.10 kg), aged 7-8 months and two sexually experienced Saanen bucks (53±2.80 kg), aged 2 years were used. The animals were sorted by body weight and litter size of their mothers in previous years and assigned to one of the two groups (control; CG and experimental; EG) in the study. Each group consisted of 9 animals. The groups were similar with regard to body weight (control 33.60±3.30 kg, experimental 35.10±3.40 kg) and mean litter size of their mothers in the previous years (control 1.88, experimental 1.88).

Management and experimental design: Experiment was conducted between August of 2008 and March of 2009. The yearling kids were housed in 1.22×1.70 m individual pens equipped with a feeder and water pot with wheat straw bedding during the study and fed with 0.6 kg/day/animal alfalfa hay and 0.4 kg/day/animal goat pellets for 5 days (August 25-29, 2008) before mating period. The daily ration of the yearling kids in Experimental Group (EG) was added 30 g animal^{-1} the feed additive (Hepato Force®, Evialis International, Cedex/FRANCE) in this period. The yearling kids were not synchronized before mating period. Mating period (the time between first mating and last mating) lasted 23 days (September 5-27, 2008). The yearling kids were fed with 0.7 kg/day/animal alfalfa hay and 0.5 kg/day/animal goat pellets from mating period to last month of gestation and 0.7 kg/day/animal alfalfa hay and 0.6 kg/day/animal goat pellets during last month of gestation. The bucks were housed in a paddock and fed with oats hay *ad libitum* and 0.8 kg/day/animal goat pellets during the study. Water was supplied *ad libitum* during the study.

Table 1: Nutrient composition of the feeds[1]

Items	Alfalfa hay	Goat pellets[2]
Dry matter (%)	94.89	92.86
Crude protein, percentage of DM	12.36	16.20
Ether extract, percentage of DM	1.72	5.11
Crude fiber, percentage of DM	35.16	8.79
Ash, percentage of DM	7.46	6.29

[1]Nutrient analyses of the feeds were performed according to AOAC (1990); [2]ProYem, growing concentrate mixture, Matli Feed Industry, Karacabey, Turkey

Table 2: Nutrient composition of the feed additive (Hepato Force) (as fed)

Nutrients	Values
Dry matter (%)	94.02
Niacin (mg kg^{-1})	2000
β-carotene (active) (mg kg^{-1})	30
Betaine (mg kg^{-1})	2000
Choline chloride (mg kg^{-1})	7000
Methionine (mg kg^{-1})	55000
Lysine base (mg kg^{-1})	4400
Sorbitol (mg kg^{-1})	65000
Vitamin A (IU kg^{-1})	8000,000
Vitamin D3 (IU kg^{-1})	200,000
Vitamin E (mg kg^{-1})	8500
Vitamin C (mg kg^{-1})	150
Vitamin B1 (mg kg^{-1})	750
Copper (sulphate)	300
Iron (sulphate) (mg kg^{-1})	1500
Manganese (oxide) (mg kg^{-1})	4000
Zinc (oxide) (mg kg^{-1})	6500
Iodine (iodate) (mg kg^{-1})	90
Cobalt (carbonate) (mg kg^{-1})	25
Selenium (selenite) (mg kg^{-1})	40
Soluble phosphorus (%)	2.5
Magnesium (%)	3
Sodium (%)	3
Calcium (%)	3

Nutrient compositon of alfalfa hay and goat pellets consumed by the yearling kids was shown in Table 1. Nutrient compositon of the feed additive was shown in Table 2.

Behavioral observations: The yearling kids and bucks were kept together in a paddock for 1 h twice a day during mating period. Each yearling kid was randomly assigned to one of the 2 bucks. The yearling kids to come into estrus in the time of introducing the bucks were mated and sexual behaviors of the yearling kids in estrus were observed. During the observations, soliciting, sniffing scrotum, head-turning, anogenital sniffing, non-firm standing, squatting and tail-fanning were recorded as proceptive behavior and firm standing was recorded as receptive behavior. All the behavioral traits investigated are shown in Table 3. The behaviors of animals were noted on individual checksheets prepared for each animal. Each yearling kid was considered to be in estrus when she was directly observed to accept a mount from the buck (Romano *et al*., 2000).

Litter size: At kidding time, the yearling kids were closely monitored to facilitate accurate recording of the number of kids born for a final assessment of litter size.

Table 3: Behavioral traits recorded during the observation periods

Traits	Response
Soliciting	The female approaches to the male, nuzzles the body of him shows a tendency to stay in the vicinity of the male and follows him
Sniffing scrotum	The female sniffs the scrotum and anogenital region of the male
Head-turning	The female stands and swings her head to look at the courting male
Anogenital sniffing	The female allows the male to sniff her tail and genitalia
Non-firm standing	The female stands in front of the male in response to the courtship of him but does not allow him to mount and she avoids when the male attempts to mount
Squatting	Typical urination posture of the female
Tail-fanning	Repeated movement of the tail
Firm standing	The female stands still to receive a mount attempt or mount

Statistical analysis: Sexual behaviors (proceptive and receptive behaviors), the numbers of kids born per group, kidding percentages (percentage of animals kidding) and multiple birth percentages were compared by Pearson Chi-Square test. SPSS (2004) 13 computer program package was used for the statistical analyses. Significance was accepted at $p<0.05$.

RESULTS AND DISCUSSION

During the study, the yearling kids consumed all the goat pellets given daily and amount of alfalfa hay consumed by the animals was similar between groups. The yearling kids in EG consumed the whole of the feed additive given for 5 days before mating period.

Sexual behaviors: Sexual behaviors data were shown in Table 4. All the yearling kids showed at least one proceptive and receptive behavior and mated with one of the bucks. During mating period, one each animal in both CG and EG showed a second estrus but sexual behaviors in second estrus were not recorded. The numbers of proceptive behaviors were same in CG and EG and the numbers of receptive behaviors (14 and 15 for CG and EG, respectively) were similar for CG and EG. There were no statistically differences for proceptive and receptive behaviors between CG and EG ($p>0.05$) (Table 4).

In the ruminant species, an increasing estradiol level in the circulation evokes the LH surge and this estradiol rise is essential for the manifestation of females's sexual behavior (Mori, 1992; Goodman, 1994). Higher estradiol levels decrease the latency to the expression of sexual behavior whereas they increase on the other hand both the duration and the intensity of sexual behavior (Fabre-Nys *et al*., 1993; Goodman, 1994).

β-carotene, vitamin A, vitamin C, selenium, manganese and zinc play a major role in synthesis of estradiol (Lothammer *et al*., 1976; Hurley and Doane, 1989; Corah and Ives, 1991; Basini and Tamanini, 2000; Murray *et al*., 2001). Treating with cobalt results in stronger manifestations of estrus (Hurley and Doane, 1989). Suboptimal ovarian activity and depressed estrus are associated with copper (Hidiroglou, 1979).

Table 4: Behavioral and reproductive traits

Groups			
Sexual behaviors	CG[1] (n = 9)	EG[2] (n = 9)	p-value
Proceptive	42	42	NS
Receptive	14	15	NS
Total	56	57	NS
Reproductive traits			
The numbers of kids	9	14	NS
Kidding percentage	55.56% (5 of 9)	88.89% (8 of 9)	NS
Multiple birth percentage	44.44% (4 of 9)	66.67% (6 of 9)	NS

[1]Control group; [2]Experimental group; NS: Not Significant

It hypothesized that the feed additive may improve sexual behaviors due to role of the vitamins and minerals indicated above in synthesis of estradiol and ovarian activity. However, the feed additive used before mating period did not affect sexual behaviors in the study (Table 4). Results of sexual behaviors in present study were similar to those of the previous study conducted by using same feed additive in ewes. Influences of the nutrients on sexual behaviors in ruminants have not been adequately investigated. Therefore, we could not have a chance of comparing the results of sexual behavior obtained in the study with those in other similar studies. It suggested that effect of the feed additive on sexual behaviors was not observed because of limited number of the yearling kids used in this study. In addition, amount of the feed additive added to ration might be inadequate.

Litter size: The numbers of kids born were 9 and 14 in CG and EG, respectively. Kidding percentages (percentage of animals kidding) were 55.56% (5 of 9 animals in CG) and 88.89% (8 of 9 animals in EG). Multiple birth (twin) percentages were 44.44 and 66.67% in CG and EG, respectively. There were no statistically differences for the number of kids, kidding percentages and multiple birth percentage between groups ($p>0.05$) (Table 4).

The numerical (non-significant) difference for the number of kids between groups was because of higher kidding and multiple birth percentages in EG than those in CG (Table 4). The three major variables that contribute to litter size are ovulation rates, embryonic survival and foetal survival (Koyuncu and Yerlikaya, 2007).

Negative impacts of vitamin E and/or selenium deficiencies have been observed on various components of the reproductive event including ovulation rate (Harrison *et al*., 1984). Short-term β-carotene supplementation positively affects ovarian follicular development and ovulation rate in goats

(Arellano-Rodriguez *et al*., 2007). It is generally known that short-term supplementary lupin grain (*Lupinus angustifolius*) feeding significantly increases the ovulation rate in ewes (Downing and Scaramuzzi, 1991; Downing *et al*., 1995). The increase in the ovulation rate after lupin feeding is interpreted as a local effect of glucose and glycogenic amino acids such as methionine (increased availability of energetic substrates for growing and developing follicles) or anabolic actions of insulin on the ovary (Downing *et al*., 1995). Glucose is the major source of energy for the ovary (Rabiee *et al*., 1997) and hepatic oxidation of sorbitol found in the feed additive, leads to glucose production (Boyles, 1993). In ruminants, up to 35% of glucose requirements can be met by amino acids. Amino acids supplementation can therefore result in an increase in glucose (Vinoles, 2003).

In the present study, higher multiple birth (twin) percentage in EG (66.67%) compared to CG (44.44%) might be due to the feed additive containing vitamin E, selenium, β-carotene, sorbitol as source of glucose and methionine (glycogenic amino acid) improving ovulation rate. As a result of ultrasound examinations in the study, observed embryonic deaths are observed in CG (2 of 9 animals) and EG (1 of 9 animals) during pregnancy and did not establish pregnancy in two animals in CG in spite of mating. These animals did not come into estrus again.

Observed litter size increases in pigs supplemented vitamin A are primarily due to increased embryonic survival mediated via an improvement in early embryonic synchrony and increased progesterone levels during the early post-ovulatory period (Whaley *et al*., 1997; Smith and Akinbamijo, 2000). Copper, iodine, iron, manganese, selenium and zinc are known to influence embryonic and fetal survival (Hidiroglou, 1979; Hambidge *et al*., 1985; Davis and Mertz, 1987; Hurley and Keen, 1987). Manganese, cobalt and vitamin A are necessary for normal fertility in ruminants and are associated with conception rate (Hidiroglou, 1979; Smith and Akinbamijo, 2000). The administration of iodine to cattle resulted in higher conception rate. Feeding goats semipurified diets low in zinc caused low conception rate and reduced the number of kids per goat (Hidiroglou, 1979).

Higher kidding percentage in EG (88.89%) compared to CG (55.56%) might be due to positive effects of above mentioned minerals and vitamin A on embryonic survival and conception rate. Hemingway *et al.* (2001) reported that the multi-trace element/vitamin ruminal bolus administered to ewes before mating period significantly increased lambing percentage. The ruminal bolus was composed of copper, selenium, cobalt, iodine, manganese, zinc, vitamin A, D_3 and E. The result obtained by Hemingway *et al.* (2001) supports positive effect of the feed additive on kidding percentage (Table 4). It suggested that significant differences for the number of kids born and kidding and multiple birth percentages may be obtained in a study conducted by using more animals than used in current study.

CONCLUSION

We investigated effects of the feed additive having a wide utilization area such as preventing ketosis and fatty liver, increasing production and improving reproduction on sexual behaviors and litter size in yearling kids. The results showed that the feed additive containing many nutrients improving animal health and reproduction had a positive effect on kidding and multiple percentages. These findings will be useful to help further explore the frequency, timing and amount of multiple nutrients supplementation that may alter reproductive performance of yearling kids. Different results can be attained when this study is renewed with changing amount of the feed additive and using larger number of animals. Additional studies investigating hormonal changes are needed to evaluate and prove the efficacy of supplementing multiple nutrients on sexual behaviors and litter size.

ACKNOWLEDGEMENT

The researchers would like to thank ANC Animal Nutrition and Health Corporation, Kocaeli, Turkey for their support.

REFERENCES

AOAC, 1990. Official Methods of Analysis. 15th Edn., Association of Official Analytical Chemists, Washington, DC., USA., pp: 200-210.

Alexandre, G., G. Aumont, J.C. Mainaud, J. Fleury and M. Naves, 1999. Productive performances of Guadeloupean Creole goats during the suckling period. Small Rumin. Res., 34: 155-160.

Arellano-Rodriguez, G., C.A. Meza-Herrera, R. Rodriguez-Martinez, G. Velazquez-Mendez and M. Mellado *et al*., 2007. Hort-term betacarotene supplementation positively affects ovarian follicular development and ovulation rate in goats. J. Applied Anim. Res., 32: 177-180.

Basini, G. and C. Tamanini, 2000. Selenium stimulates estradiol production in bovine granulosa cells: Possible involvement of nitric oxide. Domest. Anim. Endoc., 18: 1-17.

Beach, F.A., 1976. Sexual attractivity, proceptivity and receptivity. Horm. Behav., 7: 105-138.

Boyles, D.W., 1993. Sorbitol clearance and its effects on feedlot performance and carcass characteristics of steers. Degree Diss., Texas Technology University, USA.

Corah, L.R. and S. Ives, 1991. The effects of essential trace minerals on reproduction in beef cattle. Vet. Clin. North Am. Food Anim. Pract., 7: 40-57.

Davis, G.K. and W. Mertz, 1987. Copper. In: Trace Elements in Human and Animal Nutrition, Mertz, W. (Ed.). 5th Edn., Academic Press, New York, pp: 301-359.

Downing, J.A., J. Joss, P. Connell and R.J. Scaramuzzi, 1995. Ovulation rate and the concentrations of gonadotrophic and metabolic hormones in ewes fed lupine grain. J. Reprod. Fertil., 103: 137-145.

Downing, J.A. and R.J. Scaramuzzi, 1991. Nutrient effects on ovulation rate, ovarian function and the secretion of gonadotrophic and metabolic hormones in sheep. J. Reprod. Fert. Suppl., 43: 209-227.

Downing, J.A., J. Joss and R.J. Scaramuzzi, 1997. Ovulation rate and the concentrations of LH, FSH, GH, prolactin and insulin in ewes infused with tryptophan, tyrosine or tyrosine plus phenylalanine during the luteal phase of the oestrous cycle. Anim. Rep. Sci., 45: 283-297.

Edey, T.N., R. Kilgour and K. Bremner, 1978. Sexual behaviour and reproductive performance of ewe lambs at and after puberty. J. Agric. Sci., 90: 83-91.

Fabre-Nys, C., G.B. Martin and G. Venier, 1993. Analysis of the hormonal control of female sexual behavior and the preovulatory LH surge in ewe: Roles of quantity of estradiol and duration of its presence. Horm. Behav., 27: 108-112.

Gelez, H., E. Archer, D. Chesneau, D. Lindsay and C. Fabre-Nys, 2004. Role of experience in the neuroendocrine control of ewes sexual behavior. Horm. Behav., 45: 190-200.

Goodman, R.L., 1994. Neuroendocrine Control of the Ovine Estrus Cycle. In: The Physiology of Reproduction, Knobil, E., J.D. Neill, G.S. Greenwald, C.L. Markert and D.W. Pfaff (Eds.). Raven Press, New York, pp: 659-710.

Hambidge, K.M., C.E. Casey and N.F. Krebs, 1985. Zinc. In: Trace Elements in Human and Animal Nutrition, Mertz, W. (Ed.). 5th Edn., Academic Press, Orlando, ISBN: 0124912524, pp: 1-137.

Harrison, J.H., D.D. Hancock and H.R. Conrad, 1984. Vitamin E and selenium for reproduction of the dairy cow. J. Dairy Sci., 67: 123-132.

Hemingway, R.G., J.J. Parkins and N.S. Ritchie, 2001. Enhanced reproductive performance of ewes given a sustained-release multi-trace element/vitamin ruminal bolus. Small Rumin. Res., 39: 25-30.

Hidiroglou, M., 1979. Trace element deficiencies and fertility in ruminants: A review. J. Dairy Sci., 62: 1195-1206.

Hostetler, C.E., R.L. Kincaid and M.A. Mirando, 2003. The role of essential trace elements in embryonic and fetal development in livestock. Vet. J., 166: 125-139.

Hurley, L. and C. Keen, 1987. Manganese. In: Trace Elements in Human and Animial Nutrition, Mertz, W. (Ed.). Academic Press, San Diego, CA., pp: 85-223.

Hurley, W.L. and R.M. Doane, 1989. Recent development in the role of vitamins and minerals in reproduction. J. Dairy Sci., 72: 784-804.

Kosior-Korzecka, U. and R. Bobowiec, 2003. Changes in the level of endogenous leptin, FSH, 17β-oestradiol and metabolites during lupin-induced increase in ovulation rate in ewes. J. Vet. Med., 50: 343-349.

Koyuncu, M. and H. Yerlikaya, 2007. Effect of selenium-vitamin E injections of ewes on reproduction and growth of their lambs. S. Afr. J. Anim. Sci., 37: 233-236.

Lothammer, K.H., L. Ahlswede and H. Meyer, 1976. Untersuchungen uber eine spezifische Vitamin-A unhabhangige Wirkung des β-Carotins und die Fertilitat des Rindes. 2. Mitteilung: Weitere klinische Befunde und Befruchtunsergebnisse. Dtsch. Tierarztl. Wschr., 83: 353-358.

Martin, G.B., J.T. Milton, R.H. Davidson, G.E. Banchero Hunzicker, D.R. Lindsay and D. Blache, 2004. Natural methods for increasing reproductive efficiency in small ruminants. Anim. Reprod. Sci., 82-83: 231-245.

Mori, Y., 1992. Central Integration of Photoperiodicity for Gonadotropin Release in Ruminants. In: Brain Control of the Reproductive System, Yokoyama, A. (Ed.). Japan Scientific Societies Press, Tokyo, pp: 93-118.

Murray, A.A., M.D. Molinek, S.J. Baker, F.N. Kojima, M.F. Smith, S.G. Hillier and N. Spears, 2001. Role of ascorbic acid in promoting follicle integrity and survival in intact mouse ovarian follicles *in vitro*. J. Reprod. Fertil., 121: 89-96.

Pillon, D., A. Caraty, C. Fabre-Nys and G. Bruneau, 2003. Short-term effect of oestradiol on neurokinin B mRNA expression in the infundibular nucleus of ewes. J. Neuroendocrinol., 15: 749-753.

Rabiee, A.R., I.J. Lean, J.M. Gooden and B.G. Miller, 1997. Short-term studies of ovarian metabolism in the ewe. Anim. Reprod. Sci., 47: 43-58.

Romano, J.E., C.J. Christians and B.G. Crabo, 2000. Continuous presence of rams hastens the onset of estrus in ewes synchronized during the breeding season. Applied Anim. Behav. Sci., 66: 65-70.

Rosciszewska, Z.E., 1985. The influence of earlier mating experience of ewes on their subsequent mating behaviour and reproductive performance. Anim. Reprod. Sci., 9: 223-229.

SPSS, 2004. Base System User's Guide Version 5.0. SPSS Inc., Chicago, IL, USA.

Smith, O.B. and O.O. Akinbamijo, 2000. Micronutrients and reproduction in farm animals. Anim. Reprod. Sci., 60-61: 549-560.

Tilbrook, A.J., P.H. Hemsworth, J.S. Topp and A.W.N. Cameron, 1990. Parallel changes in the proceptive and receptive behaviour of the ewe. Applied Anim. Behav. Sci., 27: 73-92.

Vinoles, C., 2003. Effect of nutrition on follicle development and ovulation rate in the Ewe. Ph.D. Thesis, Swedish University of Agricultural Sciences, Uppsala.

Whaley, S.L., V.S. Hedgpeth and J.H. Britt, 1997. Evidence that injection of vitamin A before mating may improve embryo survival in gilts fed normal or high energy diets. J. Anim. Sci., 75: 1071-1077.