Protein Levels and Sources in Molasses for Growing Cattle

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Introduction

Blackstrap molasses is a byproduct of the sugar industry and is an economical source of supplemental energy for beef cattle in Florida. As warm season perennial forages grown in Florida may be low in protein, molasses based liquid supplements fed to beef cattle are usually fortified with protein in addition to minerals and vitamins.

Cattle utilize and require two types of digestible protein. The first type is rumen degraded protein that is used by the microbes for their growth resulting in the synthesis of microbial protein. Another type of protein is rumen undegraded protein (also described as "bypass" or "escape" protein) that is not degraded in the rumen, but is digested to amino acids that are absorbed from the small intestine. The total metabolizable protein supply for the ruminant animal is the microbial protein plus the rumen undegraded protein that is digested and absorbed from the small intestine. Many beef production systems attempt to maximize the synthesis of microbial protein with non-protein nitrogen (NPN) and then provide additional undegraded protein if required by the animal and an economical response is expected. Sources of protein with a high proportion of undegraded protein include blood meal, feather meal, fish meal, corn gluten meal, meat and bone meal, distillers grains and brewers grains.

Meeting the requirements for rumen degraded protein usually results in increases in forage intake and microbial protein synthesis and should be a high supplementation priority along with minerals and vitamins. Klopfenstein, 1993, reviewed the international literature and suggested the requirement for rumen degraded protein is 13% of the total digestible nutrients (TDN). Moore, 1992 and Brant, 1993, reviewed supplementation research and concluded that when the TDN to crude protein (CP) ratio was below 7, protein was balanced with energy. Although the TDN:CP ratio does not include the digestibility of the protein, the ratio indicates that the crude protein requirement is approximately 14% of the TDN which is similar to the 13% proposed by Klopfenstein.

A broad base of literature supports the contention that rumen degraded protein and energy must be in balance in order to meet microbial requirements without offering excess protein, however, it is difficult to determine the TDN:CP ratio of the forage consumed in grazing ruminants due to selective grazing. Excess rumen degraded protein is absorbed and converted to urea which is recycled to the rumen through saliva, diffuses across the rumen wall or is excreted in the urine. Hammond reviewed several experiments and concluded that blood urea nitrogen (BUN) concentrations above 10 mg/dl indicated a good balance between digestible protein and digestible energy, and BUN concentrations below 8 mg/dl indicated digestible protein may have been deficient and protein supplements often improved animal

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performance. BUN concentration appears to be a useful tool to determine if degradable protein is limiting the performance of grazing beef cattle.

Research with protein and molasses supplements for growing cattle grazing Florida pastures in the summer and fall was summarized in 1990 (Kunkle et al.). During the past four years several experiments have evaluated the effects of undegraded protein supplements on the performance of growing cattle, and these trials will be summarized in this paper.

Recent Research

Molasses supplements with different levels and sources of protein were evaluated in two trials with growing cattle fed high quality bermudagrass hay (Stateler et al., 1993; Stateler, 1993). The bermudagrass hays used in the two trials had crude protein concentrations over 11%, TDN:CP ratios below 5, and resulted in BUN concentrations in yearling cattle fed these hays over 20 mg/dl. This information indicates that degraded protein in the hays was above the requirements for degraded protein (Tables 1 and 2). Cattle consuming approximately 5.8 lb/day of a molasses supplement (MOL) and a diet with a TDN:CP ratio under 6 had BUN levels above 8 mg/dl for most sampling dates, indicating that degraded protein was marginal to adequate. Urea added to molasses (MOL-UREA) increased the BUN concentrations, but gains were not improved over MOL. Molasses-soybean meal supplements (MOL-SBM) increased gains .13 lb/day over MOL in the first trial but did not improve gains in the second trial. Nylon bag studies indicated that the soybean meal used in these trials was 97% rumen degradable. Molasses-blood meal-feather meal supplements supplied .3 lb/day of undegraded protein, and increased gains .23 lb/day in the first year and .29 lb/day in the second year compared to MOL. Undegraded protein fed at .11, .20 and .31 lb/day in the second year resulted in higher gains with higher levels of undegraded protein. Undegraded protein appeared to increase forage intake slightly, but most of the added gain appeared to be from better efficiency of feed use.

Hay consumption was reduced approximately 30% when 5.8 lb/day of molasses supplements were consumed in the first year, but forage consumption was similar in the second year. The added gain/lb supplemental TDN was .25 to .35 lb for the molasses-blood meal-feather meal supplements which is high compared to other trials (Kunkle et al., 1990). This indicates that forage intake and utilization was not depressed by the supplements. The supplements were offered 3 times/week in the first year and twice a week in the second year at a level equivalent to 6 lb/day. The conditions that resulted in large increases in gain and low costs of added gain ($.35 to $.59/lb added gain) for molasses supplements are not obvious, and are contrasted by a pasture supplementation trial (Table 3). Newly weaned calves grazing residual bahiagrass pastures in the fall consumed 4.8 lb/day of the molasses supplements, but gains were improved only .11 to .32 lb/day and costs of gain were high. The same cattle at the same facility were used immediately after this experiment in a second experiment reported in Table 2 and showed an excellent response to the supplements. The molasses-blood meal-feather meal supplement increased gains .23 lb/day over MOL, again indicating that .3 lb/day of undegraded protein improved gains.

Supplementation of degraded protein has been shown to improve the performance of cattle when it is deficient. Limpograss had a high digestibility (57 to 60%), a low crude protein (5.4 to 8.1%), and a TDN:CP ratio ranging from 7.1 to 10.8 in experiments conducted across 4 years at the Beef Research Unit near Gainesville, Florida (Tables 4 and 5). BUN concentrations ranged from 5.3 to 6.2 also indicating degraded protein was deficient and supplementing growing cattle with a urea based supplement improved gains .62 to .76 lb/day in the 4 trials. Additional nitrogen fertilizer (132 vs. 44 lb/acre) improved forage crude protein levels, increased BUN concentrations and improved gains of growing cattle. Nitrogen fertilization provides another approach to correcting a protein deficiency and improving cattle performance. Undegraded protein (.3 lb/day) from corn gluten and blood meals in addition to degraded protein from urea improved gains of cattle .25 lb/day above urea supplemented cattle when averaged across the two fertilization rates and years.

Ammoniation improves crude protein, digestibility and intake of low quality forages. Brown (1993) supplemented ammoniated stargrass hay with molasses, cottonseed meal and molasses-cottonseed meal (Table 6). Growing steers fed stargrass hay supplemented with 4.5 lb/day molasses (dry matter) reduced hay intake by 3.7 lb/day and gains were improved only .28 lb/day. Supplementing ammoniated hay with 1 lb/day of cottonseed meal improved gains .48 lb/day, maintained total dry matter consumption and doubled gain/feed ratio. A molasses-cottonseed meal supplement fed at 6 lb/day reduced hay consumption 1.8 lb/day, improved gains from .51 to 1.70 lb/day, and improved energy utilization of the diet. This trial demonstrates the dramatic effects that protein can have on the forage consumption and energy utilization. Cottonseed meal provided both degraded protein and undegraded protein. The degraded protein requirements were likely met from the forage (TDN:CP ratio=5.6), but amino acids and carbon chains provided by the degraded protein may have increased microbial protein synthesis as reported by McCollum and Horn, 1990.

Cottonseed and feather meal supplements at different levels of protein were compared for growing steers fed ammoniated stargrass hay and molasses (Table 7). All diets had a TDN:CP ratio below 4 and were supplemented with .15, .30 or .45 lb/day of protein from cottonseed meal or feather meal. Gains were increased as the level of supplemental protein increased up to .45 lb/day but total dry matter consumed was similar, therefore the higher gains were apparently from improved energy utilization. The improvement in performance appeared to more closely follow the total quantity of protein rather than the quantity of undegraded protein. Supplementing .45 lb/day of protein from cottonseed meal or feather meal provided an estimated .19 or .30 lb/day of undegraded protein and improved gains .62 and .67 lb/day respectively, over the gains of steers fed an ammoniated hay-molasses diet.

In another study feather meal alone or in combination with blood meal was evaluated as a protein supplement for 480 lb growing steers fed low quality stargrass hay (Table 8). Feather meal supplemented to provide .34 lb/day of undegraded protein improved gains .37 lb/day over steers fed molasses-urea with a .4 lb/day increase in hay offered. Substituting part of the feather meal with blood meal did not change the gains. A similar study (Table 9) with heifers showed that feeding .34 lb/day of undegraded protein from feather meal improved gains .25 lb/day over heifers fed molasses-urea. A molasses supplement providing .34 lb/day of undegraded protein from feather meal and 5% fish oil was also evaluated in the heifer study. Heifer gains were improved .13 lb/day when supplemented with fish oil. Pregnancy rate was highest (83%) in Brangus heifers supplemented with molasses-feather meal-fish oil compared to a 42% pregnancy rate for Brangus heifers supplemented with molasses-feather meal and a 16% pregnancy rate for Brangus heifers supplemented with molasses-urea. This study has limited numbers of animals but the improved pregnancy rate from fish oil appeared encouraging and additional studies are in progress.

Effects of protein sources in molasses based supplements on the pregnancy rates of heifers was investigated in two additional trials. Crossbred heifers were weaned, grazed on bahiagrass pasture during the fall, fed stargrass hay during the late fall and winter, and pastured with bulls for 60 days in the spring. Consumption of the molasses-urea (MOL-UREA) supplement was reduced to 2.0 lb/day compared to 5.1 lb/day for molasses supplemented heifers, and gains were .09 lb/day for MOL-UREA compared to .29 lb/day for molasses supplemented heifers (Table 10). Heifer weights at the beginning of the breeding season and pregnancy rates were reduced for MOL-UREA supplemented heifers compared to heifers supplemented with molasses. Molasses-cottonseed meal and molasses-feather meal supplements were readily consumed and gains were improved .20 to .31 lb/day above the molasses supplemented heifers. Pregnancy rates were similar. Protein supplied from cottonseed meal or feather meal gave similar results in this trial.

Another study evaluated the effects of a molasses-cottonseed meal supplement with ammoniated and untreated stargrass hay (Table 11). Cottonseed meal added to molasses supplement improved gains .35 lb/day for heifers fed ammoniated hay, but only .09 lb/day for heifers fed untreated hay. The breeding weights and proportion of heifers reaching target weights followed trends in gains, but the pregnancy rate was lowest for molasses-urea supplemented heifers. The percent of heifers reaching puberty was similar for all supplements, but there was a trend for a lower pregnancy rate in cycling heifers supplemented with molasses-urea compared molasses or molasses-cottonseed meal-urea supplements. Staples et al. , 1993, summarized research indicating that diets with excess protein were frequently associated with a lower reproductive rate in lactating dairy cows. Cattle fed diets with excess protein have high BUN's and possible mechanisms relating high BUN to lower pregnancy rates were proposed. The BUN's of heifers supplemented with molasses-urea in this trial were similar to those supplemented with molasses-cottonseed meal-urea. Additional research is needed to determine the relationships of supplements and BUN concentrations to reproductive performance.

Summary

In cow-calf and stocker production systems meeting the degraded protein requirements should be given a high priority along with meeting mineral and vitamin requirements. Degraded protein requirements are usually met when the diet TDN:CP ratio is 7 or lower or the blood urea nitrogen is 10 mg/dl or higher. Degraded protein requirements can be met with high protein supplements containing non-protein nitrogen such as urea or with feeds containing rumen degraded protein.

After the degraded protein requirements are met then undegraded protein can be supplemented to meet the animal protein requirements and improve performance when profitable. A summary of 8 different experiments with growing beef cattle conducted at 3 different locations in Florida with several warm season perennial grass pastures and hays has

shown that gains are usually improved when protein sources such as cottonseed meal, feather meal and blood meal are fed in molasses based liquid supplements. A summary of 24 evaluations in experiments reviewed in this paper show an increase in gains ranging from .02 to .91 lb/day and with an average of .31 lb/day across several sources and levels of supplemental protein in situations where rumen degraded protein requirements were met. When increases in gain were high, the supplemental protein usually increased forage intake but when smaller increases in gain were reported, forage intakes were usually similar and an improved efficiency in the use of feed consumed was apparent. In 12 comparisons with .20 to .37 lb/day of supplemental undegraded protein from feather, blood, and/or corn gluten meals, the increased gains ranged from .18 to .67 lb/day and averaged .32 lb/day. Feeding sources of undegraded protein to growing beef cattle improved performance and may be profitable in selected beef production systems.

Literature Cited

Brant, M.H. 1993. Predicting the effects of supplementation of forage diets on forage intake and total diet metabolizable energy concentration. M. S. Thesis. University of Florida.

Brown, W. F. 1993. Hay ammoniation and energy-protein supplementation for beef cattle. Proc. Conf. on Livestock Production in the Tropics. pp 51-58.

Holderbaum, J.F., L.E. Sollenberger, J.E. Moore, W.E. Kunkle, D.B. Bates, and A.C. Hammond. 1991. Protein supplementation of steers grazing limpograss. J. Prod. Agric. 4:437-441.

Klopfenstein, T.J. 1993. Strategies for predicting the first limiting nutrient for grazing cattle. Proc. 4th Annual Florida Ruminant Nutrition Symposium, pp 112-126.

Kunkle, W.E., D.B. Bates, and F.M. Pate. 1990. Using molasses and protein supplements for grazing beef cattle. Proc. Florida Ruminant Nutrition Symposium, pp 21-30.

Lima, G.F., L.E. Sollenberger, W.E. Kunkle, J.E .Moore, and A.C. Hammond. 1993. Influence of nitrogen fertilization and supplementation on performance of beef heifers grazing limpograss. Agronomy Abstracts, pp 167.

McCollum, F.T., III, and G.W. Horn. 1990. Protein supplementation of grazing livestock: A review. The Professional Animal Scientist 6:1-16.

Moore, J.E. 1992. Matching protein and energy supplements to forage quality. Proc. 3rd Annual Florida Ruminant Nutrition Symposium, pp 31-44.

Staples, C.R., C.M. Garcia-Bojalil, B.S. Oldick, and W.W. Thatcher. 1993. Protein intake and reproductive performance of dairy cows: A review, a suggested mechanism, and blood and milk urea measurements. Proc. 4th Annual Florida Ruminant Nutrition Symposium, pp 21-30.

Stateler, D.S. 1993. Effect of protein level and source in molasses slurries on the performance of growing cattle. M. S. Thesis. University of Florida.

Stateler, D.A., W.E. Kunkle, and A.C. Hammond. 1993. Effect of protein level and source in molasses slurries on the performance of growing cattle fed hay during the winter. J. Anim. Sci. 71:1 (Supplement 1).

Table 1. Effect of Protein Level and Source in Molasses Slurries on the Performance, Intake and Cost of Growing Cattle Fed Bermudagrass Hay During Winter[a]

	TREATMENT					
Item	CONTROL[b]	MOL[c]	MOL-UREA[d]	MOL-SBM[e]	MOL-BM-FM High[f]	SE[g]
Initial shrunk weight, lb (12-26-91)	501	509	496	508	525	3.5
Daily gain, lb (103 days)	.13[h]	.82[i]	.77[i]	.95[j]	1.05[j]	.04
Height increase, in.	1.7[h]	2.4[i]	2.5[i]	2.8[i]	2.8[i]	.14
Condition score change[l]	-1.0[h]	-.55[i]	-.58[i]	-.52[ij]	-.29[j]	.08
Plasma urea N, mg/dl						
Day 0	11.5[ij]	5.9[h]	10.9[i]	12.4[j]	12.0[ij]	.4
Day 27	21.5	13.8	20.7	16.3	19.8	1.7
Day 55	22.6	13.0	18.0	16.9	17.8	1.8
Day 103	20.2	14.0	18.3	16.2	18.9	1.3
Hay consumed, lb/day						
As fed	11.3[h]	9.8[i]	9.7[i]	9.5[i]	10.3[hi]	.35
Dry matter	9.9[h]	8.6[i]	8.5[i]	8.3[i]	9.1[hi]	.31
Hay loss, % offered[m]	7.0	8.8	10.9	7.4	11.2	1.7
Slurry intake, lb/day						
As fed	-	5.9	5.6	5.8	5.8	.09
Dry matter	-	4.5	4.3	4.5	4.5	.07
Undegraded protein	-	.02	.02	.02	.31	-
Diet TDN:CP ratio	4.4	5.8	4.8	4.6	4.3	-
Total diet cost, $/day[n]	.361[h]	.70[i]	.70[i]	.74[j]	.80[k]	.01
Slurry cost, $/day[n]	-	.38	.38	.43	.45	.01
Cost of gain, $/lb[n]						
Total	3.62[h]	.86[i]	.91[i]	.78[i]	.76[i]	.56
Added	-	.55	.59	.53	.49	-

[a]Stateler, D.A. 1993. University of Florida.
[b]All treatments fed hay free choice; 11.4% crude protein and 50% TDN as fed.
[c]Fortified molasses (84%) and 16% corn; 8.7% crude protein as fed.
[d]Fortified molasses-urea (84%) and 16% corn; 13.5% crude protein as fed.
[e]Fortified molasses (84%) and 16% soybean meal; 15.1% crude protein as fed.
[f]Fortified molasses-urea (84%), 8% corn, 4% blood meal and 4% feather meal; 19.2% crude protein as fed.
[g]Standard error of mean; n = 3.
[hijk]Means within a row lacking a common superscript letter differ ($P < .05$).
[l]Body condition scored from 1 to 9 (thin to fat), initial body condition averaged 5.3.
[m]Includes unconsumed hay and estimated waste.
[n]Prices (as fed) including handling: SBM $.118/lb, corn meal $.064/lb, blood meal $.240/lb, hydrolyzed feather meal $.141/lb, fortified molasses $.064/lb, fortified molasses-urea $.068/lb and bermudagrass hay $.028/lb.

Table 2. Effect of Protein Level and Source in Molasses Slurries on the Performance, Intake and Cost of Growing Cattle fed Bermudagrass Hay during Winter[a]

	TREATMENT							
Item	CON TROL[b]	MOL[c]	MOL-UREA[d]	MOL-SBM[e]	MOL-BM-FM Low[f]	MOL-BM-FM Medium[g]	MOL-BM-FM High[h]	SE[i]
Initial shrunk weight, lb (12-26-92)	544	548	540	536	539	540	560	5
Daily gain, lb (92 days)	.57[j]	1.60[k]	1.61[k]	1.62[k]	1.64[k]	1.78[kl]	1.89[l]	.06
Height increase, in.	1.3[j]	1.8[k]	2.0[k]	1.8[k]	2.0[k]	1.9[k]	1.7[k]	.13
Condition score change[o]	-.8[j]	-.1[k]	-.1[k]	-.1[k]	-.1[k]	-.1[k]	-.1[k]	.05
Plasma urea N, mg/dl								
Day 0	11.9[j]	10.3[j]	11.4[j]	12.4[jk]	18.1[m]	16.5[lm]	14.6[kl]	.8
Day 28	15.9[k]	7.7[j]	13.5[k]	12.9[k]	12.3[k]	14.3[k]	15.5[k]	1.4
Day 56	16.3	11.5	13.4	15.3	13.4	14.4	15.4	1.2
Day 92	13.4	9.1	14.1	13.1	14.3	14.0	13.9	1.4
Hay consumed, lb/day								
As fed	12.3	12.3	11.6	11.2	11.8	11.7	12.3	.54
Dry matter	10.8	10.8	10.2	9.9	10.4	11.0	10.8	.48
Hay loss, % offered[p]	13.5	10.8	11.0	18.0	12.8	10.5	15.3	2.1
Slurry intake, lb/day								
As fed	-	5.9	5.9	5.9	5.9	5.9	5.9	-
Dry matter	-	4.5	4.5	4.5	4.5	4.5	4.5	-
Undegraded protein	-	.02	.02	.02	.11	.20	.31	-
Diet TDN:CP ration	4.8	5.9	5.4	4.8	5.1	4.9	4.6	-
Total diet cost, \$/day[q]	.43[j]	.80[kl]	.78[k]	.85[lm]	.82[kl]	.86[lm]	.89[n]	.02
Slurry cost, \$/day[q]	-	.39[j]	.40[k]	.44[m]	.42[l]	.44[m]	.46[n]	.001
Cost of gain, \$/lb[q]								
Total	.76[j]	.50[k]	.49[k]	52[k]	.50[k]	.48[k]	.47[k]	.02
Added	-	.38	.38	.42	.39	.36	.35	-

[a]Stateler, D. S. 1993. University of Florida.
[b]All treatments fed hay free choice; 11.3% crude protein and 54% TDN as fed.
[c]Fortified molasses (84%) and 16% corn; 8.7% crude protein as fed.
[d]Fortified molasses-urea (84%) and 16% corn; 13.5% crude protein as fed.
[e]Fortified molasses (84%) and 16% soybean meal; 15.1% crude protein as fed.
[f]Fortified molasses-urea (84%), 13.6% corn, 1.2% blood meal and 1.2% feather meal; 15.2% crude protein as fed.
[g]Fortified molasses-urea (84%), 10.8% corn, 2.6% blood meal and 2.6% feather meal; 17.2% crude protein as fed.
[h]Fortified molasses-urea (84%), 8% corn, 4% blood meal and 4% feather meal; 19.2% crude protein as fed.
[i]Standard error of mean; n = 3.
[jklmn]Means within a row lacking a common superscript letter differ ($P < .05$).
[o]Body condition scored from 1 to 9 (thin to fat), initial body condition averaged 5.3.
[p]Includes unconsumed hay and estimated waste.
[q]Prices (as fed) including handling: SBM \$.118/lb, corn meal \$.064/lb, blood meal \$.240/lb, hydrolyzed feather meal \$.141/lb, fortified molasses \$.064/lb, fortified molasses-urea \$.068/lb and bermudagrass hay \$.028/lb.

Table 3. Effect of Protein Level and Source in Molasses Slurries on the Performance of Growing Cattle Grazing Bahiagrass During Fall[a].

Item	TREATMENT					
	CONTROL[b]	MOL[c]	MOL-UREA[d]	MOL-SBM[e]	MOL-BM-FM High[f]	SE[g]
Initial shrunk weight, lb (10-7-92)	502	508	498	518	504	5
Daily gain, lb (64 days)	.63	.73	.70	.83	.96	.16
Height increase, in.	1.6	1.9	2.1	1.9	2.2	.2
Slurry intake, lb/day						
As fed	-	5.0	4.9	5.0	5.0	.04
Dry matter	-	3.8	3.8	3.9	3.8	.03
Undegraded protein	-	.02	.02	.02	.23	-
Slurry cost, $/day[j]	-	.32[h]	.33[h]	.37[i]	.38[i]	.003
Cost of added gain, $/lb[j]	-	2.91	4.31	1.76	1.15	-

[a]Stateler, D. S. and W. E. Kunkle. 1993. University of Florida.
[b]All treatments grazed bahiagrass pasture.
[c]Fortified molasses (84%) and 16% corn; 8.7% crude protein as fed.
[d]Fortified molasses-urea (84%) and 16% corn; 13.5% crude protein as fed.
[e]Fortified molasses (84%) and 16% soybean meal; 15.1% crude protein as fed.
[f]Fortified molasses-urea (84%), 8% corn, 4% blood meal and 4% feather meal; 19.2% crude protein as fed.
[g]Standard error of mean; n = 3 for CONTROL, MOL and MOL-UREA; n = 2 for MOL-SBM and MOL-BF; highest standard error for each variable is reported.
[hi]Means within a row lacking a common superscript letter differ ($P < .05$).
[j]Prices (as fed) including handling: SBM $.118/lb, corn meal $.064/lb, blood meal $.240/lb, hydrolyzed feather meal $.141/lb, fortified molasses $.064/lb, fortified molasses-urea $.068/lb and bermudagrass hay $.028/lb.

Table 4. Effect of Protein Supplement and Aeschynomene on the Performance of Growing Cattle Grazing Limpograss Pasture during the Summer[a].

Item	Treatment				
	Protein Supplement[b]			Limpograss Aeschy-nomene	SE
	None	.2 lb day	.7 lb day		
Daily gain, lb					
1987	.79	1.17	1.41	1.32	.17
1988	.51	1.17	1.19	.97	.17
Blood urea nitrogen,[c] mg/100 ml					
1987	6.2	6.8	11.9	10.4	1.08
1988	5.8	9.6	10.9	12.0	1.08
Total gain, lb/acre					
1987	176	254	284	191	29.2
1988	123	262	232	111	29.2
Forage digestibility, %[d]					
1987	60	60	60	65	6.1
1988	57	57	57	64	6.1
Forage crude protein, %					
1987	5.8	5.8	5.8	7.8	.54
1988	8.0	8.0	8.0	12.0	.54
Forage TDN:CP ratio					
1987	10.3	10.8	10.8	8.5	.31
1988	7.1	7.1	7.1	5.3	.31

[a]Holderbaum et al., 1991. J. Prod. Agric. 3:437-441.
[b]Protein provided by urea fed in a corn based supplement.
[c]Concentrations below 8 mg/100 ml indicate protein may be limiting gain.
[d]Invitro organic matter digestibility.

Table 5. Effects of Nitrogen Fertilizer and Protein Supplements on the Performance of Heifers Grazing Limpograss Pasture during the Summer[a].

Item	Nitrogen lb/acre	Protein Supplement		
		None	Urea[b]	Bypass[c]
Daily gain, lb	44	.14	.90	1.23
(July to October)	132	.78	.87	1.04
Blood urea nitrogen,[d]	44	5.3	15.6	17.5
(mg/100 ml)	132	9.3	17.5	17.6
Carrying capacity	44	258	249	254
(head days/acre)	132	271	262	291
Total gain, lb/acre	44	33	223	300
(July to October)	132	210	223	300
Forage crude protein, %[e]	44	5.4	5.8	5.4
	132	6.7	6.9	7.6
Forage TDN:CP ratio[e]	44	10.4	9.2	10.1
	132	8.1	8.0	7.5

[a]Lima et al., 1993, Agronomy Abstracts, pp 167 and personal communication. Average of 2 years data (1992 and 1993) except as noted.

[b]Supplement contained 84.9% corn, 12.5% urea, 2.2% Dynamate and .4% limestone was fed at 1.7 lb/day which provided .6 lb/day of rumen degraded crude protein and .1 lb/day of undegraded protein (calculated values).

[c]Supplement contained 42.9% corn, 9.2% urea, 35.5% corn gluten meal, 9.5% blood meal, 2.3% Dynamate and .6% limestone was fed at 1.7 lb/day and provided .6 lb/day of rumen degraded protein and .3 lb/day of undegraded protein (calculated values).

[d]Concentrations below 8 mg/100 ml indicate protein may be limiting gain.

[e]Data for 1 year.

Table 6. Effects of Protein and Molasses Supplements on the Performance of Growing Steers fed Ammoniated Stargrass Hay.[a]

Item	Control	Molasses	Cottonseed Meal	Molasses-Cottonseed Meal
Daily gain, lb (102 days)	.51[c]	.79[d]	.99[d]	1.70[e]
Feed intake, lb DM/day				
Ammoniated hay	12.2	8.5	11.4	10.4
Molasses	-	4.5	-	5.0
Cottonseed meal	-	-	1.0	1.0
Undegraded protein	-	-	.19	.19
Total	12.2[c]	13.0[c]	12.4[c]	16.4[d]
Gain/feed	.042	.061	.080	.103
Diet TDN:CP ratio	5.0	5.6	4.2	4.6

[a]Brown, W. F., 1993.
[b]All treatments fed ammoniated (4% ammonia) stargrass hay free choice (10.8% crude protein in dry matter, 49% IVOMD). Trial started December 14, 1989 and steers weighed 510 lb.
[cde]Means within a row lacking a common superscript letter differ ($P < .05$).

Table 7. Effect of Protein Level and Source in Molasses Slurries on the Gain and Intake of Growing Steers fed Ammoniated Stargrass Hay[a]

	TREATMENT						
Item	Control[b]	Cottonseed Meal .15lb CP	Cottonseed Meal .30lb CP	Cottonseed Meal .45lb CP	Feather Meal .15lb CP	Feather Meal .30lb CP	Feather Meal .45lb CP
Daily gain, lb (145 days)	.46	.85	.99	1.08	.69	.95	1.13
Feed consumed, lb DM/day							
Hay	13.4	12.4	10.9	11.1	12.0	12.5	11.7
Molasses	3.3	3.0	2.7	2.3	3.2	3.0	2.9
Cottonseed Meal	-	.34	.69	1.03	-	-	-
Feather Meal	-	-	-	-	.17	.34	.51
Urea	-	-	-	-	.14	.14	.14
Total	16.7	15.7	14.3	14.4	15.5	16.0	15.3
Undegraded protein	0	.06	.13	.19	.10	.20	.30
Gain/feed	.028	.054	.069	.075	.044	.059	.074
Diet TDN:CP ratio	3.9	3.8	3.7	3.5	3.3	3.2	3.0

[a]Brown, W. F. 1993. University of Florida. Personal communication.
[b]All treatments fed ammoniated (4% ammonia) stargrass hay free choice (17% crude protein in dry matter, 54% IVOMD). Trial started November 3, 1991 with 3 pens of 7 steers each per treatment.

Table 8. Effects of Protein Source in Molasses Supplements on the Performance of Steers fed Stargrass Hay.[a]

Item	MOL-UREA[b]	MOL-FM-UREA[c]	MOL-FM-RBM[d]	MOL-FM-HBM[e]
Initial shrunk weight, lb	496	472	474	468
Daily gain, lb	.12[f]	.49[g]	.50[g]	.48[g]
Feed, lb/day as fed				
Hay offered	5.6	6.0	6.0	6.2
Supplement consumed	4.9	4.8	4.8	4.6
Undegraded protein	0	.34	.37	.34
Diet TDN:CP ratio	3.4	3.7	4.2	4.2

[a]W.F. Brown and F.M. Pate. 1993. Ona Research and Education Center, Univ. of Florida. Personal communication. All treatments fed stargrass hay (9% crude protein and 40% TDN, as fed).
[b]Standard molasses (95%) and 5% urea.
[c]Standard molasses (85.5%), 13% feather meal and 1.5% urea.
[d]Standard molasses (87%), 11% feather meal and 2% ring dried poultry blood.
[e]Standard molasses (87%), 11% feather meal and 2% poultry blood hydrolyzed with feathers.
[fg]Means within a row lacking a common superscript letter differ ($P < .05$).

Table 9. Effects of Protein Source and Fish Oil in Molasses Supplements on the Feed Intake, Gain and Pregnancy Rates of Heifers fed Stargrass Hay.[a]

Item	MOL-UREA[b]	MOL-FM-UREA[c]	MOL-FM-CM-UREA[d]	MOL-FM-UREA FISH OIL[e]
Initial full weight, lb	580	572	576	572
Daily gain, lb	-.13[f]	.12[g]	.16[g]	.25[g]
Feed, lb/day as fed				
Hay offered	6.4	5.6	7.0	5.6
Supplement consumed	3.8	4.8	4.8	4.8
Undegraded protein	0	.34	.31	.34
Diet TDN:CP ratio	3.6	3.7	4.3	4.0
Pregnancy rate, %				
Brangus	16[fg]	42[gh]	66[hi]	83[ij]
Braford	0	11	0	0

[a]Pate, F.M. and W.F. Brown. 1993. Ona Research and Education Center, Univ. of Florida. Personal communication. All treatments fed stargrass hay (9% crude protein and 40% TDN as fed).
[b]Standard molasses (95%) and 5% urea.
[c]Standard molasses (85.5%), 13% feather meal and 1.5% urea.
[d]Standard molasses (85.5%), 11% feather meal, 2% catfish meal and 1.5% urea.
[e]Standard molasses (81.5%), 13% feather meal, 1.5% urea and 5% catfish oil.
[fghij]Means within a row lacking a common superscript letter differ ($P < .05$).

Table 10. Effects of Protein Source in Molasses Supplements on the Supplement Consumption, Gain and Pregnancy Rate of Crossbred Beef Heifers.[a]

Item	MOL[b]	MOL-UREA[c]	MOL-CSM-UREA[d]	MOL-FM-UREA[e]	SE
Full weight, lb					
Day 0	569	573	586	560	11
Day 133	606	586	670	626	22
Day 259	734[fg]	699[f]	783[g]	741[fg]	18
Daily gain, lb (0-133 days)	.29	.09	.60	.49	.13
Feed intake, lb DM/day					
Supplement	5.1	2.0	4.6	4.6	.22
Undegraded protein	0	0	.15	.24	-
Pregnancy rate, %	44.4	7.4	48.2	48.2	-
Blood urea nitrogen, mg/dl					
Day 78	6.4[f]	19.3[h]	16.8[gh]	14.9[g]	.9
Day 138	7.9[f]	20.4[g]	20.7[g]	19.3[g]	.7
Day 198	17.9[fg]	19.3[gh]	19.8[h]	16.7[f]	.5
Blood glucose, mg/dl					
Day 78	79.3	77.3	74.5	72.6	3.6
Day 138	76.5[f]	80.6[f]	89.9[g]	76.5[f]	2.3
Day 198	78.5	79.2	80.2	69.6	3.6

[a]Rutter, L.M. and F.M. Pate. 1991. Ona Research and Education Center, Univ. of Florida. Personal communication. Stargrass hay (10.9% crude protein, 50.6% TDN) offered from day 68 to day 198 of the trial.

[b]Standard molasses (100%).

[c]Standard molasses (91%), 4.5% urea and 4.5% water.

[d]Standard molasses (77.6%), 18% cottonseed meal, 2.2% urea and 2.2% water.

[e]Standard molasses (87%), 9% feather meal, 2% urea and 2% water.

[fgh]Means within a row lacking a common superscript letter differ ($P < .05$).

Table 11. Effects of Protein Source in Molasses Supplements and Hay Ammoniation on the Gain, Feed Intake and Pregnancy Rate of Crossbred Beef Heifers.[a]

	Untreated stargrass hay		Ammoniated stargrass hay			
Item	MOL-UREA[b]	MOL-CSM-UREA[c]	MOL[d]	MOL-CSM-UREA[c]	MOL-CSM-UREA[e]	SE
Initial weight, lb (October)	526	523	523	526	527	6.6
Daily gain, lb (140 or 126 days)	.68[fg]	.77[g]	.60[f]	.95[h]	.95[h]	.04
Plasma urea N, mg/dl						
Day 0	13.8	14.0	13.6	14.1	13.5	.5
Day 56	21.2[h]	16.9[g]	7.6[f]	19.5[gh]	19.9[h]	.9
Day 112	18.7[g]	14.6[f]	13.9[f]	21.7[h]	21.6[h]	.7
Start breeding	20.9[h]	18.9[g]	14.0[f]	20.9[h]	19.6[gh]	.6
End breeding	21.3[g]	23.3[h]	18.1[f]	24.3[h]	23.6[h]	-
Breeding weight, lb	615[f]	626[fg]	604[f]	653[g]	655[g]	8.8
Target weight, % heifers	21.4	19.1	16.7	35.7	50.0	-
Heifers cycling, %	38.1	33.3	42.9	28.6	33.3	-
Pregnancy rate, %						
All heifers	26.2	42.9	38.1	47.6	47.6	-
Cycling heifers	31.3	57.1	61.1	75.0	42.9	-

[a]Rutter, L.M., W.F. Brown and F.M. Pate. 1993. Ona Research and Education Center, Univ. of Florida. Personal communication.
[b]Standard molasses (91%), 4.5% urea and 4.5% water.
[c]Standard molasses (77.6%), 18% cottonseed meal, 2.2% urea and 2.2% water.
[d]Standard molasses (100%).
[e]Stargrass hay fed from beginning of trial in this treatment and approximately 60 days after trial started for other treatments.
[fgh]Means within a row lacking a common superscript letter differ ($P < .05$).