Agricultural Experiment Station U.S. Department of Agriculture

Clayton Livestock Research Center

PROGRESS REPORT

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ENERGY VALUE OF GROUND COTTON BURRS AND COTTONSEED HULLS BY TOTAL DIET AND CORN REPLACEMENT METHODS

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Progress Report No. 19 (October, 1980) presented the results of a study of the energy value of ground cotton burrs in a finishing ration for heifers. A "corn replacement" technique was used in which ground cotton burrs replaced an equal amount of steam flaked corn on an "as fed" basis. In such a technique the net energy for gain (NEg) of the cotton burrs is equal to the NEg of the corn it replaced plus the change in energy deposition caused by the replacement. One of the advantages of this method is that the energy value is related to a standard feed and thus makes it possible to compare values for feed energy determined in different experiments. The standard feed (corn in this case) must be one for which a reliable value for NEg is available and comparable samples are used in the different trials.

In a recent study from California net energy values of uncleaned and cleaned cotton gin trash have been determined. Because of the importance of these cotton by-products in certain cattle feeding areas this Progress Report will relate the net energy value of ground cotton burrs used in the New Mexico trials to those reported for cleaned and un-

Table 1. Composition, Dry Matter Basis

Item	Ash	Crude protein	Calcium	Phosphorus	NEm	NEg
	%	%	%	%	Mcal/100 lb.	
Gin trash, mean anal.[a]	8.5	7.9	.33	.16	45	6
Uncleaned gin trash (Calif.)[b]	26.3	11.6	2.67	.32	27	-9
Cleaned gin trash (Calif.)[b]	19.5	10.9	2.42	.32	38	15
Ground burrs (New Mexico)[c]	16.8	9.3	.17	.13	46	17

[a]Ensminger, M. E. and C. G. Olentine. 1978. Feeds and Nutrition. Ensminger Publishing Co., Clovis, CA.

[b]Axe, D., D. Addis, J. Clark, J. Dunbar, W. Garrett, N. Hinman and R. Zinn. 1982. Feeding value of cleaned and uncleaned cotton gin trash. Proc. West. Sec. Amer. Soc. An. Sci. 33:57.

[c]Analysis of ground cotton burr sample used in the trials reported in Progress Report No. 19, (October 1980) Clayton Livestock Research Center. The NE values were recalculated and expressed on a dry matter basis.

cleaned cotton gin trash used in the California studies. Additionally the net energy values of cottonseed hulls determined by "total diet replacement" and "corn replacement" are reported.

The International Feed Nomenclature system does not recognize cotton burrs as an identifiable feed but includes the cotton burr in the term cotton gin by-product (cotton gin trash). Cottonseed hulls are considered an identifiable feed item in the International Feed Nomenclature. Even though cotton gin trash is an identifiable feed item it is highly variable since it is composed mostly of fragments of burrs and stems, with small amounts of immature cottonseed, lint and leaf fragments and varying amounts of dirt. Because of the variable composition the energy values determined at this Center and those determined in California must be related to the composition of the products tested.

Table 1 shows the comparative analysis of the gin trash used in the California studies, the ground burrs used in the New Mexico trials and an average analysis taken from a table of feed composition. In many feeding areas the terms "ground cotton burrs" and "cotton gin trash" are sometimes used interchangeably. From a comparison of the ash, protein and net energy values the ground burrs used in the New Mexico trials appear to be comparable to the cleaned gin trash used in the California Trials. The large difference in the calcium content cannot be explained from the information at hand. The NEm value listed for the ground burrs used in New Mexico was calculated from equation (2) which describes the relationship between NEm concentration and NEg concentration in the data of Lofgreen and Garrett, Jour. An. Sci. 27:793 (1968). It is obvious from the data shown in table 1 one must use care in applying energy values to different lots of gin trash without some knowledge of its composition, especially the dirt content which would be reflected in the ash level.

Since the net energy value found for ground cotton burrs was somewhat higher than the average book value for gin trash and considerably higher than uncleaned gin trash used in a California trial a study was undertaken to reinvestigate the net energy of cottonseed hulls by replacement procedures similar to that used with the cotton burrs.

Experiment 1. Twenty-four long yearling steers weighing slightly over 800 pounds were removed from a fescue pasture and divided into two pens. One pen was fed the ration shown in table 2 and the second pen was fed a ration consisting of 80% of the basal ration shown in table 2 plus 20% cottonseed hulls. Cattle were provided free choice access to their respective rations for 99 days prior to slaughter. Results of

Table 2. Composition of Basal Ration

Ingredient	Amount
	%
Steam flaked corn	66.1
Ground alfalfa hay	15.0
Hominy feed	5.0
Fat	3.0
Molasses	7.0
Urea	.85
Limestone	.6
Dicalcium phosphate	.65
TM salt	.5
Ammonium chloride	.3
Premix[a]	1.0
Total	100.0

[a] Supplied 2,000,000 IU of vitamin A, 30g rumensin and 10g tylosin per ton of finished feed

Table 3. Energy Value of Hulls By a Total Diet Replacement Method

Item	Level of hulls 0	20
Number of steers	12	12
Initial weight, lb.	810	813
Days fed	99	99
Daily feed intake, lb.	23.28[a]	30.01[b]
Daily weight gain, lb.	3.31[a]	3.83[b]
Feed per pound gain, lb.	7.03[a]	7.84[b]
Dressing percent	62.63	63.31
Quality grade[c]	11.5	12.0
NE of complete ration, Mcal/100 lb.		
NEm	83.1	74.4
NEg	55.8	49.6
NE of hulls, Mcal/100 lb.		
NEm	-	49.5
NEg	-	24.8

a, b $P < .01$

c Choice = 13, low choice = 12, high good = 11, good = 10.

experiment 1 are summarized in table 3. Dilution of the basal ration by the addition of 20% hulls caused a 29% increase in total feed consumption. It is normally observed that when a high energy dense diet is diluted with a bulky, low energy dense material feed consumption will increase. If the dilution is not too great the increase will be sufficient to offset the dilution and rate of gain will be maintained. In this case the cattle overcompensated for the dilution and consumed more net energy than those fed the basal ration. Consequently the rate of gain was significantly increased over those receiving the basal ration. Of course the feed required to produce a pound of gain was increased because of the energy dilution.

From published equations it is possible to calculate energy deposition from weight gain and body weight (equation 1). Knowing body weight, feed intake, energy deposited in weight gain and the relationship of NEm to NEg concentration in diets of varying energy level it is possible to estimate that combination of NEm and NEg concentrations which will supply the net energy required for maintenance and for gain to exactly equal the observed feed intake and maintain the proper relation between NEm and NEg (equation 2). Thus, the basal ration containing no hulls had to have 83.1 Mcal NEm and 55.8 Mcal NEg per 100 lb of feed to achieve 3.31 lb of gain at a feed intake of 23.28 lb and maintain the ratio between NEm and NEg for that type of ration. The ration diluted with 20% hulls contained 74.4 Mcal NEm and 49.6 Mcal NEg per 100 lb calculated in the same manner. To reduce the concentration of NEg from 55.8 to 49.6 Mcal per 100 lb, cottonseed hulls would have to contain 24.5 Mcal per 100 lb, as fed. The 49.5 Mcal NEm per 100 lb was calculated from the equation describing the relationship of NEm and NEg concentrations over a wide range of energy levels (equation 2).

Experiment 2. One hundred twenty No. 1 Okie and crossbred steers weighing approximately 475 lb were divided at random into six pens of 20 head each. Two pens were fed the basal ration shown in table 2. Two pens were placed on a ration in which 10% of the steam flaked corn was replaced with a like amount of cottonseed hulls and two pens were fed a ration in which 20% corn was replaced with 20% hulls. The duration of the feeding period was 203 days. The results of experiment 2 are shown in table 4. As was observed in experiment 1, dilution of the energy of the

Table 4. Energy Value of Cottonseed Hulls by a Corn Replacement Method

Item	Level of hulls 0	10	20
Number of steers	40	40	40
Initial weight, lb.	477	473	479
Days fed	203	203	203
Daily feed intake, lb.	16.57[a]	17.94[b]	19.86[c]
Daily weight gain, lb.[d]	2.65[a]	2.58[a]	2.80[b]
Feed per pound gain, lb.	6.25[a]	6.95[b]	7.09[b]
Dressing percent	64.51	63.40	63.87
Quality grade[e]	11.8	12.4	10.8
NE of complete ration, Mcal/100 lb.			
NEm	88.6	79.7	78.3
NEg	59.6	53.4	52.4
NE of hulls, Mcal/100 lb.			
NEm		f	49.0
NEg		f	24.0

a, b, c $P < .01$

d Corrected to equal dressing percent

e Choice = 13, low choice = 12, high good = 11, good = 10

f At 10% in the ration hulls had a slightly positive NEm value and slightly negative NEg. Thus, the hulls contributed essentially no energy to the ration.

basal ration by the addition of cottonseed hulls caused a significant increase in feed consumption. Only in the case of the 20% level of hulls, however, was the increased feed intake accompanied by an increase in gain. With 10% hulls in the ration the cattle ate enough more feed to prevent a significant decline in weight gain. As occurred in experiment 1, the addition of 20% hulls caused an over compensation in feed intake resulting in a significant increase in gain. The net energy of the complete feed was calculated as described in experiment 1. To estimate the NEg value of hulls one must relate the energy deposition on the hull-containing rations to that containing no hulls. Since hulls replaced flaked corn in equal amounts the NEg of the hulls is equal to the NEg of the corn it replaced plus any change in NEg concentration caused by the replacement. For example, in the case of the 20% hull ration 20% hulls = 20% corn + (52.4 - 59.6 Mcal), or 100% hulls = 100% corn - 36 Mcal. If corn contains 60 Mcal NEg per 100 lb then hulls at 20% in the ration contains 60 - 36 = 24 Mcal per 100 lb. At a NEg concentration of 24 Mcal per 100 lb the NEm would have to be 49 Mcal per 100 lb. At 10% in the ration hulls apparently had little value. Because all variation in such an experiment is attributed to the hulls the experimental error at low levels of feeding would be high.

In summary, the net energy values of cottonseed hulls in two experiments determined by a whole diet replacement or a corn replacement method were as follows:

	Whole diet replacement	Flaked corn replacement
	Mcal per 100 lb	
NEm	49.5	49.0
NEg	24.8	24.0

The agreement between the two methods is excellent. The levels of net energy for cottonseed hulls observed in these two studies are considerably higher than the few literature values available. The NEg value of 24 Mcal per 100 lb as fed is approximately three times the NRC value. This was also true of the cotton burr values discussed earlier. These cotton by-products may have higher energy values than previously thought provided the dirt content is not too high.

Equations:

(1) Steer Calves:

$$NEgd = (.05272g + .00684g^2)(W_{kg}^{.75})$$

Yearling Steers:

$$NEgd = (.04871g + .00629g^2)\ (W_{kg}^{.75})$$

(2) $$NEmc = 1.002 + .0702\ NEgc + .5991\ NEgc^2 - .0658\ NEgc^3$$

Where NEgd = Mcal NEg deposited daily.
g = daily weight gain in kg
W = Mean body weight in kg
NEmc = Mcal NEm per kg of feed dry matter
NEgc = Mcal NEg per kg of feed dry matter

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