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FAT QUALITY AND FEEDING VALUE OF FAT FOR FEEDLOT CATTLE

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Introduction

While much attention has been directed at understanding factors influencing the NE value of supplemental fat (Zinn, 1994), alterations in NE do not necessarily form the basis for constraints on supplementation. Indeed, greater concern is often directed at potential detrimental effects of supplemental fat on diet acceptability and feed intake (Brethour et al., 1957; Buchanan-Smith et al., 1974; Cameron and Hogue, 1968; Cuitun et al., 1975: Dinius et al., 1975; Hatch et al., 1972; Johnson and McClure, 1972; Lofgreen, 1965; etc). Although the reasons for the occasional negative impact of supplemental fats on diet acceptability are far from clear, each time the problem arises attention is drawn to the importance of "quality".

Quality Characteristics of Feed Fats

MIU (moisture, impurities, and unsaponifiables). Some condensation moisture is unavoidable with any feed fat. However, the level should be less than 1.5%. Moisture permits the formation of rust and rust will accelerate autocatalytic (non-enzymatic) oxidative rancidity. Moisture in the presence of high levels of free fatty acids and high temperature will also promote autocatalytic hydrolysis of glycerides. The practice of clearing lines with steam may increase the moisture content of fat in bulk tanks and should be avoided.

Impurities refers to filterable materials insoluble in kerosene, such as particles of hair, bone, hide, minerals, metals, etc. Thus, it is not a measure of nor does it in any way represent potentially hazardous contaminants such as pesticide residues. Feed fats should not contain more than 1% impurities. Because impurities tend to settle out, they may accumulate as sludge at the bottom of the bulk tank, ultimately clogging valves, lines, and nozzles. Consequently, tanks should be examined and cleaned on a regular basis.

Unsaponifiables refers to that material which is soluble in petroleum ether but does not react with sodium or potassium hydroxide to form soap. This includes a wide variety of compounds such as sterols, pigments, fat soluble vitamins, fatty alcohols, fatty-fatty esters (condensation products), waxes, mineral oils, pesticides, etc. Unsaponifiables usually represent less than 1% of most feed fats, with the exception of soapstocks or feed fats containing blends of soapstocks, which may contain greater than 4%.

Unsaponifiables apparently contribute very little to the energy value of feed fat. However, aside from that, a high unsaponifiable value is not any more indicative of an animal health safety hazard than is a low value indicative of wholesomeness. The potential for feed fats to become contaminated with pesticides or other toxic chemicals is real. In 1957 large losses were noted in the poultry industry presumably due to presence of dioxin contaminated tallow (Metcalf, 1972). It would be expensive to analyze every shipment of feed fat for pesticide residue. But every shipment should be certified by the supplier to be pesticide free.

<u>TFA (total fatty acids)</u>. Total fatty acids is another measure of the purity of the feed fat source. Triglycerides contain approximately 90% fatty acid and 10% glycerol. Thus, fatty acid levels of less than 90% reflect dilution with other ingredients. Because fatty acids are the primary energy source in feed fats, the value of a feed fat should be discounted based on total fatty acid content (Zinn, 1989a).

<u>FFA (free fatty acids)</u>. Free fatty acids refers to fatty acids not esterified to glycerol. In "whole" fats, the presence of high levels of free fatty acids may be an indication of improper storage and/or handling of the fat. Hydrolysis may occur as either enzymatic lipolysis during storage or prior to rendering, or as autocatalytic hydrolysis. The latter is often associated with oxidative rancidity. Antioxidants should be added to all feed fats to prevent rancidity from occurring, particularly in the presence of high levels of free fatty acids.

There was some early indication that the digestibility of free fatty acids may be lower than that of triglycerides in ruminants. Czerkawski et al (1973) observed a marked difference in digestibility of linseed oil depending on whether it was added to the diet as a triglyceride or as free fatty acids (85 vs 64% digestibility, respectively). In contrast, we have found no effect of free fatty acid content of supplemental fat on small intestinal digestibility of fat (Zinn, 1989b).

A comparison of effects of yellow grease (10% FFA) vs animal-vegetable soapstock blends (50% FFA) on growth-performance of feedlot cattle (Zinn, 1989b) is shown in Tables 1 to 6. Growth-performance and estimated NE values of yellow grease and animal-vegetable soapstock blends were similar and did not appear to be influenced by level of supplementation, averaging 5.78 and 4.61 Mcal/kg for maintenance and gain, respectively. Partially replacing animal-vegetable soapstock blend with lecithin did not influence ($P > .10$) steer performance, carcass merit or estimated NE value of the diet. Thus, it would appear that FFA levels, per se, have little influence of the feeding value of fat for feedlot cattle.

More recently, (Estrada and Zinn, unpublished) the influence of free fatty acid levels in yellow grease on growth-performance of finishing Holstein steers was evaluated (Tables 7 to 10). In contrast with the previous study (Zinn, 1989a), weight gain and DM intake during the initial 56-d period increased ($P < .10$) with increasing FFA content of the supplemental fat. However, overall (144-d) growth-performance response to High FFA yellow grease was not different ($P > .10$) from conventional yellow grease.

<u>IV (iodine value)</u>. Iodine value refers to the grams of iodine taken up by 100 grams of fat. It is a measure of degree of saturation of fatty acids (each double bond will take up two atoms of iodine). Feed fats with high iodine values ($\geq$ 60) typically contain vegetable soapstocks. With the trend away from use of tallow in cooking, the iodine value of yellow grease has increased markedly.

Recent controversy has arisen over the potential influence of unsaturated: saturated fatty acid ratio on the feeding value of supplemental fats. While there is very little empirical data with feedlot cattle, in vitro studies (Henderson, 1973; Maczulak et al., 1981) have demonstrated that the unsaturated fatty acids play a more active role in inhibiting ruminal bacteria, particularly cellulolytics. Of the unsaturated fatty acids tested, oleic (C18:1) was found to be the most inhibitory. Since cellulolytics play a lessor role in the digestive function of feedlot cattle, it has been thought that the effects of ratio of unsaturated fatty acids may be limited under those conditions. However, in a recent series of feeding trials comparing tallow (high degree of saturation) and yellow grease (lower degree of saturation) Brandt (1988) observed similar and positive responses to both fat sources in their first trial, while in the second, performance of steers receiving the yellow grease supplemented diets was markedly below that of tallow, and similar to that of the controls (non-supplemented steers). Soy soapstocks (low degree of saturation) were also compared in that trial and like yellow grease was poorly utilized compared with tallow. The differences between the two trials of Brandt (1988) are puzzling, since diets and sources of fats were similar. Additionally, the level of supplementation was low (3.5%).

As a follow-up to the work of Brandt (1988) we conducted a series of trials (Zinn, unpublished; Tables 11 to 18) to further evaluate the influence of unsaturate:saturate ratio on growth-performance of feedlot steers (these trials essentially compare tallow vs yellow grease). Consistent with Brandt (1988), growth-performance responses and NE estimates in the first trial were poorer for steers receiving the more unsaturated yellow grease. However, the magnitude of the depression in performance with yellow grease was much greater than expected, and inconsistent with our previous experiences evaluating yellow grease (Zinn, 1989a). The estimated NEm and NEg values for tallow, 50:50 blend of tallow and yellow grease, and yellow grease were 5.78, 4.67; 5.98, 4.87 and 3.98, 3.07 Mcal/kg, respectively. Due to the very low estimate for the value of yellow grease a second trial was conducted making a direct comparison of yellow grease and tallow. Feed intake was greater ($P < .05$) for tallow vs yellow grease supplemented diets. Otherwise, feed efficiency and diet NE were not different ($P > .10$) for the two fat sources.

IPV (initial peroxide value). Peroxide value refers to current state of oxidative rancidity. It is measured in milliequivalents/kilogram of fat. A IPV of less than 5 indicates that the sample is not rancid. Properly handled fat should not exceed an IPV of 10. However, the rancidity of fat can change quickly, depending on conditions. Consequently, the best indicator of the rancidity of the fat might be to simply smell the fat.

The presence of trace amounts of copper in complete mixed diets can greatly accelerate rancidity, particularly if the fat source has a high iodine value. Oxidation or rancidity, does not appear to have a detrimental effect on the palatability of the fat or on the utilization of the fat, per se, in swine and poultry (Halloran, 1986). However, the presence of oxidized fat may lead to loss of fat soluble vitamins in the diet.

Generalizations About Feed Fat Type

Growing-finishing trials with feedlot cattle have not revealed consistent differences between tallow, yellow grease, blended animal-vegetable soapstock, cottonseed soapstock or soybean soapstock (Lofgreen, 1965; Brandt, 1988; Zinn, 1989a, Tables 1 to 18). However, a problem with comparing fat sources on the basis of animal performance is that supplemental fats usually comprise less than 8% of diet dry matter. The precision obtainable in such studies does not usually permit detection of subtle (less than 10%) differences in the feeding value of fat sources.

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Table 1. COMPOSITION OF EXPERIMENTAL DIETS FED TO STEERS

Item	Treatment 1	2	3	4	5	6
Ingredient composition, % of total, DM basis						
Alfalfa hay	8.00	8.00	8.00	8.00	8.00	8.00
Sudangrass hay	4.00	4.00	4.00	4.00	4.00	4.00
Steam rolled barley	58.90	58.90	58.90	58.90	58.90	58.90
Steam flaked corn	18.00	11.45	11.45	4.90	4.90	4.90
Cottonseed meal	.90	3.45	3.45	6.00	6.00	6.00
Yellow grease		4.00		8.00		
Blended fat[a]			4.00		8.00	6.00
Crude lecithin						2.00
Cane molasses	8.00	8.00	8.00	8.00	8.00	8.00
Urea	.30	.30	.30	.30	.30	.30
Trace mineral salt[b]	.50	.50	.50	.50	.50	.50
Dicalcium phosphate	.10	.10	.10	.10	.10	.10
Limestone	1.30	1.30	1.30	1.30	1.30	1.30
Vitamin A[c]	+	+	+	+	+	+

[a]Blended animal-vegetable fat.

[b]Trace mineral salt contained: $CoSO_4$, .068%; $CuSO_4$, 1.04%; $FeSO_4$, 3.57%; ZnO, .75%; $MnSO_4$, 1.07%; KI, .052%; and NaCl, 93.4%.

[c]2,200 IU/kg diet.

Table 2. CHEMICAL ANALYSES OF SUPPLEMENTAL FAT BLENDS[a]

Item	Supplemental fat source YG[b]	BVF[c]	BVFL[d]
Moisture, %	.12	.86	.90
Impurities, %	.10	.59	.53
Unsaponifiables, %	.52	4.16	3.63
Iodine value	71.02	62.45	69.40
Free fatty acids, %	9.7	52.8	49.2
Total fatty acids, %	90.7	93.7	92.1
Fatty acid profile, % total			
C12:0	.7	6.3	5.7
C14:0	1.4	3.2	3.0
C16:0	20.0	27.1	26.3
C16:1	2.2	1.0	.4
C18:0	12.1	10.2	9.7
C18:1	46.8	30.9	30.7
C18:2	16.3	20.4	23.2
C18:3	.4	.8	.9

[a]Yellow grease.

[b]Blended animal-vegetable fat.

[c]Blended animal-vegetable fat (75%) plus crude corn-soy lecithin (25%).

Table 3. INFLUENCE OF SOURCE OF FAT SUPPLEMENTATION ON GROWTH PERFORMANCE OF FEEDLOT STEERS AND NET ENERGY VALUE OF THE DIET

	Source of Fat Supplementation		
Item	Yellow grease	Blended fat[a]	SD
Empty body weight, kg			
Initial	305	304	6
Final	422	416	11
Empty body gain			
Weight, kg/d	.996	.944	.096
Energy, Mcal/d	4.05	3.71	.61
Fat, kg/d	.373	.339	.070
Protein, kg/d	.140	.136	.017
Dry matter intake, kg/d	6.41	6.19	.42
Dry matter conversion	6.50	6.60	.34
Diet net energy, Mcal/kg			
Maintenance	1.96	1.94	.06
Gain	1.31	1.29	.05

[a]Blended animal-vegetable fat.

Table 4. INFLUENCE OF FAT SOURCE ON CARCASS MERIT AND COMPOSITION OF GAIN OF FEEDLOT STEERS

	Source of Fat Supplementation		
Item	Yellow grease	Blended fat[a]	SD
Carcass weight, kg	288	283	8
Rib eye area, cm^2	78.0	79.9	2.8
Fat thickness, cm	1.31	1.25	.23
KPH, %[b]	3.17	3.25	.26
Marbling score, degrees[c]	4.19	4.37	.30
Retail yield, %	50.0	50.4	.7
Empty body composition, %			
Water	53.6	54.1	1.3
Protein	16.2	16.3	.3
Fat	26.5	25.9	1.7

[a]Blended animal-vegetable fat.
[b]Kidney, pelvic and heart fat as a percentage of carcass weight.
[c]Coded: Minimum slight = 4, minimum small = 5, etc.

Table 5. INFLUENCE OF LECITHIN ON UTILIZATION OF A SUPPLEMENTAL VEGETABLE FAT BLEND BY STEERS: FEEDLOT CATTLE GROWTH PERFORMANCE AND NET ENERGY VALUE OF THE DIET

Item	8% Blended fat[a]: 0% Lecithin	6% Blended fat: 2% Lecithin	SD
Empty body weight, kg			
Initial	304	302	6
Final	424	420	11
Empty body gain			
Weight, kg/d	1.008	.993	.096
Energy, Mcal/d	4.22	3.85	.61
Fat, kg/d	.390	.347	.070
Protein, kg/d	.139	.145	.017
Dry matter intake, kg/d	6.33	6.22	.42
Dry matter conversion	6.31	6.29	.34
Diet net energy, Mcal/kg			
Maintenance	2.01	1.97	.06
Gain	1.36	1.32	.05

[a]Blended animal-vegetable fat.

Table 6. INFLUENCE OF LECITHIN ON UTILIZATION OF SUPPLEMENTAL VEGETABLE FAT BY STEERS: CARCASS MERIT AND COMPOSITION OF GAIN

Item	8% Blended fat[a]: 0% Lecithin	6% Blended fat: 2% Lecithin	SD
Carcass weight, kg	289	286	8
Rib eye area, cm^2	78.5	79.8	2.8
Fat thickness, cm	1.37	1.23	.23
KPH, %[b]	3.51	3.39	.26
Marbling score, degrees[c]	4.51	4.49	.30
Retail yield, %	49.7	50.3	.7
Empty body composition, %			
Water	53.3	54.1	1.3
Protein	16.1	16.3	.3
Fat	26.9	25.8	1.7

[a]Blended animal-vegetable fat.
[b]Kidney, pelvic and heart fat as a percentage of carcass weight.
[c]Coded: Minimum slight = 4, minimum small = 5, etc.

Table 7. COMPOSITION OF DIETS FED TO STEERS

Item	Treatments 1	2	3	4
Ingredient composition, % (DM basis)				
Alfalfa hay	6.00	6.00	6.00	6.00
Sudangrass hay	6.00	6.00	6.00	6.00
Steam-flaked barley	39.80	39.80	39.80	39.80
Steam-flaked corn	39.80	34.80	34.80	34.80
High FFA yellow grease		5.00	2.50	
Conventional yellow grease			2.50	5.00
Cane molasses	5.00	5.00	5.00	5.00
Urea	1.00	1.00	1.00	1.00
Limestone	1.70	1.70	1.70	1.70
Trace mineral salt[a]	.50	.50	.50	.50
Magnesium oxide	.20	.20	.20	.20
Monensin[b]	+	+	+	+
Nutrient composition (DM basis)[c]				
NE, Mcal/kg				
Maintenance	2.01	2.19	2.19	2.19
Gain	1.36	1.52	1.52	1.52
Crude protein, %	13.9	13.4	13.4	13.4
ADF, %	8.4	8.4	8.4	8.4
Lipid, %	2.8	7.5	7.5	7.5
Calcium, %	.85	.85	.85	.85
Phosphorus, %	.33	.33	.33	.33
Magnesium, %	.28	.28	.28	.28

[a]Trace mineral salt contained: $CoSO_4$, .068%; $CuSO_4$, 1.04%; $FeSO_4$, 3.57%; ZnO, 1.24%; $MnSO_4$, 1.07%; KI, .052%; and NaCl, 92.96%.

[b]28 mg/kg, DM basis.

[c]Based on tabular values for individual feed ingredients (NRC, 1984) with exception of supplemental fat which was assigned NE_m and NE_g values of 6.03 and 4.79, respectively.

Table 8. COMPOSITION OF SUPPLEMENTAL FATS

Item	Supplemental fat: Conventional Yellow grease	High FFA Yellow grease
Moisture	.12	.63
Insoluble impurities	.10	3.00
Unsaponifiable matter	.37	.59
Iodine value	87.2	75.2
Total fatty acids	90.50	83.94
Free fatty acids	14.80	42.30
Fatty acid profile, %		
C12:0	.17	2.41
C14:0	.84	1.98
C14:1	.16	.21
C15:0		.12
C16:0	15.88	16.56
C16:1	2.18	2.03
C17:0		.36
C18:0	8.43	9.61
C18:1	48.43	49.33
C18:2	20.11	14.28
C18:3	1.89	1.06
C20:0	.38	.29
C20:1	.79	.73

Table 9. INFLUENCE OF FREE FATTY ACID CONTENT OF SUPPLEMENTAL YELLOW GREASE ON GROWTH-PERFORMANCE OF FINISHING HOLSTEIN STEERS

Item	0% Fat	Yellow grease FFA, %[a]			SD
		42.0	28.5	15.0	
Weight, kg/d					
initial	372.8	374.5	378.3	372.7	12.3
56-d[b]	421.1	439.5	441.4	428.8	14.2
144-d[b]	527.5	555.5	551.1	538.7	18.5
Weight gain, kg/d					
1-56 d[cd]	.86	1.16	1.13	1.00	.11
56-144 d	1.22	1.33	1.25	1.25	.10
1-144 d[de]	1.08	1.26	1.20	1.15	.08
DM Intake,kg/d					
1-56 d[de]	6.37	7.20	7.03	6.60	.41
56-144 d	8.40	8.36	8.14	8.26	.35
1-144 d	7.61	7.90	7.71	7.61	.32
DM intake/gain					
1-56 d[e]	7.38	6.22	6.37	6.61	.67
56-144 d	6.94	6.35	6.54	6.62	.43
1-144 d[c]	7.07	6.30	6.44	6.61	.32
Diet NE,Mcal/d					
Maintenance[e]	2.13	2.29	2.27	2.22	.07
Gain[e]	1.46	1.54	1.58	1.54	.06
Observed/expected NE					
Maintenance	1.06	1.04	1.03	1.01	.03
Gain	1.08	1.05	1.05	1.02	.04

[a]42% FFA = 100% high FFA yellow grease, 28.5% FFA = 50% high FFA yellow grease and 50% conventional yellow grease, 15.0% FFA = 100% conventional yellow grease.

[b]Supplemental fat main effect, $P < .10$.

[c]Supplemental fat main effect, $P < .01$.

[d]Linear effect of FFA level in yellow grease, $P < .10$.

[e]Supplemental fat main effect, $P < .05$.

Table 10. INFLUENCE OF FREE FATTY ACID CONTENT OF SUPPLEMENTAL YELLOW GREASE ON CARCASS CHARACTERISTICS OF FINISHING HOLSTEIN STEERS

		Yellow grease FFA, %[a]			
Item	0% Fat	42.0	28.5	15.0	SD
Carcass wt, kg[b]	319.2	336.1	333.4	325.9	11.2
Dressing %[b]	60.0	60.7	60.0	60.4	.1
Rib area, cm^2	77.0	76.5	75.5	78.3	3.1
Fat thickness, cm	.81	.86	.70	.70	.24
KPH, %[c]	1.75	2.26	2.04	2.02	.20
Yield grade	2.2	2.6	2.4	2.3	.3
Retain yield, %[d]	51.0	50.2	50.6	51.1	.6

[a]42% FFA = 100% high FFA yellow grease, 28.5% FFA = 50% high FFA yellow grease and 50% conventional yellow grease, 15.0% FFA = 100% conventional yellow grease.

[b]Supplemental fat main effect, $P < .10$.

[c]Supplemental fat main effect, $P < .05$.

[d]Linear effect of % FFA in yellow grease, $P < .10$.

Table 11. COMPOSITION OF EXPERIMENTAL DIETS FED TO STEERS[a]

Item	0% fat	Iodine value 47.0	Iodine value 59.5	Iodine value 72.0
		%		
Alfalfa hay	6.32	6.00	6.00	6.00
Sudangrass hay	6.32	6.00	6.00	6.00
Steam flaked corn	76.65	72.82	72.82	72.82
Yellow grease			2.50	5.00
Tallow		5.00	2.50	
Cane molasses	7.47	7.10	7.10	7.10
Limestone	1.64	1.56	1.56	1.56
Urea	1.07	1.02	1.02	1.02
Trace mineral salt[b]	.53	.50	.50	.50
Vitamin A[c]	+	+	+	+
Lasalocid[d]	+	+	+	+
Nutrient composition[e]				
Net energy, Mcal/kg				
Maintenance	2.10	2.34	2.33	2.33
Gain	1.44	1.64	1.64	1.63
Crude protein, %				
Total	13.7	13.0	13.0	13.0
Rumen degradable[f]	8.5	8.0	8.0	8.0
Ether extract, %	3.5	8.3	8.3	8.3
Calcium, %	.80	.75	.75	.75
Phosphorus, %	.30	.27	.27	.27

[a]Dry matter basis.

[b]Trace mineral salt contained: $CoSO_4$, .068%; $CuSO_4$, 1.04%; $FeSO_4$, 3.57%; ZnO, .75%; $MnSO_4$, 1.07%; KI, .052%; and NaCl, 93.4%.

[c]2200 IU/kg.

[d]32 mg/kg.

[e]Based on tabular values for individual feed ingredients (NRC, 1984) with exception of supplemental fat which was assigned NE_m and NE_g values of 6.03 and 4.79, respectively (Zinn, 1988).

[f]Based on the following estimates for ruminal degradability of dietary crude protein: alfalfa hay, 70%; sudangrass hay, 65%; steam flaked corn, 50%; soybean meal, 60%; cane molasses, 100% and urea, 100%.

Table 12. COMPOSITION OF YELLOW GREASE AND TALLOW[a]

	Yellow grease	Tallow
Moisture, %	.56	.16
Impurities, %	.50	.08
Unsaponifiables, %	.24	.29
Iodine value	72.0	46.8
Free fatty acids, %	8.0	10.0
Fatty acid profile, %		
C14:0	1.1	2.7
C16:0	17.8	24.6
C16:1	2.5	3.4
C18:0		18.7
C18:1	58.2	46.1
C18:2	19.5	4.2
C18:3	.9	.3

[a]Analysis provided by Baker Commodities Inc., Los Angeles, CA.

Table 13. INFLUENCE OF SATURATION ON THE COMPARATIVE FEEDING VALUE OF SUPPLEMENTAL FAT IN A GROWING-FINISHING DIET FOR FEEDLOT CATTLE

		Iodine value			
Item	0% fat	47.0	59.5	72.0	SD
Pen replicates	4	4	4	4	
Weight, kg					
Initial[b]	301	306	304	304	13
Final[c]	456	469	463	453	23
Weight gain, kg/d					
1-56 d[b]	.97	1.15	1.11	1.04	.12
1-150 d	1.04	1.09	1.07	1.00	.11
DM intake, kg/d					
1-56 d	6.0	6.0	5.7	5.6	.38
1-150 d	6.4	6.1	6.0	6.0	.39
DM intake/gain					
1-56 d[c]	6.34	5.25	5.16	5.44	.77
1-150 d	6.18	5.66	5.64	6.03	.38
Diet NE, Mcal/kg					
Maintenance[c]	2.17	2.34	2.35	2.25	.09
Gain[c]	1.49	1.64	1.65	1.56	.08

[a]Initial and final weights reduced 4% to adjust for digestive tract fill.
[b]Treatment 1 versus treatments 2, 3 and 4, $P<.10$.
[c]Treatment 1 versus treatments 2, 3 and 4, $P<.05$.

Table 14. TREATMENT EFFECTS ON CARCASS MEASUREMENTS

Item	0% fat	Iodine value 47.0	Iodine value 59.5	Iodine value 72.0	SD
Carcass weight, kg	295	303	304	289	16
Carcass composition, %					
Water	50.8	50.8	51.0	50.8	.9
Fat	29.9	30.0	29.6	30.0	1.2
Protein	15.1	15.1	15.2	15.1	.3
Dressing percentage[a]	64.7	64.7	65.6	63.8	.9
Rib eye area, cm^2	80.1	77.9	80.9	76.8	4.9
Fat thickness, cm	1.03	1.23	1.14	1.18	.17
KPH, %[b]	2.47	2.72	2.88	2.42	.32
Marbling score, degrees[c]	4.23	4.11	4.07	4.18	.37
Retail yield, %	51.0	50.0	50.5	50.4	.8
Liver Abscess, %	0	0	0	0	0

[a]Quadratic effect with saturation (treatments 2, 3 and 4), $P<.05$.
[b]Kidney, pelvic and heart fat as a percentage of carcass weight.
[c]Coded: Minimum slight = 3, minimum small = 4, etc.

Table 15. COMPOSITION OF BASAL DIET FED TO STEERS

Item	Supplemental fat	
	Yellow grease	Tallow
Ingredient composition, % (DM basis)		
Sudangrass hay	6.00	6.00
Alfalfa hay	6.00	6.00
Steam-flaked corn	74.38	74.38
Yellow grease	5.00	
Tallow		5.00
Cane molasses	5.00	5.00
Limestone	1.50	1.50
Urea	1.12	1.12
Trace mineral salt[a]	.40	.40
Sodium bicarbonate	.60	.60
Nutrient composition (DM basis)		
NE, Mcal/kg[b]		
Maintenance	2.30	2.30
Gain	1.62	1.62
Crude protein, %	12.5	12.5
Ether extract, %	8.2	8.2
Calcium, %	.80	.80
Phosphorus, %	.25	.25

[a]Trace mineral salt contained: $CoSO_4$, .068%; $CuSO_4$, 1.04%; $FeSO_4$, 3.57%; ZnO, 1.24%; $MnSO_4$, 1.07%; KI, .052%; and NaCl, 92.96%.

[b]Based on tabular NE values for individual feed ingredients (NRC, 1984) with exception of supplemental fat which was assigned NE_m and NE_g values of 6.03 and 4.79, respectively (Zinn, 1988).

Table 16. COMPOSITION OF YELLOW GREASE AND TALLOW

Item	Supplemental fat	
	Yellow grease	Tallow
Moisture	.33	.13
Insoluble impurities	.03	.07
Unsaponifiable matter	.57	.45
Total fatty acids	93.75	92.52
Free fatty acids	12.07	13.09
Fatty acid profile, %		
C12:0	.34	.09
C14:0	1.39	3.25
C14:1	.24	.93
C16:0	19.26	25.91
C16:1	2.53	3.65
C18:0	9.98	18.04
C18:1	48.21	43.91
C18:2	16.80	3.53
C18:3	1.25	.71

Table 17. INFLUENCE OF YELLOW GREASE VERSUS TALLOW ON PERFORMANCE OF FEEDLOT STEERS AND NE VALUE OF THE DIET

Item	Supplemental fat: Yellow grease	Supplemental fat: Tallow	SD
Days on test	94	94	
Pen replicates	8	8	
Live weight, kg[a]			
Initial	403.6	400.8	6.9
Final	510.9	509.7	12.2
Weight gain, kg/d	1.17	1.20	.10
DM intake, kg/d[b]	7.52	7.72	.17
Gain/DM intake	.153	.154	.006
DM intake/gain	6.48	6.47	.47
Diet net energy, Mcal/kg			
Maintenance	2.29	2.27	.13
Gain	1.60	1.58	.11
Observed/expected diet net energy			
Maintenance	.99	.99	.05
Gain	.99	.98	.07

[a]Initial and final live weights were reduced 4% to account for digestive tract fill.
[b]Treatments differ, P<.05.

Table 18. INFLUENCE OF YELLOW GREASE VERSUS TALLOW ON CARCASS CHARACTERISTICS

Item	Supplemental fat: Yellow grease	Supplemental fat: Tallow	SD
Pen replicates	8	8	
Carcass weight, kg	333.3	333.9	7.6
Dressing percentage	65.2	65.5	.9
Rib eye area, cm^2	88.0	86.7	3.3
Fat thickness, cm	1.30	1.47	.26
KPH, %[ab]	2.74	3.05	.18
Marbling score, degrees[c]	4.02	3.96	.36
Retail yield, %	50.4	49.7	.91
Preliminary yield grade	3.4	3.5	.2
Liver abscess, %	5.0	0	7.4

[a]Kidney, pelvic, and heart fat as a percentage of carcass weight.
[b]Treatments differ, P<.05.
[c]Coded: Minimum slight = 3, minimum small = 4, etc.