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Nutrient composition of cottonseed meal surveyed

A survey was conducted to provide up-to-date information regarding the nutrient content of cottonseed meal, including both means and degree of variation. This information should be of value to nutritionists considering the use of cottonseed meal in their diets.

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A key factor for the successful formulation of poultry diets is an accurate knowledge of the nutrient composition of candidate ingredients. This is especially true for alternative feedstuffs that might not be consistent in their nutrient content or for which recent analyses may not be available.

The nutritionist desires knowledge not only of the mean values for the major ingredients but also of their anticipated variation. Where possible, any effect the type of processing method or locality of production may have on nutrient composition is also important information.

The increase in cotton production in the southern U.S. in recent years, along with improved processing methods that produce meals with lower gossypol content, have made cottonseed meal a more attractive candidate ingredient in diets for poultry and aquaculture.

A study was undertaken to examine the nutrient composition of cottonseed meal produced during the 2000 crop year.

This study was designed to provide nutritionists with current mean values for major nutrients as well as determining the extent of variability in nutrient content. Major cottonseed meal producers participated in this study, with samples obtained from 16 mills in the major cotton-producing states.

Representative samples were obtained from outgoing shipments of cottonseed meal over a two-month period during peak processing times. A total of 20 samples were taken from each mill. All samples were analyzed for moisture, crude protein, fat and macro- and micro-mineral content. Metabolizable energy (ME; kcal/kg) was calculated from the proximate composition by the following equation (National Research Council; NRC, 1994): ME = (21.26 x % dry matter) + (47.13 x % oil) - (30.85 x % crude fiber).

Selected samples, chosen to be representative of the range of meals, were analyzed for total amino acids, free and total gossypol and total (+) and (-) gossypol enantiomers. It has been reported that cottonseed meal with a high (+) to (-) gossypol enantiomer ratio was less toxic and more favorable to broiler production (Joseph et al., 1986; Wang et al., 1987; Gamboa et al., 1997; Bailey et al., 2000).

In order to determine factors that might influence the overall nutritional value of the sample, correlation coeffi-

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TABLE

1. Macronutrient content of cottonseed meal from various processors[1]

Mill	Extraction process[a]	Dry matter, %	Crude fiber, %	Crude protein, %	Crude fat, %	ME, kcal/kg[b]
A	Solvent	91.24	12.32	43.84	1.98	1,653
B	Solvent*	91.97	15.77	44.54	0.33	1,484
C	Solvent*	90.85	11.87	43.45	1.93	1,658
D	Solvent	91.23	11.59	43.06	4.32	1,785
E	Solvent	91.47	10.14	42.92	1.66	1,710
F	Solvent	91.47	8.62	44.40	2.17	1,781
G	Solvent	91.53	9.72	42.61	4.44	1,855
H	Mechanical	93.83	12.27	43.05	5.11	1,857
J	Solvent*	91.69	9.87	44.64	2.30	1,753
K	Solvent	90.69	13.20	42.78	1.96	1,619
L	Mechanical	92.62	11.80	42.82	6.10	1,892
M	Solvent	91.50	9.78	42.96	1.66	1,721
N	Solvent	91.40	13.94	42.55	2.38	1,625
O	Solvent	91.34	14.38	44.20	2.60	1,620
R	Solvent	91.24	12.09	42.43	5.25	1,814
T	Solvent*	91.66	9.64	43.81	2.51	1,769
Mean		91.63	11.69	43.32	2.92	1,725
Std. deviation		0.71	1.98	0.84	1.61	109

[1]Assays conducted by the Agricultural Diagnostic Laboratory at the University of Arkansas and A&A Laboratories, Springdale, Ark.
[a]Mills marked with asterisk did not add soapstocks to meal during processing.
[b]Metabolizable energy calculated from proximate composition (NRC, 1994).

2. Mineral content of cottonseed meal from various processors[1]

	% as-fed basis								
Mill	Phos.	Potas.	Calcium	Magnesium	Sulfur	Sodium	Iron	Zinc	Copper
A	1.16	1.57	0.20	0.64	0.41	0.1470	0.0057	0.0063	0.0013
B	1.10	1.69	0.23	0.67	0.40	0.0147	0.0053	0.0064	0.0011
C	1.19	1.56	0.19	0.63	0.41	0.1533	0.0042	0.0059	0.0013
D	1.10	1.53	0.19	0.61	0.39	0.3050	0.0053	0.0055	0.0010
E	0.94	1.47	0.22	0.58	0.44	0.1539	0.0036	0.0062	0.0016
F	1.21	1.62	0.20	0.68	0.41	0.1212	0.0053	0.0063	0.0014
G	1.09	1.67	0.19	0.66	0.42	0.2209	0.0053	0.0054	0.0013
H	1.04	1.51	0.21	0.61	0.44	0.0132	0.0041	0.0060	0.0015
J	1.13	1.70	0.21	0.67	0.40	0.1928	0.0060	0.0057	0.0013
K	1.12	1.51	0.22	0.63	0.39	0.1573	0.0054	0.0059	0.0012
L	1.11	1.55	0.23	0.68	0.39	0.0090	0.0058	0.0056	0.0011
M	1.01	1.62	0.18	0.67	0.40	0.1533	0.0058	0.0054	0.0012
N	1.08	1.49	0.19	0.60	0.39	0.1515	0.0057	0.0056	0.0013
O	1.17	1.53	0.20	0.65	0.41	0.2046	0.0050	0.0061	0.0015
R	1.09	1.53	0.22	0.61	0.39	0.4094	0.0044	0.0087	0.0010
T	0.98	1.47	0.21	0.58	0.41	0.1852	0.0046	0.0055	0.0013
Mean	1.10	1.56	0.21	0.64	0.41	0.1620	0.0051	0.0060	0.0013
SD	0.07	0.07	0.02	0.03	0.02	0.1026	0.0007	0.0008	0.0002

[1]Assays conducted by Agricultural Diagnostic Laboratory, University of Arkansas.

cients between crude fiber and crude protein, crude fiber and ME, fat and crude protein and fat and ME were determined (SAS Institute, 1992). When significant correlations between factors were observed, linear regression was used to evaluate the relationship between the factors.

Survey results

The macronutrient content of the samples is shown in Table 1. No real correlation between various geographic locations and nutritional content of the meals could be found. The majority of the mills utilized solvent processing with only two of the 16 mills using mechanical extraction. Four of the mills reported adding soapstock back to the meal during processing. Mean dry matter, crude fiber and crude protein contents were 91.63, 11.69, 43.32 and 2.92%, respectively, compared to 91.0, 11.1, 44.7 and 1.6% reported by NRC (1994).

The calculated ME content ranged from a low of 1,484 to a high of 1,892 kcal ME/kg compared to the value of 1,857 suggested by NRC (1994). This variation was expected due to the wide variation in fiber and fat content of the meals.

The calculated ME of the meals was highly correlated with both crude fiber content and crude fat content; this is to be expected because the amounts of crude fiber and crude fat are a major factor in the prediction equation.

Surprisingly, there was no significant correlation between the crude fiber content and the crude protein content; however, there was a significant negative correlation between the amount of crude fat and crude protein in the meals (figures available upon request). Each increase of 1% crude fat resulted in a decrease of 0.33% crude protein.

The micronutrient content of the samples is shown in Table 2. The average phosphorus and calcium levels in the meals were 1.10 and 0.21%, respectively, compared to the 1.25 and 0.15% suggested by NRC (1994). Little variation was noted in calcium or phosphorus content among the various mills, indicating that these values were rather consistent and could be used with a reasonable margin of safety.

Sodium content averaged 0.162% but was extremely variable. Nutritionists who formulate diets using the sodium in feed ingredients to help meet the sodium needs of animals should be cautious in assigning sodium values to cottonseed meal. Other trace minerals were fairly consistent among the various meals.

The amino acid composition of the samples is shown in Table 3. The values are expressed both as percent of the sample and as percent of the crude protein content.

When compared on the basis of percent of crude protein, the mean level of cystine and methionine in the test samples was generally higher than that shown by NRC (1994), while levels of lysine and arginine are fairly similar. Mean values from the meals used in this study should provide reasonable guidelines for nutritionists using cottonseed meal in their formulas.

Amounts of free and total gossypol and isomer values for gossypol are shown in Table 4. Free gossypol ranged from 0.07 to 0.18% in the four samples evaluated.

Because of the significant influence that levels of free gossypol may have on performance of broilers and especially on egg quality, nutritionists should probably rely more upon actual assays of the product they are using than upon tabular values.

It is possible to minimize the adverse effects of gossypol by limiting the amount of gossypol used or by neutralizing with soluble iron salts such as ferrous sulfate in a 2:1 iron:free gossypol ratio for broilers or a 4:1 ratio for laying hens; however, due to the cost of the iron supplement, one should have a reasonable estimate of the actual free gossypol content in the sample being used.

It has been reported that cottonseed meal with a high (+) to (-) gossypol enantiomer ratio was less toxic and more favorable to broiler production (Joseph et al., 1986; Wang et al., 1987; Gamboa et al., 1997; Bailey et al., 2000). The mean ratio of (+) to (-) isomer ratios in this study was within in the range observed for most commercial cottonseed meal varieties in the U.S. as reported by Bailey et al. (2000).

TABLES

3. Amino acid composition of selected samples of cottonseed meal in comparison to NRC values[1]

Amino acid	% of sample						% crude protein					
	B	J	L	N	Mean	NRC	B	J	L	N	Mean	NRC
Threonine	1.38	1.26	1.21	1.29	1.29	1.32	3.10	2.82	2.89	3.03	2.96	3.19
Serine	1.75	1.33	1.29	1.51	1.47	1.74	3.93	2.98	3.08	3.55	3.39	4.20
Glycine	1.80	1.69	1.62	1.67	1.70	1.70	4.04	3.78	3.87	3.92	3.90	4.11
Cysteine	0.72	0.76	0.67	0.77	0.73	0.62	1.61	1.70	1.60	1.81	1.68	1.50
Valine	1.94	1.82	1.81	1.60	1.79	1.88	4.36	4.08	4.33	3.76	4.13	4.54
Methionine	0.63	0.63	0.61	0.61	0.62	0.52	1.41	1.41	1.46	1.44	1.43	1.26
Isoleucine	1.41	1.30	1.27	1.14	1.28	1.33	3.17	2.91	3.04	2.68	2.95	3.21
Leucine	2.55	2.38	2.32	2.32	2.39	2.43	5.72	5.33	5.55	5.45	5.51	5.87
Tyrosine	1.19	1.14	1.11	1.15	1.15	1.13	2.67	2.55	2.65	2.70	2.64	2.73
Phenylalanine	2.30	2.20	2.12	2.18	2.20	2.22	5.16	4.93	5.07	5.12	5.07	5.36
Histidine	1.20	1.14	1.11	1.15	1.15	1.10	2.69	2.55	2.65	2.70	2.65	2.65
Lysine	1.81	1.79	1.58	1.77	1.74	1.71	4.06	4.01	3.78	4.16	4.00	4.13
Arginine	4.74	4.45	4.23	4.63	4.51	4.59	10.64	9.97	10.11	10.88	10.40	11.09
Tryptophan	0.42	0.41	0.43	0.44	0.43	0.47	0.94	0.92	1.03	1.03	0.98	1.14

[1]Assays conducted by Experiment Station Chemical Laboratories at the University of Missouri, Columbia.

4. Free and total gossypol and isomer values for selected samples of cottonseed meal[1]

Mill	--AOCS gossypol--		--2-AP HPLC gossypol--			Isomer ratio --(% of total)--	
	% free	% total	% total	% (+)	% (-)	(+)	(-)
B	0.07	1.15	0.95	0.56	0.39	58.7	41.3
J	0.14	1.45	1.27	0.80	0.47	62.8	37.2
L	0.13	1.38	1.15	0.69	0.47	59.5	40.5
N	0.18	1.49	1.25	0.79	0.46	63.0	37.0
Mean	0.13	1.37	1.16	0.71	0.45	61.0	39.0

[1]Assays conducted by Texas A&M Research Center in San Angelo, Texas.

Conclusions

The results of this survey provide up-to-date information regarding the nutrient content of cottonseed meal, including both means and degree of variation. This information should be of value to nutritionists considering the use of cottonseed meal in their diets. It is recommended that assays for free gossypol be consistently conducted due to its variability and the negative impact it may have on performance of monogastric animals.

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