Mineral Composition of Distillers Dried Grains with Solubles

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Primary Audience: Nutritionists, Quality Control Personnel

SUMMARY

Production of distillers dried grains with solubles (DDGS) is expected to double within the next few years and substantially increase the quantities of DDGS available to the feed industry. To properly evaluate the potential role of this ingredient, a complete nutritional profile, including mineral composition, must be available to feed formulators. Twelve samples of commercially prepared DDGS were obtained from the northern central United States and analyzed for mineral composition. Analysis indicated an enormous range of 0.09 to 0.44% with an average value of 0.23% in sodium content. The average composition of many of the other minerals (except calcium and sulfur) agreed with projected values based on a 3-fold increase of the levels found in yellow corn grain.

Key words: distillers dried grains with solubles, feed ingredient, mineral, sodium

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DESCRIPTION OF PROBLEM

Increased emphasis on ethanol production in the United States has and will continue to lead to significant increases in the amount of distillers dried grains with solubles (DDGS) available to the feed industry. When considering the potential use of an ingredient such as DDGS, primary emphasis is placed on obtaining accurate information regarding metabolizable energy and amino acid composition. Nevertheless, a complete nutrient profile is necessary for consideration of its role in poultry and animal feeds. Although DDGS has been available as a feed ingredient for decades [1, 2, 3], it is not a completely homogenous ingredient. Fermentation residues from the beverage industry may be based on mixtures of several grains, whereas the DDGS that is becoming increasingly available is usually from ethanol plants with corn as the only grain input.

In an undergraduate demonstration project involving incorporation of DDGS in laying hen formulas [4], use of the NRC [5] value for sodium in this ingredient led to a severe deficiency with an almost total cessation of egg production. Subsequent analysis of the sodium content of the DDGS sample revealed 0.09% sodium in contrast with 0.48% as listed by the NRC [5]. Reformulation of the feed to provide the intended level of sodium (0.18%) led to resumption of the level of egg production observed prior to initiation of the study. The levels of sodium listed by the NRC for distillers dried grains (0.09%), DDGS (0.48%), and dehydrated distillers solubles (DDS; 0.26%) appear to be inconsistent. That is, no combination of distillers dried grains and DDS could pro-

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TABLE 1. Mineral composition (%) of distillers dried grains with solubles

	Mineral					
Sample	Sodium	Potassium	Phosphorus	Calcium	Magnesium	Sulfur
1	0.09	0.99	0.74	0.02	0.26	—
2	0.12	0.89	0.73	0.01	0.26	—
3	0.29	0.70	0.59	0.07	0.21	—
4	0.11	0.99	0.77	0.09	0.33	0.58
5	0.12	0.89	0.68	0.07	0.30	0.87
6	0.11	0.67	0.50	0.07	0.23	0.45
7	0.09	0.92	0.67	0.07	0.27	0.94
8[A]	0.42	0.89	0.60	0.31	0.26	1.06
9[A]	0.44	0.99	0.70	0.71	0.31	1.04
10[A]	0.39	0.94	0.69	0.62	0.30	0.78
11[A]	0.43	0.99	0.73	0.69	0.33	1.10
12[A]	0.43	0.99	0.73	0.47	0.31	0.73
Average ± SD	0.25 ± 0.15[C]	0.91 ± 0.11	0.68 ± 0.07	0.29 ± 0.27	0.28 ± 0.04	0.84 ± 0.21
NRC (1994)	0.48	0.65	0.72	0.17	0.19	0.30
Projected[B]	0.10	0.90	0.84	0.06	0.36	0.24

[A]Samples were obtained from the same plant at different times.
[B]Projected assuming a 3-fold increase compared to yellow corn grain [5], see text.
[C]Average sodium content of samples 1 to 7 = 0.13% and of samples 8 to 12 = 0.42%.

vide the sodium level stated for DDGS by the NRC [5].

In modern ethanol fermentation facilities, unless liquid solubles are diverted to ruminant feeding or some other purpose, they are added to the grain residues prior to drying. The source of sodium reflected in NRC values for DDGS and DDS is unclear, as this element is apparently not added during the fermentation procedure. Because approximately two-thirds of the weight of incoming corn is converted into carbon dioxide or ethanol during fermentation [6], it is normally expected that the concentrations of all unfermented nutrients, such as oil, protein, and minerals, will be increased 3-fold. Thus, if corn grain normally contains between 0.02 and 0.04% sodium, one would expect a value of approximately 0.10% in DDGS, a

TABLE 2. Mineral composition (ppm) of distillers dried grains with solubles

	Mineral				
Sample	Manganese	Iron	Aluminum	Copper	Zinc
1	15	73	60	10	69
2	15	82	87	18	66
3	16	122	46	13	88
4	13	101	20	5	63
5	13	90	21	7	80
6	9	67	13	3	61
7	13	77	39	7	54
8[A]	19	161	68	9	44
9[A]	38	272	89	9	49
10[A]	38	270	78	9	51
11[A]	48	325	112	12	52
12[A]	22	145	38	17	49
Average ± SD	22 ± 12	149 ± 86	56 ± 30	10 ± 4.3	61 ± 13
NRC (1994)	24	280	NL[c]	57	80
Projected[B]	21	135	NL[c]	9	54

[A]Samples were obtained from the same plant at different times.
[B]Projected assuming a 3-fold increase compared to yellow corn grain [5], see text.
[C]Not listed.

value that differs markedly from that of the NRC.

As DDGS promises to become an increasingly available feed ingredient, and because unintended variations in the content of sodium and other minerals can lead to suboptimal animal performance, a study was conducted to determine the mineral composition of a number of DDGS samples currently available to the feed industry.

MATERIALS AND METHODS

Twelve samples of commercially prepared DDGS from the northern central United States were obtained directly from manufacturers. Initial observations indicated that DDGS from one source, a major production facility, contained a higher level of sodium than that from other plants. To confirm these observations and to gauge variation, 4 additional samples from this source were obtained. All samples were evaluated for mineral composition at the Agriservices Laboratory of the University of Georgia [7].

RESULTS AND DISCUSSION

The mineral composition of 12 DDGS samples is presented in Tables 1 and 2. Although our primary interests were centered on sodium, compositions of 10 other minerals are provided to enhance the database for currently available samples of DDGS.

An enormous range of 0.09 to 0.44% sodium in samples was evident. Although an average value is provided (0.25%), it is emphasized that use of this value in feed formulation is to be strictly discouraged. The average sodium value for samples 1 to 7 was 0.13%, a value that approximates a 3-fold increase in sodium content of corn [5]. Samples 8 to 12, from a major DDGS producer averaged 0.43% sodium. Clearly, DDGS from respective suppliers must be analyzed so as to properly characterize the ingredient prior to use. Although sulfur is not usually considered in the formulation of monogastric diets, the average content of this element in the DDGS samples tested was almost 3 times higher than indicated by the NRC. Calcium levels were also much higher. The content of most other minerals appeared generally consistent with a 3-fold concentration increase, with the exception of calcium in 5 samples. Interestingly, these samples were those also very high in sodium. Plant variation is evident in these data.

The source of the extraordinary variation noted in the sodium content of DDGS samples is not immediately clear. It has been suggested that in some plants, by-product streams that contain sodium from other manufacturing processes may find their way into the solubles fraction, which is subsequently added to grain residues. A simple consideration of the sodium content of corn grain and the multiplier effect resulting from starch fermentation adequately accounts for sodium values of DDGS of 0.09 through 0.12 but not higher levels of some samples observed in this study.

CONCLUSIONS AND APPLICATIONS

1. Mineral analysis of DDGS is reported for those considering the use of this ingredient in formulated feeds.
2. Sodium content of DDGS proved to be extremely variable (0.09 to 0.44%).
3. Nutritionists need to properly characterize the mineral content of DDGS from respective suppliers prior to incorporation into balanced rations.

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4. Layer diets contained 51.4% corn, 20.0% distillers dried grains plus solubles, 15.2% soybean meal, 9.7% limestone, 2.1%

animal vegetable fat, 0.9% dicalcium phosphate, 0.3% vitamin premix, 0.17% L-lysine HCL, 0.08% DL-methionine, 0.06% mineral premix, and 0.01% salt.

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