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Title:

New Approach For Determining The Nutrient Composition Of Soybean Hulls

Abstract:

Increasing the use of soybean hulls in the diets of ruminants is limited by the uncertainty of the variation in nutrient content. By-products are inherently variable in nutrient content and this variation must be accounted for in diet formulation. The proposed project will examine the use of physical separation of soybean hulls combined with nutrient analysis to develop prediction equations. If successful, the nutrient composition of soybean hulls that are separated in a similar manner could be predicted without extensive chemical analysis. Livestock producers and the feed industry could use this process in making decisions on incorporating soybean hulls in feeding programs.

Objectives:

- To determine nutritive variability that exists in soybean hulls as a feed ingredient.
- To use physical separation of soybean hulls and analysis of fractions to develop predictions equations.
- Evaluate prediction equations using soybean hulls of known composition

Justification:

Soybean hulls have become widely available to cattle producers in the Southeast and they are becoming a common ingredient in many rations. Three objectives to feeding soybean hulls to cattle are to: 1) supply an economical energy supplement, 2) minimize potential negative effects of non-fiber carbohydrates on ruminal digestion, and 3) replace a portion of the fiber in the diet (Pugh, 2003). This line of reasoning is affecting not only the beef industry, but the dairy industry as well. Feed costs, which account for almost 50% of total costs, are major considerations for efficient production in livestock. Producers here have opportunities to reduce feed costs through the use of by-products such as soybean hulls. However, since soybean hulls are a by-product rather than a primary product of the soybean industry, determining the variation in nutrient content of soybean hull is needed. Soybean hulls are produced by cracking soybeans with a roller to decrease the size of seeds and a blast of air removes the hulls and some meat. The hulls are then separated into three categories: large hulls and meats, small hulls and meats, and fines. Hulls are toasted to destroy any urease activity. Hulls can be ground, kept whole, pelleted, or kept loose to sell in bulk. Three different feedstuffs are formed in the processing of soybeans: 1) soybean hulls, which are soybean seed coats; 2) soybean mill feed, which are hulls and mill processes of soy grits and flour, and; 3) soybean mill run, which are soybean hulls and bean meats. Any of these are often classified by some segments of the feed industry as “soybean hulls.” Kung and Lin (1997) reported crude protein varies from 9% to 16.5%. Formulating diets containing soybean hulls is difficult unless the protein value is known. Without this knowledge, diets would be formulated using the lower value for the soybean hulls, and thus the true value of the soybean hulls to the soybean industry would be underestimated. In addition, animals would be consuming excess crude protein. Soybean hulls are frequently added to diets based on their fiber content. Particle size of the fiber is an important attribute that should be considered in diet formulation. Fiser et al. (2002) found soybean hulls increased gains when used to supplement to forage diets. Martin and Hibberd (1990) showed organic matter total tract digestibility increased with increasing levels of soybean hulls, thus demonstrating the addition of soybean hulls increase organic matter digestibility. Increases in total VFA production in response to soybean hull or fiber supplementation have been reported by Fiser and Vanzant (2002). Soybean hulls have the potential to provide additional energy and protein to forage diets. If nutrient composition of soyhulls and the variation of nutrients are known, feeding strategies can be developed to optimize their use in diets for livestock diets. The typical analysis of a soybean hull is as follows:

Dry matter, %	**91.0**
Crude Protein, %	**10.0**
Fat, %	**02.0**
Crude fiber, %	**36.0**
Neutral Detergent Fiber, %	**61.1**
Acid Detergent Fiber, %	**45.5**
Calcium, %	**0.45**
Phosphorus, %	**0.16**
Total Digestible Nutrients, %	**71.0**

Materials and methods:

16 samples of soybean hulls were obtained from the Tennessee Farmer's Co-operative in Maryville, Tennesee to use in this experiment. Nutrient composition of each sample was determined in the Animal Science Ruminant Nutrition Laboratories. Analyses includes: Dry Matter (DM), Ash, Crude Protein (CP), Neutral Detergent Fiber (NDF), and Acid Detergent Fiber (ADF). Each sample was subjected to physical separation of 15 grams for 5 minutes each using a KECK® Sieve Analysis Field Kit. The 15 grams of soybean hulls were placed in the top of the sieve tower loaded with four progressively smaller sieves. The sieve sizes were 51 OPN, 40 OPN, 30 OPN, and 20 OPN. The contents remaining on the top of each sieve was removed, weighed and composited for further analyses. The process was repeated until all grams in the sample were collected from each sieve. Dry matter, Ash, CP, NDF, and ADF will be run on each sample. F57 filter bags (Ankom, Inc., Mecedon, NY) were used sequentially to determine NDF and ADF of the samples. The data generated from 15 samples were used to develop prediction equations relating the quantity of sample at each sieve to the nutrient profile of NDF and CP of the original material. The accuracy of the prediction equations will be determined by how well

the prediction matches the actual nutrient content of the remaining original samples. Using the data based on the 15 samples, 6 samples were chosen at random (Sample 2, 6, 8, 11, 13, and 16) to predict the unknown NDF and CP values.

Results and Discussion:

16 samples were used for the procedure, but one sample proved to be an outlier in each nutrient profile and was thrown out. Of the remaining 15 samples the average weight was 119.52 grams. The weights ranged from 110.38 to 122.89 grams. The average amount of sample lost was 1.04 grams or .87%. The most grams lost of all trials were 2.96 grams, while the least amount was .52 grams. On a Dry Matter (DM) basis, 51 OPN had an average of 22.17 grams. 40 OPN had an average of 18.83, 30 OPN had an average of 13.00, 20 OPN average was 26.74, and 0 was 29.18.

Table 1. shows the percent of each nutrient in each fraction of the separated soyhulls. The DM and Ash compositions were each significantly different, with the most DM percent being in the bottom fraction of the tower, as well as ash. The least of the DM percentage and Ash percentage was Screen 30. NDF values were the same for Screen 20 and 0, while the other three fraction were significantly different. So the Screen 20, or the particle size, did not make a difference in the neutral detergent fibers. ADF values were the same for Screen 20 and 0, while the other three fractions were significantly different. The CP fractions were the same in Screen 20 and 51, while the other three fractions were significantly different. Each column represents the tower and each section that was formed by the different screens. Each value is a percent of the whole sample that was measured out in each fraction.

Table 1. Percent of each nutrient in fractions of separated soyhulls.

SIZE	DM	ASH	NDF	ADF	CP
0	26.29[a]	30.50[a]	24.75[a]	25.35[a]	27.05[a]
20	24.13[b]	22.63[b]	24.72[a]	24.60[a]	22.71[b]
30	12.57[e]	11.81[e]	12.72[d]	12.66[d]	12.50[d]
40	16.98[d]	15.85[d]	17.23[c]	17.19[c]	15.64[c]
51	19.77[c]	19.21[c]	20.03[b]	20.42[b]	20.77[b]

Table 2 shows the nutrient composition of the separated soyhulls. These values are an average for all 15 samples and their determined values found in the lab. Each sample had five parts that were analyzed in duplicate, expect for the CP. All sections in the sieve on a DM basis were very close, with the average of the 15 whole samples being 93.44%. The Ash varied between 4.94-6.12%, with the average being 5.19%. The NDF varied from 60.08-65.37%, with the average being 64.10%. The ADF varied from 44.76-47.75%, with an average 46.95% of the entire samples. The CP of the sections was close, ranging from 12.92-14.44%, with an average of 13.77% CP. The finest particle size of the soybean hulls had the highest DM, Ash, and CP%. Screen 40 had the highest NDF and ADF%.

Table 2. Nutrient composition of separated soyhulls.

SIZE	DM	ASH	NDF	ADF	CP
0	93.66	6.12	60.08	44.76	14.18
20	93.45	4.94	65.37	47.71	12.92
30	93.00	4.95	64.53	47.13	13.69
40	93.52	4.91	64.76	47.41	13.62
51	93.56	5.05	65.77	47.75	14.44

Tables 3. and Table 4. show the process of using the prediction equation. These six samples were chosen at random and Table 3. states the grams of dry matter that would be known if this method of trying to predict the NDF% value. The samples would have been shaken in the sieve to obtain particle size and weighed. Table 4. takes the uses the average NDF%, which is found by multiplying the NDF% X the DM grams, and compares it to the estimated NDF%. To obtain the Estimated NDF%, the total grams of DM are divided by the total NDF grams.

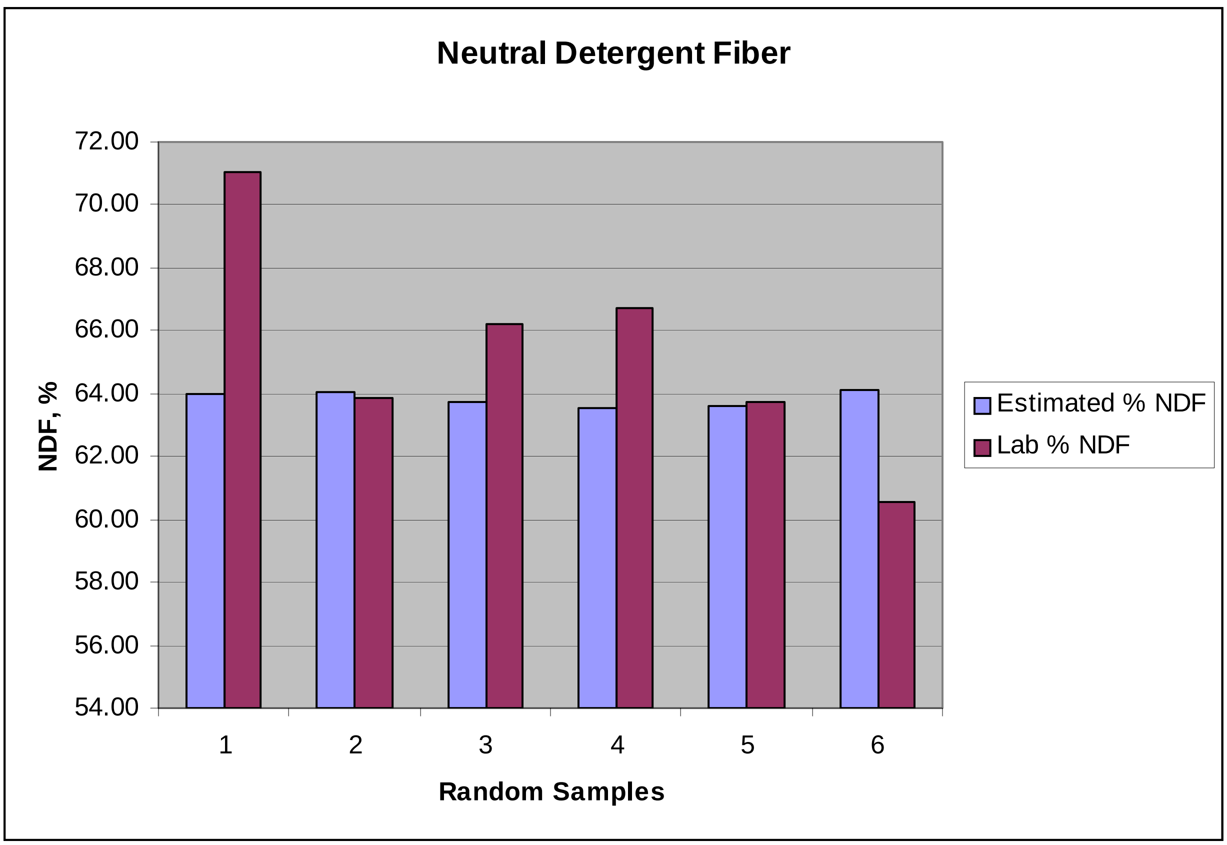
Table 3. Grams of DM of Random Samples

Grams of dry matter						
Sample No.	0	20	30	40	51	
2	27.17	26.7	14.31	19.3	26.05	113.53
6	23.37	27.84	16.46	23.39	19.51	110.57
8	31.84	26.3	13.11	18.12	22.17	111.54
11	36.46	29.2	13.45	17.88	16.83	113.82
13	31.44	24.43	12.39	15.51	18.85	102.62
16	23.22	24.74	13.68	18.14	29.05	108.83

Table 4. Predicted Values of NDF%

Sample No.	NDF grams based on averages of composition 0	20	30	40	51		EST % NDF	LAB
2	16.32	17.45	9.23	12.50	17.13	72.64	63.99	71.04
6	14.04	18.20	10.62	15.15	12.83	70.84	64.07	63.88
8	19.13	17.19	8.46	11.73	14.58	71.10	63.74	66.22
11	21.91	19.09	8.68	11.58	11.07	72.32	63.54	66.74
13	18.89	15.97	8.00	10.04	12.40	65.30	63.63	63.74
16	13.95	16.17	8.83	11.75	19.11	69.80	64.14	60.52

This chart shows the predicted value compared to the lab value.



Tables 5. and Table 6. show the process of using the prediction equation again. These six samples were chosen at random and Table 5. states the grams of dry matter that would be known

if this method of trying to predict the NDF% value. The samples would have been shaken in the sieve to obtain particle size and weighed. Table 6. takes the uses the average CP%, which is found by multiplying the CP% X the DM grams, and compares it to the estimated CP%. To obtain the Estimated CP%, the total grams of DM are divided by the total CP grams.

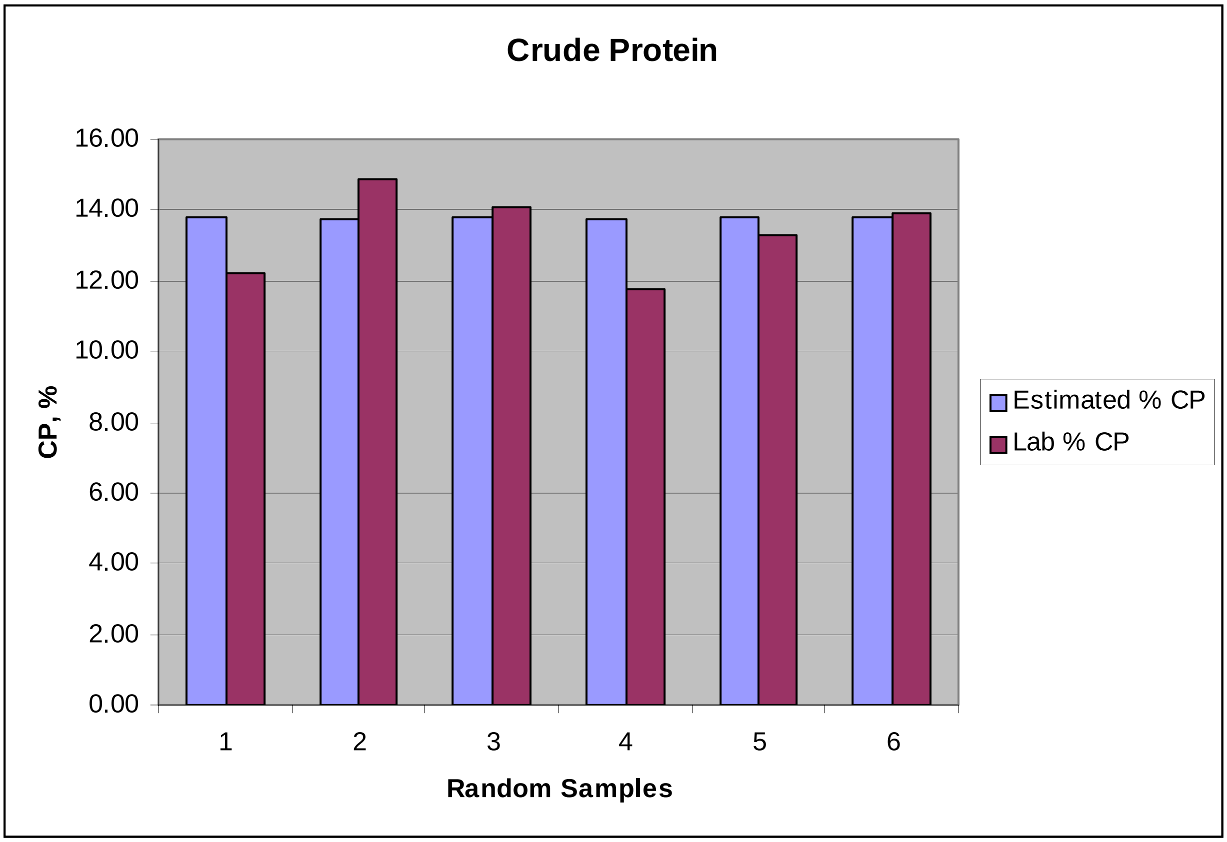
Table 5. Grams of DM of Random Samples

Grams of dry matter						
Sample No.	0	20	30	40	51	
2	27.17	26.7	14.31	19.3	26.05	113.53
6	23.37	27.84	16.46	23.39	19.51	110.57
8	31.84	26.3	13.11	18.12	22.17	111.54
11	36.46	29.2	13.45	17.88	16.83	113.82
13	31.44	24.43	12.39	15.51	18.85	102.62
16	23.22	24.74	13.68	18.14	29.05	108.83

Table 6. Predicted Values of CP%

	CP based on averages of composition							
Sample No.	0	20	30	40	51		EST % CP	LAB
2	3.85	3.45	1.96	2.63	3.76	15.65	13.79	12.24
6	3.31	3.60	2.25	3.19	2.82	15.17	13.72	14.87
8	4.51	3.40	1.79	2.47	3.20	15.38	13.79	14.07
11	5.17	3.77	1.84	2.44	2.43	15.65	13.75	11.78
13	4.46	3.16	1.70	2.11	2.72	14.15	13.78	13.27
16	3.29	3.20	1.87	2.47	4.19	15.03	13.81	13.93

The following chart shows the predicted value compared to the lab value of the CP%.



Conclusion:

This method of looking at the nutrient composition of soybean hulls by particle size is a method that with a little more research and refinement could be one that is used by the feed industry. This method was proven to work with predicting the NDF% and CP%. These two nutrient values were chosen due to the fiber and protein are two most important components in a feed when comparing price, energy, and level of consumption. In having only 15 samples to try to predict the nutrient values, equations were established that were successful 50% of the time. By having more samples, data would be more accurate and predicted values were be closer.

Literature cited:

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