Evaluation of the Feeding Values of Some Cereal Grains and By-Products by Digestion Trials in Chickens

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ABSTRACT

The feeding values of 3 grains and 2 brans were determined using mature R.I.R. cocks. The feeding values of yellow corn were: 80.42 S.V., 78.22 T.D.N., and 3285.2 kcal M.E. The corresponding values for barley were: 49.29, 51.08, and 2145.4. The feeding values of wheat were lower than those of corn by about 10%.

The associative effect of the basal ration on the digestion coefficients of the tested ration is evident from the data of wheat by direct and indirect methods. The feeding values of wheat bran were found as: 27.02 S.V., 30.16 T.D.N., and 1266.7 kcal M.E. The corresponding values for rice bran were: 48.43, 43.82, and 1840.4. The low feeding values of barley, wheat bran and rice bran limit their use in high energy rations for broilers and layers.

The linear multiple regression equation of the effect of CF and NFE on TDN was calculated. The value of this equation in predicting the TDN from chemical analysis is obvious.

INTRODUCTION

The proper feeding of poultry necessitates a complete knowledge of the feeding value of the ingredients used in their feeding. Grains and their by-products contribute to poultry rations about 50–60%. Therefore, their feeding value in terms of digestible nutrients such as crude protein (C.P.), crude fiber (C.F.), ether extract (E.E.), and nitrogen free extractives (N.F.E.) as well as their total digestible nutrients (T.D.N.), starch value (S.V.) and metabolizable energy (M.E.) should be available to the poultry nutritionist to formulate economical and well balanced rations.

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The first step towards establishing the feeding value of a feedstuff is to determine the digestion coefficients of its nutrients. The fact that urine and feces are excreted together through the cloeca of the fowl makes it difficult to estimate the digestion coefficient of the protein and consequently of the feedstuff. Several procedures have been used in an endeavour to overcome this difficulty (1,4,12).

The necessity of analyzing home grown feedstuffs is visualized due to probable variation in nutrient composition which in turn affects the digestion and the feeding value of the ingredients (12). The state of production of the hen has been reported to affect digestion; C. P. was more and C. F. was less digestible for laying hens than for hens that were not laying (5). The methods adopted for separating urine from feces as well as the methods of feeding (direct or indirect) were also reported to affect the digestibility and the feeding value of tested ingredients (7).

The objective of this study is to determine the feeding values of corn, wheat, barley, wheat bran, and rice bran. A comparison is also made between the feeding value of wheat obtained by the direct and indirect feeding methods.

MATERIALS AND METHODS

Six digestibility trials were conducted. Two 1-year old Rhode Island Red males were used for each digestion trial. Tested ingredients were given for 11 days; the first 5 days being regarded as the preliminary period while the next 6 days were considered as the collection period.

Cocks were weighed before and after the digestion trial to be sure of no loss in body weight. Cocks were placed in metabolic cages which are $60 \times 60 \times 90$ cm. Feeds were ground before being offered to the cocks. The amount of feed consumed by each cock was determined from the preliminary period. The daily amounts of the tested feedstuffs needed for each cock during the collection period were weighed and kept separately in tight containers. A sample of each feedstuff was also kept for the chemical analysis.

Droppings of cocks were quantitatively collected and transferred to a previously weighed aluminum dish using a spray of 2% boric acid solution (7). Droppings were dried at 80°C until constant weight then kept in tight containers. The air-dried droppings gathered during the whole collection period for each cock were well mixed, ground and stored in screw-capped bottle for the chemical analysis.

Proximate analysis of feedstuffs and droppings followed procedures outlined by the American Official Agricultural Chemists (2). The procedure outlined by Ekman *et al.* (4) was used to determine the fecal protein ($N \times 6.25$). The conversion factors for S.V. per one unit of digestible C.P., E.E. and crude carbohydrates were: 1.03, 3.11 and 1.00, respectively (7). The deduction of C.F. was considered as 0.3 unit of S.V. for each 1% C.F. The M.E. was computed assuming 4.20 kcal per gram T.D.N. as suggested by Titus (12).

The feeding value of yellow corn and wheat were estimated by the direct method. However, barley, rice bran, and wheat bran — which cannot be fed alone — were estimated by the indirect method using the yellow corn as the basal ration. The feeding value of wheat was estimated also by the indirect method using the horse beans as the basal ration (Table 1). Data were analyzed by procedures given by Steel and Torrie (11).

Table 1 Methods of feeding the tested feedstuffs

Digestion trial No.	Feedstuff tested	Technique description	Basal ration	(%)	Tested ration	(%)
1	Yellow corn	Direct	—		Yellow corn	(100)
2	Barley	Indirect	Yellow corn	(50)	Barley	(50)
3	Wheat	Direct	—		Wheat	(100)
4	Wheat	Indirect	Horse beans	(40)	Wheat	(60)
5	Wheat bran	Indirect	Yellow corn	(60)	Wheat bran	(40)
6	Rice bran	Indirect	Yellow corn	(60)	Rice bran	(40)

RESULTS AND DISCUSSION

Effect of method of feeding wheat on its feeding value

From Table 2 it may be noted that the digestion coefficients of C.F. and E.E. showed a slight increase in the direct feeding. However, considering the low content of wheat of these 2 components it becomes evident that moderate changes in the digestibilities of these components would result in minor changes in the feeding value (Table 3). On the other hand, the digestion coefficient of C.P. in the indirect feeding was higher to the extent of 17 percentage points than in the direct feeding. This is known as increasing associative effect and occurs as a result of assuming that the digestion coefficients of the basal feed (horse beans in this case) when fed alone will be the same as when fed in combination with the tested ration (wheat).

A slight decrease in the digestion of N.F.E. is observed in the indirect feeding as compared with the direct feeding. It may be noted that the coefficient of digestion of organic matter (O.M.) was slightly affected. Similarly, the effect of the direct or indirect feeding of wheat is insignificant in terms of the feeding value being higher in the latter to the extent of 1.48–2.11% (Table 3).

Coefficient of digestibility and the feeding value of grains

The values of C.F. content of yellow corn, wheat and barley as fed are: 2.57, 5.72 and 7.87%, respectively, indicating the suitability of the 3 grains in the same sequence for feeding chickens. Digestion coefficient of O.M. was the highest for corn, followed by wheat and at last the barley. Crude protein was digested to almost the same extent in corn and wheat while it was about 16 percentage points less in the barley.

Similarly Potter *et al.* (10) reported a low coefficient of digestibility of C.P. in barley. However, they obtained increased digestibility of the C.P. by water or enzyme treatments. The digestion coefficient of N.F.E. of corn was about 6 percentage points higher than that of wheat while the latter was 15 percentage points higher than that of the barley (Table 2). Similar results for corn were found by Bondi and Mayer (3) and Galal (7). Slightly higher digestion coefficients of N.F.E. were reported by Galal (7) and Halnan (8). On the other hand, Titus and Fritz (12) reported the digestion coefficient of N.F.E. in barley as 82% which is 21 percentage points higher than found in this study (Table 2). The low digestion coefficients of the barley nutrients may be partly due to the inherent limitations of the indirect technique and the probable depressing nature of the associative effect of corn on barley.

Table 2 Chemical analysis (C.A.) and digestion coefficients (D.C.) of some cereal grains and by-products

Feedstuff	Yellow corn		Barley		Wheat			Wheat bran		Rice bran	
Nutrient(s)	C.A. %	D.C. %	C.A. %	D.C. %	C.A. %	D.C.[a] %	D.C.[b] %	C.A. %	D.C. %	C.A. %	D.C. %
D.M.	89.77	81.18	90.55	47.58	90.06	73.64	77.08	88.81	27.87	89.96	35.51
O.M.	88.36	84.01	86.71	55.73	86.18	77.30	78.30	83.70	35.74	78.48	42.96
Ash	1.41	—	3.84	—	3.88	—	—	5.11	—	11.48	—
C.P.	9.22	77.30	8.21	61.04	11.82	77.21	94.27	11.71	37.01	12.14	51.77
C.F.	2.57	26.98	7.87	0.00	5.72	36.31	37.32	10.91	26.28	8.66	0.78
E.E.	3.84	83.21	1.78	30.31	3.54	84.45	89.11	2.70	0.00	9.81	83.07
N.F.E.	72.73	86.92	68.85	65.49	65.10	80.52	78.42	58.38	39.32	47.87	39.94

[a] Direct feeding.
[b] Indirect feeding.

Table 3 S.V., T.D.N. and M.E. values of some cereal grains and by-products

Feedstuff	S.V. %	T.D.N. %	M.E. (kcal/kg)
Yellow corn	80.42	78.22	3285.2
Barley	49.29	51.08	2145.4
Wheat[a]	71.48	70.36	2955.1
Wheat[b]	72.73	71.41	2999.2
Wheat bran	27.02	30.16	1266.7
Rice bran	48.43	43.82	1840.4

[a] Direct feeding.
[b] Indirect feeding.

Digestion coefficients of C.F. in yellow corn and barley were comparable to each other and lower than that of wheat to the extent of 10 percentage points. In this regard, Fraps (6) in a compilation of several digestion experiments with poultry presented a range from 0–49% for the digestibility of C.F. Coefficients of digestibility of E.E. in wheat and yellow corn were comparable and fall within reported values (3,7).

The feeding values computed in terms of S.V., T.D.N. and M.E. were 80.42, 78.22 and 3285.2 for corn and 71.48, 70.36 and 2955.1 for wheat, respectively. Similar values were reported by Titus and Fritz (12), Ewing (5), Galal (7) and Ibrahim (9). However, the feeding values of barley: 49.29 S.V., 51.08 T.D.N. and 2145.4 kcal M.E. are lower than most reported values. The T.D.N. values reported by Ibrahim (9) and Galal (7) were 55.22 and 64.26, repectively.

Seemingly the associative effect of the basal ration was evident in depressing the feeding value of barley as a result of the lower digestibility of most nutrients.

Coefficients of digestibility and the feeding value of wheat and rice brans

The chemical analysis of the two feedstuffs reveals similar dry matter content (D.M.). However, the ash of rice bran was slightly over double that of wheat bran. Also the E.E. of the rice bran was a little higher than 3.5 times that of the wheat bran.

The digestion coefficient of C.P. in rice bran surpassed its corresponding figure in wheat bran to the extent of 15 percentage points (Table 2). The remarkable depression in the digestion coefficients of C.P., N.F.E., and E.E. may be due to the depressing associative effect of corn on the digestion of these nutrients of wheat bran. In this regard, Halnan (8) reported that the nutritive value of the bran correlated with its starch content and that the other constituents of the N.F.E. were apparently non-utilizable by the fowl. This could explain the low digestion coefficients of the N.F.E. found in this study.

The digestion coefficient of E.E. of rice bran contributes measurably to the feeding value of this feedstuff in contrast with the almost non-digestible E.E. of wheat bran. The digestion coefficients of C.F. in the two feedstuffs behaved in an opposite direction to that of E.E. Except for C.F., the digestion coefficients of the other nutrients of the wheat bran were lower than those observed by Ibrahim (9) and Galal (7).

The feeding values of wheat bran were 27.02 S.V., 30.16 T.D.N. and 1266.7 kcal M.E. (Table 3). Higher T.D.N. values were reported by Ibrahim (9) and Galal (7) being

36.56 and 39.13, respectively. These investigators used the direct feeding method, and besides the bran used in their studies was of better quality. Table 3 shows the feeding value of rice bran to be 48.43 S.V., 43.82 T.D.N., and 1840.4 kcal M.E.. Galal (7) reported similar results.

Therefore, such feedstuffs as barley, rice bran, and wheat bran should be used to a very limited extent if not at all in formulating energy-rich rations. On the other hand, they may be valuable in self-restricting rations where dilution of nutrients is desirable.

Multiple linear regression equation

The data allowed calculation of the following multiple linear regression equation:

$$TDN = 95.508 - 6.052\,(CF) + 0.053\,(NFE)$$

This equation describes the relationship between TDN, CF, and NFE. It also enables prediction of the TDN if NFE and CF percentages were known for similar feedstuffs. The effect of both CF and NFE on the TDN was found to be highly significant (Table 4).

Table 4 Multiple regression analysis

Source of variation	d.f.	S.S.	M.S.	F
Regression	2	3105.9	1552.95	53.14[a]
Error	8	233.8	29.22	
Total	10	3339.7		

[a] $P < 0.01$

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تقدير القيمة الغذائية لبعض الحبوب ومخلفاتها بأستعمال تجارب الهضم في الدجاج

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المستخلص

قدرت القيمة الغـــذائية لثلاث أنواع من الحبوب وهي الذرة الصفراء والقمح والشعير ونوعين من متخلفات المطاحن والمضارب وهما الردة والرجيع وذلك بأجراء تجارب هضم على ديوك بالغة من نوع الرود أيلاند الأحمر .

كانت القيمة الغـذائية للذرة الصفراء كالآتي : ٨٠ر٤٢ معادل نشا ، ٧٨ر٢٢ مركبات كلية مهضومة ، ٣٢٨٥ر٢ ســـعر طاقة قابلة للتمثيل ، بينما كانت القيم المناظرة للشعير هي ٤٩ر٢٩ ، ٥١ر٠٨ ، ٢١٤٥ر٤ على التوالى . وكانت القيمة الغذائية للقمح تقل بمقدار حوالى ١٠ ٪ عن نظيراتها في الذرة الصفراء .

وبمقارنة القيم الغذائية للقمح المقدرة بالطريقتين المباشرة وغير المباشرة يتضح أن للعليقة الأساسية تأثير على معاملات الهضم للعليقة المختبرة .

وقدرت القيمة الغذائية للردة وكانت كالآتي :– ٢٧ر٠٢ معادل نشا ، ٣٠ر١٦ مركبات مهضومة كلية ، ١٢٦٦ر٧ سعر طاقة قابلة للتمثيل . بينما كانت أرقام الرجيع المناظرة هي ٤٣ر٤٨ ، ٨٢ر٤٣ ، ١٨٤٠ر٤ على التوالى . ويتضح من ذلك انخفاض القيمة الغذائية لهاتين المادتين الأمر الذى يجعل الإستفادة منهما محدودة خاصة في العلائق المرتفعة الطاقة .

وقـــد استخدمت النتائج المتحصل عليها في حساب معادلة الانحدار لمعرفة تأثير كل من الألياف الخام والمستخلص الخالى من النتروجين على المركبات المهضومة الكلية .

ويمكن من هذه المعادلة التنبؤ بالقيمة الغذائية كمركبات مهضومة كلية من معرفة بعض مكونات التحليل الكيمائي للعليقة .