Prediction of Metabolisable Energy Value and *in vivo* Digestibility of Some Organic Feedstuffs and Diet for Roosters

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Abstract

Digestibility coefficients of organic nutrients and metabolisable energy (ME) values of organic maize, wheat, barley and diet (complete feed mixture) were investigated in an experiment with individually followed at 64 weeks of age, 60 Hubbard roosters. In the experiment, average *in vitro* ME (MJ/kg) values were obtained 13.31-13.81 for maize; 12.42-12.99 for wheat; 10.73-11.71 for barley; 11.43-12.58 for soybean meal; 11.27 for diet. Digestibility coefficients (%) for dry matter (DM), organic matter (OM), crude protein (CP), ether extract (EE), crude fiber (CF), nitrogen free extract (NFE), neutral detergent fiber (NDF) and acid detergent fiber (ADF) were identified respectively 87.41, 88.44, 65.85, 85.42, 12.03, 94.55, 42.36 and 14.26 for maize; 84.81, 86.27, 71.67, 72.31, 25.71, 95.74, 60.79 and 35.71 for wheat; 77.77, 79.19, 72.28, 58.21, 15.92, 87.80, 44.77 and 27.36 for barley; 70.06, 72.27, 73.38, 94.31, 24.40, 95.97, 67.99 and 45.47 for soybean meal; 82.83, 86.83, 71.77, 89.55, 24.76, 93.66, 58.36 and 28.76 for diet. The average *in vivo* ME (MJ/kg) values were determined 13.98 for maize; 13.62 for wheat; 11.84 for barley; 13.67 for soybean meal; 13.35 for diet.

Key words: Organic feedstuffs and diet, metabolisable energy, digestibility

Horozlarda Bazı Organik Yemlerin ve Karma Yemin *in vivo* Sindirilebilirliğinin ve Metabolik Enerji Değerinin Tahminlenmesi

Özet

Organik mısır, buğday, arpa ve karma yemin organik besin maddelerinin sindirilebilirlikleri ve metabolik enerji (ME) değerleri, 64 hafta yaşında 60 Hubbard horozun izlendiği bir çalışma ile incelenmiştir. Çalışmada *in vitro* ME (MJ/kg) değerleri mısır için 13.31-13.81, buğday için 12.42-12.99, arpa için 10.73-11.71, soya fasulyesi küspesi için 11.43-12.58, karma yem için 11.27 olarak saptanmıştır. Kuru madde (KM), organik madde (OM), ham protein (HP), eter ekstrakt (EE), ham selüloz (HS), N'siz öz maddeler (NÖM), nötral deterjan lif (NDF) ve asit deterjan lif (ADF) için sindirim dereceleri (%) sırasıyla mısır için 87.41, 88.44, 65.85, 85.42, 12.03, 94.55, 42.36 ve 14.26, buğday için 86.27, 71.67, 72.31, 25.71, 95.74, 60.79 ve 35.71, arpa için 77.77, 79.19, 72.28, 58.21, 15.92, 87.80, 44.77 ve 27.36, soya fasulyesi küspesi için 70.06, 72.27, 73.38, 94.31, 24.40, 95.97, 67.99 ve 45.47, karma yem için 82.83, 86.83, 71.77, 89.55, 24.76, 93.66, 58.36 ve 28.76 olarak tespit edilmiştir. Ortalama *in vivo* ME (MJ/kg) değerleri ise mısır için 13.98, buğday için 13.62, arpa için 11.84, soya fasulyesi küspesi için 13.67, karma yem için 13.35 olarak belirlenmiştir.

Anahtar kelimeler: Organik yemler ve karma yem, metabolik enerji, sindirilebilirlik

Introduction

The composition of feedstuffs may vary widely due to differences in climate, soil conditions, maturity, cultivar, management, and processing factors. There is very little published research on metabolisable energy value and the digestibility of organic feedstuffs and diets (Blair, 2008). The knowledge of chemical and physical features of diets is important in judging their nutritional consequences. However, in some cases, an animal response may correspond to a combination of so many dietary factors that it becomes difficult to distinguish them. In these cases, the prediction of animal responses based only on chemical and physical analyses of diets may be limited, either because some analyses are missing or because there are difficulties in building models that take account of interaction complexities (McNab and Boorman, 2002).

The present study was conducted to estimate the metabolisable energy and *in vivo* digestibility coefficients of some organic feedstuffs and diet for roosters. Because it is important that the objective to improve sustainability of organic production.

Materials and Methods

At 64 weeks of age, 60 Hubbard roosters of similar

Table 1. Analyzed nutrient composition of organic feedstuffs, g/kg.

Nutrient composition	Maize	Wheat	Barley	Soybean meal
Dry matter	873.46	886.67	890.18	909.54
Crude ash	12.42	16.78	26.31	54.32
Organic matter	861.04	869.89	863.87	855.22
Crude protein	79.33	161.97	148.72	440.60
Ether extract	37.74	18.71	21.25	101.56
Crude fiber	21.99	24.17	74.06	68.98
N-free extract	721.98	665.03	619.84	244.09
Starch	607.05	514.50	424.24	43.48
Total sugar	50.36	52.23	47.09	118.00
Neutral detergent fiber	69.49	86.54	189.66	214.14
Acid detergent fiber	14.20	19.89	61.89	80.18

body weight were obtained. Birds were placed into individual metabolic cages and distributed into 6 groups with 12 roosters. Trial consisted of initial 2 days for preliminary adjustment to the feedstuffs and diet, followed by 5 days for excreta collection. Feedstuffs and diet were fed with150 g at 08 am each day. Feed intake was measured individually. Temperature and relative humidity was maintained within the optimum range. Lighting was 16 h light and 8 h darkness. Water was consumed *ad libitum*. Excreta were collected from individual birds daily. In all, 60 fresh excreta samples were collected in plastic trays, weighed, dried at 65 ^{0}C and stored in an air tight plastic bag in a freezer until samples were required for analysis. Feedstuffs, diets and excreta samples were ground through a 1 mm screen in preparation for chemical analysis. DM content was determined by oven-drying at 105 ^{0}C for 16 h. The Kjeldahl method was used for the analysis of total nitrogen content of diets and crude protein was expressed as nitrogen x 6.25 (AOAC, 1980). In order to estimate protein digestibility, faecal and urinary N were chemically separated according to the method of Marquardt (1983). EE content was obtained by the Soxhlet extraction using anhydrous diethyl ether. The CF content was determined using 12.5 H_2SO_4 % and 12.5 NaOH % solutions (Nauman and Bassler, 1993). NFE calculated as 100 − % (moisture + crude protein + ether extract + crude ash + crude fiber). The samples were analyzed for the NDF and ADF according to the procedures of Goering and Van Soest (1970). The samples were analyzed for starch, sugar, crude ash according to the procedures of the AOAC (1980). Estimates for ME using a prediction equation (TSI, 1991): ME, MJ/kg = 0.3431 (ether extract %) + 0.1551 (crude protein %) + 0.1301 (sugar %) + 0.1669 (starch %). Digestibility coefficient was determined by accurately measuring feed intake and excreta output.

From these measurements, together with chemical analysis for nutrients, the digestibility coefficient was calculated. The nutrient makeup of the organic maize, wheat, barley and soybean meal are detailed in Table 1. The ingredient and analyzed composition of the diets is presented in Table 2.

Table 2. The ingredient and analyzed composition of the organic diet, g/kg

Ingredient	
Maize	380
Wheat	180
Barley	300
Soybean meal	100
Vitamin premix*	5
Mineral premix*	5
Dicalcium phosphate	10
Ground limestone	15
Iodised sodium chloride	5
Analyzed composition	
Dry matter	897.93
Crude ash	43.85
Organic matter	854.08
Crude protein	141.35
Ether extract	30.42
Crude fiber	41.00
N-free extract	663.49
Starch	456.55
Sugar	32.10
Neutral detergent fiber	146.26
Acid detergent fiber	34.36

*Vitamin premix provides per kg of diet: 10 000 000 IU vitamin A, 1 500 000 IU vitamin D_3, 20 000 mg vitamin E, 3 000 mg vitamin K_3, 2 000 mg vitamin B_1, 6 000 mg vitamin B_2, 25 000 mg niacin, 8 000 mg calpan, 4 000 mg vitamin B_6, 15 mg vitamin B_{12}, 750 mg folic acid, 300 000 mg cholin cloride. Mineral premix provides per kg of diet: 80 000 mg mangan, 60 000 mg iron, 60 000 mg zinc, 5 000 mg copper, 200 mg cobalt, 1 000 mg iodine, 150 mg selenium.

Data were subjected to ANOVA using General Linear Models (SPSS 15.0®, 2006).

Results and Discussion

Results are presented in Tables 3, 4 and 5. The average *in vitro* ME (MJ/kg) values were obtained 13.31-13.81 for maize; 12.42-12.99 for wheat; 10.73-11.71 for barley; 11.43-12.58 for soybean meal; 11.27 for diet. Digestibility coefficients for DM, OM, CP, EE, CF, NFE, NDF and ADF (%) were obtained respectively 87.41, 88.44, 65.85, 85.42, 12.03, 94.55, 42.36 and 14.26 for maize; 84.81, 86.27, 71.67, 72.31, 25.71, 95.74, 60.79 and 35.71 for wheat; 77.77, 79.19, 72.28, 58.21, 15.92, 87.80, 44.77 and 27.36 for barley; 70.06, 72.27, 73.38, 94.31, 24.40, 95.97, 67.99 and 45.47 for soybean meal; 82.83, 86.83, 71.77, 89.55, 24.76, 93.66, 58.36 and 28.76 for diet. The average *in vivo* ME (MJ/kg) values were obtained 13.98 for maize; 13.62 for wheat; 11.84 for barley; 13.67 for soybean meal; 13.35 for diet. The findings about ME and *in vivo* digestibility are consistent with reported in the literature. The results are similar to NRC (1994, 2001), reported that apparent ME and true ME (kcal/kg) values as 3350 and 3470 for maize; 2900-3120 and 3167 for wheat; 2640 and 2900 for barley. Jacob et al. (2008) indicated true ME (kcal/kg) values as 3603 for organic maize and 3592 for

organic wheat. Just as Buchanan et al. (2007) specified that apparent ME and true ME (kcal/kg) values as 3089 and 3664 for organic diet. Kearl et al. (1979) reported that true ME (kcal/kg) values as 3060-3717 and 2356-2614 for wheat and soybean meal. Boldaji et al. (1985) determined apparent ME and true ME (kcal/kg) values as 3440 and 4040 for maize; 2980 and 3540-3550 for wheat; 2810-2840 and 3370-3440 for barley; 2510 and 2900 for soybean meal. Lessire (1990) stated that apparent ME and true ME (kcal/kg) values as 3324 and 3470 for maize; 2366 and 2483 for soybean meal. Nadeem et al. (2005) determined apparent ME and true ME (kcal/kg) values as 3244 and 3672 for maize; 3106 and 3561 for wheat; 2544 and 2957 for soybean meal. In the present study, organic feedstuffs and diet consumptions, live weights of roosters and the amounts of excreta obtained in normal physiological limits (Leeson and Summers, 1997). Between *in vivo* and *in vitro* ME correlation coefficient (r) for organic feedstuffs and diet were obtained 0.749 (p<0.01). These results indicate that harmony between *in vivo* and *in vitro* ME values.

In conclusion, further, the amino acid profile and digestibility of organic feedstuffs may need to be considered and the combination of feedstuffs in the poultry diets and during the life of animals.

Table 3. In vitro ME values of organic feedstuffs and diet

	Maize	Wheat	Barley	Soybean meal	Diet
ME, MJ/kg[1]	13.31±0.01	12.42±0.11	10.73±0.04	12.58±0.04	11.27±0.07
ME, kcal/kg[1]	3182±3.0	2969±26.8	2564±10.1	3006 ±10.4	2694±16.2
ME, MJ/kg[2]	13.81±0.01	12.99±0.02	11.71±0.02	11.43±0.02	-
ME, kcal/kg[2]	3300±2.9	3106±4.3	2798±3.6	2732±3.6	-

[1]ME values were calculated according to Härtel (1977) and the equation which is suggested/accepted European Union Commission (Commission Regulation (EC) No 152/2009). [2]ME values were calculated according to Janssen (1979; 1989). ± Standard error

Table 4. Digestibility coefficients and in vivo ME values of organic feedstuffs and diet

Digestibility coefficients, %	Maize	Wheat	Barley	Soybean meal	Diet
Dry matter	87.41±0.69	84.81±1.55	77.77±1.62	70.06±3.75	82.83±1.33
Organic matter	88.44±0.66	86.27±1.36	79.19±1.50	72.27±3.47	86.83±1.10
Crude protein	65.85±1.21	71.67±2.09	72.28±2.44	73.38±1.33	71.77±2.88
Ether extract	85.42±0.84	72.31±2.42	58.21±2.55	94.31±0.67	89.55±1.05
Crude fiber	12.03±0.12	25.71±2.98	15.92±3.02	24.40±2.36	24.76±4.21
N-free extract	94.55±0.46	95.74±0.52	87.80±1.22	95.97±0.73	93.66±0.84
NDF*	42.36±0.34	60.79±1.43	44.77±1.11	67.99±0.94	58.36±2.26
ADF*	14.26±0.19	35.71±1.91	27.36±1.59	45.47±1.58	28.76±4.04
ME$_{invivo}$,MJ/kg[1]	13.98±0.06	13.62±0.12	11.84±0.17	13.67±0.12	13.35±0.12
ME$_{invivo}$,kcal/kg[1]	3340±15.4	3254±29.1	2828±40.9	3266±29.7	3189±28.6

*NDF, neutral detergent fiber; ADF, acid detergent fiber. [1]ME, Metabolisable energy values (MJ/kg, kcal/kg) calculated according to Härtel (1977). ± Standard error

Table 5. The initial (IW) and final body weights (FW) of the roosters, daily feed intake (FI) and total collected excreta (TCE)

	Maize	Wheat	Barley	Soybean meal	Diet
IW, g	3889±146.7	4314±115.4	3953±280.2	3993±312.7	4218±180.5
FW, g	3890±138.1	4282±148.5	3835±243.5	3773±193.0	4283±108.8
FI, g/day	133.7±7.0	148.0± 0.8	142.8±2.9	125.0±8.2	142.1±3.7
TCE, g/day	49.4±4.0	58.5±7.1	91.4±7.8	117.5±10.5	64.4±6.4

± Standard error

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