Nutritional characteristics of grains fed to Canada Geese

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Introduction

Wildlife agencies in the United States have frequently provided crops, especially cereal grains, for supplementary feeding of migrating or wintering geese. At certain times, these crops constitute a primary food source. An understanding of food quality relative to the seasonal nutritional requirements of geese must be considered when selecting a crop to plant. Recognized variations in food quality and in digestive processes among poultry have led to the development of tables (e.g. Ensminger and Olentine 1978) listing basic nutritional requirements and the digestibility of feeds. Comparable data for waterfowl are generally lacking; only gross nutritional recommendations have been reported (Holm and Scott 1974). The lack of data concerning protein digestibility and metabolism by geese may be particularly important because protein, rather than energy, may be the constituent limiting reproduction in birds (Robbins 1981).

With this in mind, we supplied monotypic rations of corn, milo (sorghum), and wheat kernels to Canada geese *Branta canadensis interior* with the intent of defining coefficients of utilisation for grains according to season (winter versus spring). Corn and milo are the principal supplementary crops planted on waterfowl management areas in southern Illinois, U.S.A. and the kernels of each may be supplied as emergency rations during periods of severe winter weather. Wheat is commonly grown in the western U.S. and is available to geese as waste grain throughout the winter.

Methods

Ten adult Canada Geese live-trapped at Crab Orchard National Wildlife Refuge, Illinois, in October 1981, were confined to individual elevated, outdoor pens (1.8 m x 1.5 m x 1.0 m) constructed of welded wire. Geese were supplied water and a commercial hen feed (hereafter called basal ration) consisting of whole and cracked corn (87%), sunflower seeds *Helianthus annuus* (5.6%), wheat (4.5%), milo (2.9%), and grit. Basal ration and test grains were supplemented with vitamins A, D, niacin, and riboflavin. Prior to the initiation of the winter trial, two 22.7 kg bags of each test grain were mixed and the resulting 45 kg composite was used for both winter and spring trials.

The winter feeding trial consisted of first supplying each goose a mixed diet (50:50) of basal ration and test grain for one week, followed by a maintenance-level ration of test grain supplied for three or four days. This schedule permitted geese to maintain or gain weight depending on their respective rates of consumption, and to adjust their behaviour to monotypic diet. We presume that geese having fed *ad libitum* on basal ration for at least 30 days were physiologically acclimatised to grain consumption. Actual feeding trials employed the total collection method (Schneider and Flatt 1975). Geese were supplied with 600 g (wet weight) of grain per 3-day test period, except with milo where time limitations restricted the winter trial to two days. Procedures used during spring trials were comparable, except that pre-trial conditioning was restricted to three or four days and the milo trial was extended to three days. Geese were maintained on basal ration between test periods.

Excreta and spilled grain were collected from a metal tray suspended beneath each pen and sorted. Each faecal sample minus the grain was air dried at 24°C for 24 hrs to facilitate handling, weighed, and then frozen at −20°C for subsequent analysis. Grain remaining in individual feed trays was removed at the end of each trial, combined with the spilled grain, air dried (24°C) for 48 hrs, and weighed to the nearest 0.1 g.

A 200 g random sample was collected from each 45 kg composite of test grain and frozen for subsequent chemical analysis (Table 1). Grain samples were ground in a Wiley mill with a 1 mm mesh screen. Dry matter (DM) was determined by drying duplicate samples in vacuo to a constant weight at 100°C (Horwitz 1980: 125). Gross energy (GE) was estimated using a Parr

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Table 1. Dry matter, crude protein, and gross energy content of corn, milo, wheat, and basal ration fed to Canada Geese, 1st January through 11th May 1982. Crude protein and gross energy expressed on a dry matter basis. See text for composition of basal ration.

Ration	Dry matter (%)	Crude protein (%)	Gross energy (kcal/g)
Corn	91.2	8.8	4.40
Milo	86.3	10.4	4.47
Wheat	88.5	14.3	4.41
Basal ration	89.4	9.7	4.52

adiabatic oxygen bomb calorimeter. Nitrogen content was determined using a modified Kjeldahl technique involving sample digestion with a mixture of phosphoric and sulfuric acids (5:100). Crude protein (CP) concentration was estimated as 6.25 times percent nitrogen. Faecal samples were dried overnight at 50°C to a moisture content of 5 to 8%. After being ground in a Wiley mill and mixed, samples were analysed as described above for dry matter, crude protein and gross energy content. The uric acid content of excreta was determined according to Marquardt (1983).

Coefficients of utilisation were calculated for dry matter, energy, and crude protein to reflect the percent of each which was metabolisable (dry matter and energy) or digestible (crude protein). Coefficients for dry matter and energy were calculated as intake minus faecal and urinary loss, expressed as a percent of intake. Coefficients for crude protein were calculated as intake minus faecal crude protein, expressed as a percent of intake. Faecal crude protein was calculated as the loss in the excreta (faeces and urine) minus the crude protein equivalent of uric acid excreted. The calculation for crude protein utilisation differed because excess nitrogen from digested protein is excreted in the urine which, in birds, becomes mixed with the faeces. Thus, failure to correct for uric acid excretion would have resulted in seriously low estimates of utilisable crude protein. In spite of the uric acid correction, however, our estimates of crude protein digestibility are somewhat low to the extent that other nitrogenous compounds are excreted in the urine. For simplicity, all coefficients are herein referred to as digestibility coefficients even though those for dry matter and energy actually account for small losses of dry matter or energy occurring in the urine.

We selected three variables to characterise the three grains in terms of protein nutrition: percent digestibility; digestible crude protein (mg CP/g DM); and relative nitrogen retention (g N retained/g digestible CP). The first variable reflects the ease of degradation; the second indicates whether the grains differ regarding the concentration of potentially useable proteins. Clearly the two variables are interdependent since digestible CP per g DM is a function both of ease of digestion and of total protein content. The third variable, relative nitrogen retention, may indicate whether the grains differ regarding the quality of protein digested. A grain with a poor balance of amino acids might be expected to yield a lower relative nitrogen retention because one or more amino acids might limit useability of other amino acids.

Ambient temperatures (daily high/low) were recorded at the Southern Illinois Airport, 5 km East of Carbondale. Unavoidable changes in numbers of geese available from trial to trial precluded statistical comparisons of utilisation coefficients among grains and by seasons.

Results and discussion

Seasonal differences in percent digestibility were apparent between winter and spring (Table 2), but these were minor in nature and did not follow a uniform trend. Both corn and wheat showed a small decrease in percent digestibility from winter to spring, whereas in milo digestibility increased somewhat from winter to spring. Among factors possibly related directly or indirectly to seasonal differences in digestibility are dry matter intake (DMI), ambient temperature, and the physiological state of the goose. Changes in the latter two might manifest their effects by influencing dry

Table 2. Dry matter intake (DMI) and percent digestibility of dry matter (DM), gross energy (GE), and crude protein (CP) for 3 grains fed to adult Canada Geese during winter and spring, 1982. Sexes are pooled. Values given as Mean ± SD.

Grain	Trial date	Mean temp. (°C)	N	X DMI (g/day)	Digestibility (%) DM	GE	CP
Corn	6–9/1	−3	9	108±35	91±1.6	92±1.7	83±3.6
	23–26/4	13	8	122±55	89±2.6	89±1.0	77±5.4
Overall			17	115±45	90±2.3	91±2.4	80±5.3
Milo	28/2–2/3	4	9	143±35	87±1.1	88±1.1	77±3.2
	3–6/5	21	7	116±45	88±1.0	89±1.6	83±2.9
Overall			16	131±41	88±1.2	89±1.4	79±4.9
Wheat	19–22/1	2	7	172± 9	89±1.4	89±1.7	89±1.9
	8–11/5	16	4	106±29	84±1.3	84±1.6	76±3.0
Overall			11	148±38	87±3.1	87±3.0	84±6.9

matter intake. Experiments with farm animals have shown that, in general, digestibility decreases as the level of feeding increases (Schneider and Flatt 1975). Our data, however, do not reveal a consistent relationship between dry matter intake and digestibility. As dry matter intake increased between seasons, the digestibility of corn and milo decreased, but that of wheat increased (Table 2). Digestibility also may vary directly with crude protein level (Schneider and Flatt 1975) and inversely with crude fibre (CF) content (Adolph and Mao 1934). It is doubtful, however, whether either of these variables accounts for the digestibility differences observed among grains; gross energy and dry matter coefficients varied inversely with crude protein content (Table 1), and there was no consistent trend between any of the coefficients and respective crude fibre content, namely, corn, 2.9%, wheat, 2.5%, milo, 2.2% (Crampton and Harris 1969).

Utilisation coefficients for gross energy of corn (91%) and milo (89%) were similar to the 87% and 88%, respectively, calculated from data on Embden geese reported by Storey and Allen (1982). However, our value for wheat (87%) was notably greater than the 78% indicated by their data.

As an energy source for Canada Geese, corn and milo were essentially comparable and both superior to wheat, given an equivalent rate of consumption (Table 3). However, regardless of which grain was consumed, energy assimilation consistently exceeded the estimated daily existence energy requirements of the geese during the feeding trials; existence energy being calculated using Kendeigh's (1970) equations for non-passerines and assuming an average live weight of 3.5 kg. When fed to poultry, corn and milo generally yield 3.4–3.9 and 3.4–3.7 kcal/g DMI, respectively, whereas wheat supplies 2.8–3.3 kcal/g DMI (National Research Council 1977; Ensminger and Olentine 1978). Storey and Allen (1982) reported apparent metabolisable energy derived by Embden geese from corn, milo, and wheat as 4.02, 3.85, and

Table 3. Characterisation according to energy and protein metabolism of 3 grains fed to adult Canada Geese during winter and spring, 1982. Samples pooled by sex and season. Values given as Mean ± S.D. Abbreviations: Dry Matter Intake (DMI); Dry Matter (DM); Crude Protein (CP); Digestible Crude Protein (DCP).

Grain	Geese (N)	Apparent metabolisable energy (kcal/g DMI)	Digestible crude protein (mg CP/g DM)	Relative N retention (g N/g DCP)
Corn	17	3.97±0.11	70.3±4.6	0.12±0.02
Milo	16	3.96±0.06	82.5±4.6	0.09±0.01
Wheat	11	3.85±0.13	120.4±9.8	0.14±0.02

3.35 kcal/g, respectively. Sugden (1971, 1973) listed apparent metabolisable energy coefficients of 3.52 and 3.07 kcal/g DMI for hard wheat (gross energy, 4.42 kcal/g) fed to Mallard *Anas platyrhynchos* and Blue-winged Teal *A.discors*.

Although energy has generally been viewed as the principal "currency" influencing food selection and ingestion rates in animals (Pyke *et al.* 1977), organic nitrogen content and/or amino acid composition may be as important. The three grains differed in digestible crude protein with wheat supplying 120mgCP/g DM compared to 83 for milo and 70 for corn (Table 3). Wheat also surpassed the other two grains in relative nitrogen retention, averaging 0.14 g N/g digestible CP. Whereas milo was intermediate in digestible crude protein, it ranked lowest in relative nitrogen retention, with a value of 0.09 g N/g digestible CP. Robbins (1981) estimated the minimum nitrogen intake necessary for maintenance of birds to be 0.43 g N/kg 0.75/day (or 2.69 g CP/kg 0.75/day). This would amount to a daily intake of 6.86 g crude protein for a 3.5 kg goose. Based on composition (Table 1) and mean dry matter intake (Table 2), daily crude protein intakes were 10.1, 13.6, and 21.2 g from corn, milo, and wheat, respectively. Thus all three grains supplied nitrogen in excess of estimated daily maintenance needs.

The amino acid compositions of the three grains were not determined specifically for this trial; however, average values are available in the literature (e.g. National Research Council 1977: Table 19). Judging from reported values, all the grains are deficient in lysine, arginine, cystine, or methionine. Amino acid deficiencies may have been accommodated, however, given the observed rates of grain consumption.

If the three grains are evaluated strictly as an energy source, and thus without regard to total nutritive value or cost, then corn appears most appropriate; it was also preferred over the other two grains by the geese. When ambient conditions were such as to limit the foraging activities of free-flying Canada Geese wintering in the Carbondale area, our penned geese fed basal ration continued to consume all of the corn, but, as usual, left some milo and wheat in the feed trays. Presumably they would have eventually consumed both had we not provided them with further fresh rations. Free-flying geese wintering in southern Illinois also prefer corn to milo, milo being used most extensively in the late spring after the corn is depleted. As a crop, however, none of the three is entirely satisfactory if supplied alone. Thus current management strategy should be to provide a variety of natural and cultivated foods to maximise the possibility that the nutritional requirement of the geese will be met.

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Summary

Corn, milo, and wheat kernels were fed to penned Canada Geese during winter and spring to define seasonal coefficients of utilisation for grains. Corn and wheat showed a minor decrease in percent digestibility from winter to spring, whereas the digestibility of milo increased somewhat. Corn, which was preferred by geese over the other two grains, exceeded wheat in apparent metabolisable energy, produced the lowest digestible crude protein, and was intermediate in relative nitrogen retention. Wheat produced the lowest apparent metabolisable energy, but was highest in digestible crude protein and relative nitrogen retention. Milo equalled corn in apparent metabolisable energy, was intermediate in digestible crude protein, and lowest in relative nitrogen retention. The results suggest that as an emergency energy supply, corn and milo are equally suitable and both superior to wheat. As a crop, however, none of the three is entirely satisfactory if supplied alone.

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