December 1985

THE EFFECT OF DIETARY PROTEIN AND FEED SIZE ON THE ASSIMILATION EFFICIENCY OF STARLINGS AND BLACKBIRDS

Daniel J. Twedt
Denver Wildlife Research Center, U.S. Fish and Wildlife Service, Denver, CO

THE EFFECT OF DIETARY PROTEIN AND FEED SIZE ON THE ASSIMILATION EFFICIENCY OF STARLINGS AND BLACKBIRDS

Daniel J. Twedt, Denver Wildlife Research Center, U.S. Fish and Wildlife Service, Denver, CO 80225 (Present address: Caesar Kleberg Wildlife Research Institute, Texas A&I University, Kingsville, TX 78363)

Abstract: Starlings (Sturnus vulgaris) were fed 3 feed sizes and 3 protein levels of swine feeds to determine metabolizable energy and assimilation efficiency. Metabolizable energy (12 kcal/g of diet consumed) and assimilation efficiency (3296 of gross energy intake) were independent of feed size. A 46% crude protein diet was 5196 assimilated and yielded more energy per gram of diet consumed than a 2196 crude protein diet which was only 35% assimilated. Starlings failed to maintain their body weight on a cracked corn diet containing 14% crude protein. Feeding behaviors of starlings due to their assimilation efficiencies are discussed and contrasted with the feeding behaviors sad assimilation efficiences of Icterine blackbirds.

Introduction

During the winter, feedlot operators may suffer considerable loss of livestock feed to starlings (Feare 1980, White 1980). Depredations appear more severe at hoglots than at other livestock feeding areas (Dolbeer et al. 1978, White 1980). Starlings prefer high protein pellet feeds over grains (Basset et al. 1968, Crabb 1978) and 4.0-4.8 mm diameter pellets over smaller or larger feed sizes (Spencer 1961, Twedt 1984). Also, the efficiency of assimilation of insects and poultry pellets by starlings differs markedly (Thompson and Grant 1968, Taitt 1973).

My observations on captive starlings indicated possible differences in assimilation among swine feeds of different crude protein contest and physical sizes. My study was conducted to determine the efficiency of assimilation and the metabolizable energy obtained by starlings among swine feeds of 3 crude protein contents and among 3 feed sizes.

I am grateful to J. E. Winstead, Western Kentucky University for his valuable assistance and calorimetry equipment. I also thank B. R Ferrell, J. F. Glahn. J. F. Heisterberg, and R T. Sterner for their advice and editorial reviews and S. J. Silvey for her help in manuscript preparation.

Methods

Independent tests were conducted to compare the assimilation efficiency of starlings fed swine feed of different physical size and crude protein content. Commerical swine feeds (Pan-American Mills, Bowling Green, Kentucky or United Feeds, Sheridan, Indiana) consisted of ground corn with soybean protein, vitamins and minerals added. Mention of a commerical product constitutes no endorsement by the U. S. Government. Data collected on 9 individually caged, adult starlings (3 starlings/feed size) from 3 24-hour tests during April and May 1982 compare assimilation efficiences of 3 feed sizes. Test feed sizes, marketed at not less than 15% crude protein, included ground meal, 4.8 mm diameter pellets, and 9.5 mm diameter pellets.

Data collected for 16 starlings (5-6 starlings/ protein level) from 10 24-hour test periods during April and May 1983, compare assimilation efficiences among 3 feeds of different crude protein content Feeds included cracked corn (14% crude protein), 4.8 mm complete hog ration pellets (2190 crude protein), and 4.8 mm hog supplement pellets (46% crude protein).

After capture in decoy traps (9 x 3 x 1.5 m) near Bowling Green, Kentucky, during January and February 1982 and 1983, starlings were maintained on poultry feed crumbles until transferred individually into metabolic cages (53 x 46 em cylinders or 30 x 50 x 40 cm cubes). Starlings, provided with *ad libitum* water, acclimated to metabolic cages and test feeds for a minimum of 10 days prior to data collection. Natural light conditions and fluctuating ambient temperatures (average daily temperatures X±SE = 16.5±5°C) characterized tests comparing different sizes. However, tests comparing different protein contents were conducted under a controlled 12-hour light/12-hour dark cycle at between 18° and Z3°G

After fasting from 1600 h the day prior to testing, individual starlings received 100 g of test feeds at 0800 h with unconsumed feed removed at 1600 h. Recovered feed and excreta, oven-dried to a constant weight at 70°C, were ground with a WileyR Mill, pelleted, and their energy contents measured using a ParrR oxygen-bomb calorimeter. Since all starlings had less than a 496 change in body weight during these tests, nitrogen corrections used to compensate for excess changes in body weight were not employed and apparent or classical metabolizable energy (ME) values are reported.

Estimates of gross energy content (GE) for feeds and excreta represent a minimum of 4 calorimetric determinations. One way ANOVA compared consumption, excretion, energy values, and assimilation efficiences among feed sizes and between protein contents.

Livestock Nutrition Laboratory Services, Columbia, Missouri, determined the proximate chemical composition of feeds and excreta using standard analytical techniques (Horwitz 1975). Projection of these data yielded apparent digestion coefficients, GE, ME, and assimilation efficiency (Thompson and Grant 1968). Paired Student's t-tests compared between methods of determination.

Results

Starlings consumed about 23.5 g of each feed size and excreted 18.2 g per day (Table 1). Neither intake nor output differed significantly (P>0.2) among feed sizes. Bomb calorimetry indicated a mean GE content of 3.83 kcal/g for all feed sizes and a mean GE content of 3.4 kcal/g for their excreta. No significant (P>0.12) differences were detected in GE among feed sizes, among GE intake, nor among GE output

Daily energy requirements (kcal retained/day) differed at the 0.02 level of probability among feed sizes (Table 2). However, this difference probably reflects the combined effects of small differences in the consumption of feeds of slightly different energy contents, since neither ME/g of diet (1.Z kcal/g) nor ME/g of body weight (Table 2) differed significantly (P>0.13) among feed sizes. Approximately 2490 of dry matter and 320 of GE ingested was retained by starlings regardless of feed sine. Adjustment of ME values for residual ash, 5% for ground meal and 4.8 mm pellets, and 7% for 9.5 mm pellets, yields slightly *higher ME/g* of diet than reported.

Proximate chemical composition analyses of the feed and excreta (Table 3) indicate crude fat (ether extract), with a digestion coefficient of 6790, was the only fraction of

Table 1. Mean daily intake and output of dry matter (g) and gross energy (kcal) by starlings on swine feeds

N'

BIRDS		FEED				:EXCRETA		
Mean average weight	Sex M,F	type	wokfa~;et g	intake g	intake kcal	kcal /g of exreta	output g	output kcal
Series I								
75•8	2,1	ground meal	3.87+0,08	24.1+1.3	93.3+5,0	3.54_+0 .02	18.5_+1.3	65.3_+5.0
78.5	1,2	4.8 mm pellet	3.86+0.06	25.7+2,2	99.3_+8.4	3.42_+0 .13	20.1_+2.4	68.7+7.9
81.6	1,2	9.5 mm pellet	3.76+0.07	20.8+1.6	78.3_+6.1	3.27_+0 .02	15.9_+1,6	_ 52.0_+5.1
			1.58(0.25)	2.05(0.21)	2.63(0.15) .	3.1 3(0.12)	1.33(0.33)	2.07(0.21)
Series II								
82.0	2,3	21% protein	3.86+0.06	24.8+1.9	95.5+7.1	3 5 _+ . 2 0.05	17.8_+1.7	63.0+6.3
85.5	2,4	46% protein	3.88+0.02	22.2+1.1	86.2_+4.2	2 8 + . 6 0.04	14.7+0,7	_ 41.9+2.4
t (P)			0.31(0.38)	1.23(0.12)	1.17(0.14)	0 .91(0.19)	- 1.80(0.05)	_ 3.16(0.01)

***Table* 2. Mean *metabolizable* energy and assimilation efficiency of swine feeds *by* starlings determined _ *by bomb* calorimetry.**

	Metabolizable Energy		Assimilation Efficiency	
Feed Type	kcal retained/day	kca g body weight	% dry matter retained	% kcal retained
Series I				
Ground meal	27.9+2.4	0.37+0.03	23.5+2.4	30.0+2.5
4.8 mm pellet	30.7+1.0	0.39+0.02	22.2±3.5	31.2+2.2
9.5 mm pellet	26.3+1.2	0.32+0.01	24.0+2.4	33.8±1.7
F (P)	8.58 (0.02)	2.85 (0.13)	0.10 (0.91)	0.81 (0.49)
Series II				

Table 3. Proximate chemical composition (PC)a and apparent digestion coefficients (DC) of swine feeds with projected metabolizable energy *(ME)* and assimilation efficiency by starlings.

Composition and Energetics	Ground meal	Series I 4.8 mm pellet		9.5 mm pellet	Series II 21~ 46% protein protein
GE Intake (kcal)	87.3	95.4	77.0	92.6	72.0
Crude Protein					
PC	16.1	21.3	21.0	20.8	45.7
DC%	12.8	30.9	27.3	42.4	35.4
ME (kcal)	1.9	6.5	4.6	8.4	13.8
Crude Fat					
	3.5	3.6	2.6	3.9	4.2
DC%	62.5	77.8	60.0	77.9	71.6
ME (kcal)	4.7	6.5	2.8	7.0	6.2
Nitrogen Free Extract			-		
	65.7	62.2	65.6	62.0	22.5
DC%	25.3	20.0	15.3	24.0	50.0
ME (kcal)	15.6	12.5	15.3	14.5	9.8
Crude Fiber					
	5.9	5.8	4.8	6.8	10.3
DC%	___	___	___	2.9	51.1
ME (kcal)	---	---	---	0.1	2.4
Ash					
	8.8	7.1	6.0	6.5	17.3
Mean Daily ME (kcal)		22.3	25.5	22.7	30.0 32.2
ME (kcal/g-dm)	0.92	0.99	1.09	1.21	1.45
Ass iml lation Efficiency (% kcal)	25.5	26.7	29.5	32.4	44.7

a Determined by Livestock Nutrition Laboratory Services, Columbia, Missouri.

swine feed highly utilized by starlings. Crude protein and nitrogen-free extract digestion coefficients of 24% and 20%, respectively, indicate moderate utilization.

Starlings failed to maintain their body weight and ultimately died when maintained on cracked corn with a crude protein content of 13.6% Therefore, no valid data were obtained for starlings on this low crude protein diet Bomb calorimetry (Table 1) indicated no significant (P=0.38) difference in GE (kcal/g) between 21% and 46% crude protein diets. Daily intake by individual starlings averaged 23.4 g or 90.8 kcal and did not differ significantly (P>0.12) between feeds.

Excreta from the 46% crude protein diet contained significantly (P<0.01) less GE than excreta from the 21% crude protein diet Additionally, starlings on 46% crude protein diet **excreted significantly (P--4.05) less dry matter** than starlings on the 21% crude protein diet

Daily energy requirements (kcal retained/day and kcal/g of body weight) differed significantly (P<0.01) between crude protein contents; the 46% crude protein diet yielding more ME thaw the 21% crude protein diet (Table 2). Assimilation efficiences (Table 2) also differed significantly (P<0.01) with both the dry matter and the energy content (kcal) of the 46% crude protein diet assimilated more efficiently than the 21% crude protein diet Bomb calorimetry yielded ash residues of 5% for the 2196 crude protein diet and 1496 for the 46% crude protein diet Adjustment of the 46% crude protein diet for its high ash content reduces its assimilation efficiency (kcal) from 51.4% to 47.290.

Projections from proximate chemical compositions (Table 3) again establish crude fat as the most readily assimilated fraction. Proximate chemical' composition estimates of GE intake, mean daily ME, ME/g of diet, and assimilation efficiency consistently and significantly (P<0.03) underestimate those obtained by bomb calorimetry.

Discussion

Since size did not significantly alter digestive efficiency, previously reported selection among feed sizes by starlings (Twedt 1984) appear unrelated to the energy obtained from these rations. The 26 and 33 kcal/day required by starlings compares favorably with the 18 to 33 kcal/day reported by Brenner (1965) and Thompson and Grant (1968). These appear to conform to the predictive models for standard metabolic rates of passerine birds based on body weight (Lasiewski and Dawson 1967). While 44 kcal/day required for starlings on the 46% crude protein diet exceeds predictive models, it is similar to the starling's requirement of 43 kcal/day as determined by Taitt (1973). Although the increased energy demands of starlings on the 46% crude protein diet were unexpected, these birds did not gain weight and I assume they expended this energy for metabolism.

The assimilation of foods by birds is influenced by their crude protein content (Martin 1%8). Starlings reportedly assimilate 4096-45% of tile energy in 2496 crude protein poultry feed; 63% of the energy in meat scraps (about 53% crude protein) and an even greater 7396-93% of the energy in 50% crude protein mealworms (Thompson and Grant 1%8, Taitt 1973). Together with my findings, these reports indicate that as the crude protein content of food increases, the starling's assimilation efficiency increases. However, it seems that the starling's assimilation efficiency is dependent on protein quality as well as its quantity. Because of these different assimilation efficiences, starlings must consume more than twice the weight of lower crude protein vegetable-based foods (18-24 g) as higher crude protein animal-based foods (6 to 10 g) to meet their energetic demands. Assimilation differences may partially explain the preference of starlings for insects (Bruns and Haberkorn 1960) and their selection of high protein pelleted feeds from a ration of mixed grains (Besser et al. 1968, Crabb 1978).

Conversely, Icterine blackbirds utilize grains very efficiently (Table 4). Red-winged blackbirds *(Agelaius ploeniceus)* assimilate only 7096 of the energy in mealworms (Thompson and Grant unpublished), and 66 to 72% of that in poultry pellets. However, when cracked corn is consumed, they retain from 88-9296 of the ingested energy (Brenner 1%6). Similarly, brown-headed cowbirds *(Moiothrus ater/,* excrete only 170 of ingested energy from cracked corn for as 83% assimilation efficiency (Twedt unpublished).

Primarily insectivorous during the breeding season (Bent 1958), both starlings and blackbirds consume feed at livestock feedlots in winter (White 1980). Nevertheless, in Ohio, from August through October, the diet of starlings consisted of 30.396 insects, while the diet of red-winged blackbirds and brown-headed cowbirds consisted of only 7.6 and 3.49:0 insects, respectively (Williams and Jackson 1981). Similarly, White (1980) found the November to mid-March diet of starlings in Tennessee to be 3396 insects while common grackle *lQuiscaius guiscuial,* red-winged blackbird, and brown-headed cowbird diets contained only 1496, 596, and 496 insects, respectively (Table 5).

Different assimilation efficiencies may account for the different fall and winter food habits of blackbirds and starlings. Because of their poor assimilation efficiency on grains, starlings consume a higher percentage of insects in their winter diet than do blackbirds, since the blackbirds' high assimilation efficiencies allow them to efficiently exploit grains. During cold weather, the limited availability of insects and the high crude protein content of livestock feeds, as opposed to field grains, may increase the use of feedlots by starlings (Bailey 1966). Conversely, blackbirds, because of their high assimilation efficiency of grains, may forage more on unharvested grains than in feedlots.

Because of their poor assimilation efficiency, starlings in feedlots consume greater quantities of food thaw blackbirds. Thus, the reason for selective feeding by starlings, and the basis for the greater economic losses which are attributed to starlings than a similar number of blackbirds (Besser et al. 1%8), may be their assimilation efficiency.

Table 4. Comparative assimilation efficiencies of different crude protein feeds by starlings and red-winged blackbirds.

		% Assimilation Efficient	
Food Type	% Crude Protein	Starling	Redwing
Cracked Corn	14		88-92
Swine Feed	21	26-35	
Poultry Pellets	24	40-45	
Hog Supplement	46	45-51	
Meat Scraps	53	63	.

Table 5. Animal matter in the diets of starlings, red-winged blackbirds, and brown-headed cowbirds.

Season	Starling	Redwing	Cowbird
Aug - Oct l	30%	8%	3%
Nov - Mar 2	33%	5%	4%

Literature Cited

Bailey, E. P. 1966. Abundance and activity of starlings in winter in Northern Utah. Condor 68:152-162.

Bent, A. G 1958. Life histories of North American blackbirds, orioles, tanagers, and allies. Smithsonian Inst, U.S. Natl. Mus Bull. 211. U.S. Government Printing Office, Washington, D.C.

Hesser, J. F., J. W. DeGrazio, and J. L. Guarino. 1968. Costs of wintering starlings and red-winged blackbirds at feedlots. J. Wildl. Manage. 32:179-180.

Brenner, F. J. 1965. Metabolism and survival time of grouped starlings at various temperatures. Wilson Bull. 77(4):388- 395.

Brenner, F. J. 1966. Energy and nutrient requirements of the red-winged blackbird. Wilson Bull. 78(1):111-120.

Burns, H. and A. Haberkorn. 1960. Beitrage zur Ernahrungsbiologie des Stars *(Sturnus vul*garisl. Ornithol. Mitt 12:81-103.

Crabb, A. G 1978. Bird damage research at the University of California, Davis. Proc. Vertebr. Pest Control Conf., Sacramento, Calif. 8:36-39.

Dolbeer, R A., P. P. Woronecki, A. R Stickley, Jr., and S. B. White. 1978. Impact on agriculture of a winter population of blackbirds and starlings. Wilson Bull. 90(1):31-44.

Feare, G J. 1980. The economics of starling damage. Pages 39-55 /n: Bird Problems in Agriculture (E. N. Wright, I. R Inglis. and G J. Feare, Eds.), Croydon: British Crop Protection Council.

Horwitz, H. (Ed.) 1975. Methods of analysis. Assoc. of Official Analytic Chm. 12th ed. Washington, D.G

Lasiewski, R G, and W. R Dawson. 1967. A re-examination of the relation between standard metabolic rate and body weight is birds. Condor 69:13-23.

Martin, E. W. 1968. The effects of dietary protein on the energy and nitrogen balance of the tree sparrow *(Spizella arborea arboreal.* Physiol. Zool. 41:313-331.

Spencer, A. 1961. Size of food particles preferred by starlings. J. Colo-Wyo. Acad. Sci. 5:38-39 (Abstract).

Taut, M. J. 1973. Winter food and feeding requirements of the starling. Bird Study 20:226-236.

Thompson, R D., and G V. Grant 1968. Nutritive value of two laboratory diets for starlings. Lab. Anim. Car. 18(1):75- 79.

Twedt, D. J. 1984. Livestock feed sizes for reducing starling depredations at feedlots in Kentucky, U.S.A. Prot. Ecol. 6(3):Z33-240.

White, S. B. 1980. Bioenergetics of large winter-roosting populations of blackbirds and starlings. Ph.D. Dissertation, Ohio State University, Columbus, Ohio. 150

Williams, R E., and W. B. Jackson. 1981. Dietary comparisons of red-winged blackbirds, brown-headed cowbirds, and European starlings in North-Central Ohio. Ohio J. Sci. 81(5):217-225.