NUTRIENT UTILIZATION BY AND DIET PREFERENCE OF AMERICAN WHITE PELICANS (*PELECANUS ERYTHRORHYNCHOS)* WHEN OFFERED DIETS OF CHANNEL CATFISH AND(OR) GRASS CARP

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Abstract

Twelve pelicans (*Pelecanus erythrorhynchos)* captured in northeast Mississippi were used to determine nutrient metabolism when consuming channel catfish (*Ictalurus punctatus*) and(or) grass carp (*Ctenopharyngodon idella*). Another objective was to determine the dietary preference of pelicans when allowed to consume catfish and carp. For the 7-day metabolism trial pelicans were allotted to one of three treatment diets (4 birds/diet): catfish only, carp only or both (50 % catfish and 50% carp). Feces, samples of fish offered and orts were collected and analyzed for nutrient content to determine nutrient metabolism. Pelicans receiving catfish or both (4.41 % and 5.10 % body weight/day (BW/day), respectively) consumed less ($P = 0.0107$) dry matter as a percent of body weight than pelicans receiving carp (6.06 % BW/day). Pelicans consuming catfish metabolized less ($P < 0.05$) dry matter, organic matter and energy (42.2, 52.0, 74.4 %, respectively) compared to pelicans consuming both (54.8, 64.1, 81.2 %, respectively) or carp (60.0, 68.0, 83.4 %, respectively). Pelicans eating only catfish (2.5 %) tended to metabolize less ($P = 0.0579$) protein than pelicans eating only carp (28.1 %). However pelicans eating both (22.5 %) were intermediate to those eating catfish or carp for protein metabolism. For the 2-day preference trial the four pelicans that were allotted to the diet consisting of both catfish and carp for the metabolism trial were used to determine preference for catfish or carp (based on intake). Pelicans preferred ($P = 0.001$) carp (89 % of diet) compared to catfish (11 % of diet). Pelicans ate more carp and digested nutrients from carp more efficiently than they did for catfish.

Introduction

The American White Pelican (*Pelecanus erythrorhynchos)* is a large piscivorous bird found in Northern America, flying to Southern coasts for the winter months. Body size ranges from 127 to 170 cm with a beak which measures from 33 to 37 cm for males and from 26 to 33 cm for females. There has been great loss of pelican habitat, mostly due to soil erosion, flooding, drought and human infringement.[2,5,10] In non-captive settings, pelicans consume a variety of fish species such as catfish and carp.[5,8] Additionally, pelican feeding of catfish has been linked to reported loses in fish production.[3,4,6] However, in captivity pelicans are frequently fed a single species of fish. It is important to determine the nutrient utilization by pelicans in order to appropriately manage these birds. To that end, the objective of this study was to determine the nutrient utilization of diets consisting of channel catfish (*Ictalurus punctatus*) and(or) grass carp (*Ctenopharyngodon idella*) by American White Pelicans.

Methods

Metabolism Trial

Twelve pelicans were captured in northeast Mississippi and placed in 3 m X 3 m holding pens for 10 days. Each pelican was fed 1500 g/day of catfish, during the 10 day adjustment period. During the metabolism trial pelicans were housed in individual 0.6 m X 1.5 m metabolism cages, which allowed for total excreta collection. The pelicans were fed 1500 g/d of one of three diets: catfish only; carp only; or 50:50 catfish:carp for 2 days prior to initiation of the trial through the end of the 7 day collection trial. The birds were weighed at initiation and completion of the trial to calculate average body weight during the trial. Samples of fish offered were taken daily and composited throughout the trial. Orts were weighed daily and dried at 60^{o}C in a forced air oven and stored for laboratory analysis. Daily fecal output was weighed and dried at 60^{o}C in a forced air oven and stored for laboratory analysis. Dried fish, orts and excreta were ground to pass through a 2 mm screen in a Thomas Wiley Mill® (Author H. Thomas, Philadelphia, PA). Dry matter, organic matter, neutral detergent fiber, fat and crude protein were determined according to AOAC.[1] Gross energy was determined using an isoperibol oxygen bomb calorimeter (Parr Instrument Co., Moline, IL).

Preference Trial

Four pelicans being fed the 50:50 mixture of carp and catfish during the metabolism trial were used for a preference trial. Each pelican was provided 2000 g/day of catfish and 2000 g/day of carp. Prior to feeing the next day, all catfish and carp remaining were collected and weighed to calculate consumption for the previous day.

Statistical Analysis

Data was subjected to analysis of variance using the general linear model procedures of SAS.[9] Each pelican was considered the experimental unit. Significance was set at $P < 0.05$. When significant, means were separated using Fisher's protected least significant difference.

Results and Discussion

The nutritional content of catfish and carp fed to pelicans were similar, with minor differences for NDF, and gross energy content (Table 1).

Average body weights of the pelicans were similar ($P = 0.8065$) for all three treatments (Table 2). No differences ($P = 0.1022$) were detected for amount dry matter consumed on a daily basis among the three treatments. However, pelicans consuming only carp ate more ($P = 0.0107$) dry matter as a percent of body weight compared pelicans eating catfish or both catfish and carp. The increased consumption of carp compared to catfish is supported by data from the preference trial (Table 4). In the preference trial pelicans especially selected ($P = 0.0001$) to consume carp compared to catfish.

Pelicans consuming catfish only metabolized less ($P < 0.05$) dry matter and organic matter than pelicans consuming carp and or both catfish and carp (Table 3). Likewise energy was metabolized less ($P = 0.0193$) and fat tended ($P = 0.0611$) to be metabolized less by pelicans consuming catfish only compared to pelicans consuming carp or both carp and catfish. Pelicans

consuming carp only tended (P = 0.0579) to metabolize more protein than pelicans consuming catfish only, with pelicans consuming both catfish and carp being intermediate. Pelicans consuming carp ate more dry matter which usually results with decreased digestibility. However, in the present study the opposite was observed with pelicans consuming carp eating more dry matter and metabolizing more nutrients from their diet. Carp fed during this trial were smaller (approximately 100 g) than catfish (approximately 500 g). Because carp were smaller this resulted with increased surface area: body mass ratio, which may have resulted with enhanced digestion in the small intestine. Skin of catfish is thicker and is usually surrounded with a mucus layer which may inhibit enzymatic breakdown in the small intestine. Although carp have scales, their skin is relatively thin which may have been readily digested by small intestinal enzymes.

During the preference trial pelicans selected (P = 0.0001) carp compared to catfish (Table 4). While pelicans obviously preferred carp, they were not adverse to consuming catfish. Approximately 2000 g of carp were offered daily and not all carp were consumed (84.8 %). When given the choice between carp and catfish pelicans in the current study selected a diet of approximately 90 % carp to 10 % catfish. The physical attributes of catfish may have discouraged pelicans from selecting catfish. Catfish have sharp, boney fins compared to carp and catfish used in the current study were slightly more mature than carp. Finally, because of the mucus surrounding catfish pelicans may have preferred carp due to the ease of catching compared to slippery catfish. Plastic tags in catfish and carp were undigested as seen in related cormorant species.[2]

Conclusions

While pelicans preferred grass carp and more readily utilized nutrients from carp, channel catfish can be effectively fed to pelicans in captivity, but supplementing additional nutrients may need to be evaluated. Additionally, with the increased concentration of farm raised catfish in areas that pelicans spend winter months, nutrients available to wild pelicans may be reduced. However, little is known regarding the amount of nutrients required by pelicans.

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Table 1. Nutrient composition of channel catfish and grass carp fed to American White Pelicans.

	DM[1], %	**OM[1], %**	**CP[1], %**	**NDF[1], %**	**FAT, %**	**Gross energy, kcal/g**
Catfish	90.6	83.5	68.9	11.9	23.3	4694.1
Carp	93.0	86.2	67.1	4.6	25.4	5044.6

[1]DM= dry matter, OM= organic matter, CP= crude protein, NDF= neutral detergent fiber.

Table 2. Body weights and dry matter intake of American White Pelicans consuming channel catfish and(or) grass carp.

Treatment	**Body Weight, g**	**DM[1] Intake, g/day**	**DM[1] Intake, % body weight/day**
Catfish	6008	264.4	4.41[a]
Both[2]	5995	307.0	5.10[a]
Carp	5689	341.7	6.06[b]
SEM[3]	384.2	22.45	0.296
P =	0.8065	0.1022	0.0107

[1] DM= dry matter
[2] Both= diet offered consisted of 50 % catfish and 50 % carp
[3] SEM= Standard error of the mean

Table 3. Nutrient metabolisms of American White Pelicans consuming channel catfish and(or) grass carp.

Treatment	DM[1], %	OM[1], %	CP[1], %	NDF[1], %	FAT, %	Energy, %
Catfish	42.2[a]	52.0[a]	2.5[a]	93.9	71.9[a]	74.4[a]
Both[2]	54.8[b]	64.1[b]	22.5[ab]	93.1	82.6[b]	81.2[b]
Carp	60.0[b]	68.0[b]	28.1[b]	90.1	83.7[b]	83.4[b]
SEM[3]	3.84	3.12	6.76	1.38	3.31	1.86
P =	0.0260	0.0137	0.0579	0.1731	0.0611	0.0193

[1] DM = dry matter
[2] Both = diet offered consisted of 50 % catfish and 50 % carp
[3] SEM = Standard error of the mean

Table 4. Consumption of channel catfish and grass carp when both were offered to American White Pelicans.

Treatment	Consumed[1], g/day	% offered[1], %	% of diet[1], %
Catfish	246	12.26	10.76
Carp	1708	84.82	89.24
SEM[2]	109.1	5.453	4.846
P =	0.0001	0.0001	0.0001

[1]Consumed = amount of fish consumed, wet basis; % offered = g specie consumed/g specie offered (i.e. g catfish consumed/2000 g catfish offered); % of diet = g specie consumed/g total consumption
[2]SEM = standard error of the mean