Dietary Vitamin E: Effect on Nutrient Composition in Feeder Rats

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Summary and Implications

Diet has been shown to influence animal composition but has not been evaluated in feeder animals. We assessed the impact of dietary vitamin E concentration and sex on feeder rat nutrient composition. Eighteen rats were randomly assigned to a dietary treatment of 20, 90, or 400 ppm vitamin E and fed their respective diets for 9 wks. Dietary vitamin E manipulation significantly impacted nutrient composition of rats, most notably protein to fat ratios, metabolizable energy, and vitamin E concentrations. Nutrient composition also differed between sexes with males having higher protein and lower fat concentrations compared with females. These results suggest dietary vitamin E and sex do influence body nutrient composition of feeder rats. Outcomes may aid zoo animal manager decisions regarding nutritional management of carnivores receiving rats in their diets.

Introduction

Influence of diet on meat quality and resulting nutrient composition in livestock species has been well researched with documented large effects. However, dietary manipulation of non-livestock species is less studied. Composition of animals raised solely for purposes of being fed to other zoo animals (feeder animals) may be influenced by their diets as with livestock species. This warrants investigation in order to help provide information to animal managers. Additionally, comparison between male and female feeder animals has not been well researched and should be evaluated. The objective of this study was to assess the impact of three dietary vitamin E concentrations and sex on feeder rat nutrient composition.

Methods and Materials

Eighteen 3-wk old Long-Evans feeder rats born at Omaha's Henry Doorly Zoo & Aquarium were randomly assigned to a dietary treatment of 20, 90, or 400 ppm vitamin E. Standardized diets only varied in vitamin E concentrations. After 9 wks on diets, rats were euthanized and whole carcasses were stored at -80°C until analyses. Rats were freeze dried (Virtis Freezemobile 25ES, Life Scientific, Inc., St. Louis, MO) at -52°C for approximately two wks and ground through a 4-mm screen (Wiley mill No. 4, Thomas Scientific, Swedesboro, NJ).

Proximate analyses were conducted as previously described by Iske and others (2016) including dry matter, organic matter, crude protein, crude fat, and total dietary fiber. Protein to fat ratios were calculated by dividing protein concentration by fat concentration in each rat. Mineral analysis was determined by Midwest Laboratories [(Omaha, NE) ((Method 985.01); (MWL ME PROC 29)]. Vitamin E (α-tocopherol) analysis was conducted at Arizona State University via reverse-phase HPLC as previously described by McGraw and others (2006) using an Agilent 1100 Series (Santa Clara, CA).

Metabolizable energy (ME) was calculated using Atwater values (9 kcal/g fat, 4 kcal/g protein, 4 kcal/g carbohydrate) and modified Atwater values Atwater values (8.5 kcal/g fat, 3.5 kcal/g protein, 3.5 kcal/g carbohydrate) multiplied by fat, protein, and carbohydrate content. Modified Atwater values are commonly used for labeling of pet foods in the US.

Chemical analyses were conducted at Omaha's Henry Doorly Zoo and Aquarium unless otherwise noted.

Results and Discussion

Whole rat nutrient compositions are presented in Table 1. Differences in whole body nutrient compositions existed between rats fed different dietary treatments. All macronutrients which differed statistically were greatest in rats fed the 400 ppm dietary treatment excluding protein and protein:fat ratios which were 15.7 and 57.5% greater ($P = 0.006$ and 0.008, respectively), respectively, in the 20 ppm dietary treatment. Rats contained 34% more fat when consuming the 400 ppm treatment compared with 20 ppm of vitamin E. Although not significant, there was also a 32% reduction in total dietary fiber concentrations between 20 and 400 ppm fed rats.

Body vitamin E concentrations increased as dietary vitamin E increased with differences of at least 50% ($P = 0.008$). Conversely, concentrations of all analyzed minerals were lowest (numerically or statistically) in rats fed the 400 ppm dietary treatment and highest in rats fed the 20 ppm dietary treatment, except iron which was highest in rats fed the 90 ppm dietary treatment. These findings are extremely interesting and could have implications on animals that are supplemented with very high doses of vitamin E (400 ppm) compared to dietary concentrations that more closely match their requirements (20 ppm).

Interesting differences also were detected for body composition between male and female rats. Male rats contained nearly 18% more ($P = 0.0006$) protein and 17% less ($P = 0.05$) fat compared to females, resulting in a 38% increase ($P = 0.02$) in protein:fat ratios in males. Additionally, males contained nearly 20% more sulfur ($P = 0.0002$) and 25% less iron ($P = 0.003$) than females.

These results suggest higher levels of dietary vitamin E do result in compositional changes that may be of

interest to animal managers at zoos when feeding carnivores. Outcomes of our study may aid animal manager decisions regarding nutritional management of carnivores receiving rats in their diet.

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Tables and Figures

Table 1: Nutrient composition of whole rats fed diets containing 20, 90, or 400 ppm vitamin E (α-tocopherol) for nine wks (DMB)[c]

	Dietary Treatment, ppm vitamin E				Sex		
	20	**90**	**400**	**SEM**	**Male**	**Female**	**SEM**
DM, %	35.8[a]	38.6[b]	39.9[b]	1.2	36.3[a]	39.9[b]	1.0
OM, %	87.4[a]	89.6[a,b]	90.8[b]	1.3	89.1	89.4	1.1
CP, %	59.3[a]	52.9[b]	51.3[b]	2.5	59.0[a]	50.0[b]	2.1
Fat, %	28.0[a]	32.7[a,b]	37.6[b]	3.4	29.8[a]	35.7[b]	2.8
TDF, %	2.2[a,b]	2.8[a]	1.5[b]	0.6	2.3	2.1	0.5
ME[d], kcal/g	4.5[a]	4.7[a,b]	5.0[b]	0.2	4.6	4.9	0.2
ME[e], kcal/g	4.9[a]	5.2[a,b]	5.5[b]	0.2	5.1	5.3	0.2
Protein:Fat[f]	2.2[a]	1.7[a,b]	1.4[b]	0.3	2.1[a]	1.5[b]	0.2
Vitamin E, ppm	2.2[a]	3.4[a,b]	5.5[b]	1.2	2.9	4.4	0.9
Retinol, ppm	1.0	0.9	1.1	0.1	1.0	1.0	0.1
S, %	0.8[a]	0.7[a,b]	0.7[b]	0.03	0.8[a]	0.7[b]	0.02
P, %	2.2	1.9	1.6	0.3	1.9	2.0	0.3
K, %	0.8[a]	0.8[a,b]	0.7[b]	0.1	0.8	0.7	0.04
Mg, %	0.1	0.1	0.1	0.02	0.1	0.1	0.01
Ca, %	3.7	3.1	2.6	0.6	3.0	3.3	0.5
Na, %	0.3[a]	0.3[a,b]	0.3[b]	0.02	0.3	0.3	0.02
Fe, ppm	110.1	112.8	105.0	11.1	93.1[a]	125.5[b]	9.1
Mn, ppm	9.6	9.2	8.2	1.8	9.9	8.2	1.5
Cu, ppm	5.4[a]	4.6[b]	4.5[b]	0.3	5.0	4.7	0.2
Zn, ppm	94.2[a]	82.7[a,b]	75.5[b]	7.2	84.2	84.0	6.1
Ca:P[g]	1.6	1.6	1.5	0.05	1.5	1.6	0.04

[a,b] Means within a row (within section) lacking a common superscript are different ($P < 0.05$).

[c] DMB, dry matter basis; DM, dry matter; OM, organic matter; CP, crude protein; TDF, total dietary fiber; ME, metabolizable energy; S, sulfur; P, phosphorus; K, potassium; Mg, magnesium; Ca, calcium; Na, sodium; Fe, iron; Mn, manganese; Cu, copper; Zn, zinc; SEM, standard error of mean.

[d] ME = Calculated using modified Atwater: 8.5 kcal of ME/g of fat + 3.5 kcal of ME/g of CP + 3.5 kcal of ME/g of N-free extract.

[e] ME = Calculated using unmodified Atwater: 9 kcal of ME/g of fat + 4 kcal of ME/g of CP + 4 kcal of ME/g of N-free extract.

[f] Protein:fat ratio was calculated by dividing crude protein concentration by fat concentration.

[g] Calcium:phosphorus ratio was calculated by dividing calcium concentration by phosphorus concentration.