Effect of Diet on Hunting Performance of English Pointers

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ABSTRACT

A study was conducted to evaluate the influence of diet on hunting performance of English pointers during the quail-hunting season in southwest Georgia. Twenty-three trained dogs were assigned to two commercially available diets (i.e., Diet A = Eukanuba® Premium Performance Formula, The Iams Company, Lewisburg, OH; Diet B = Diamond® Premium Adult Dog Food, Diamond Pet Foods, Meta, MO). Results showed that dogs fed Diet A maintained or gained weight and body condition throughout the hunting season while dogs fed Diet B lost body weight and body condition ($P < .05$). Dogs fed Diet A demonstrated superior hunting performance ($P < .05$) compared with those fed Diet B based on total finds per hunt and on the number of birds located per hour of hunting. All blood variables were within normal ranges for adult healthy dogs throughout the season. These results imply that diet can affect the overall performance of hunting dogs and should provide useful information to trainers, handlers, and clinicians who are concerned with promoting the best performance and health in hunting dogs and other canine athletes.

INTRODUCTION

Hunting with dogs for sport or in competitive events is a popular pastime in the United States. The breed or type of dog that is used varies with the type of game that is hunted as well as the terrain and distances that are covered. Regardless of these differences, most hunting work involves several hours of endurance activity interrupted with short periods of intense running or sprinting. If a dog is hunted often during a season, the major nutritional concerns are feeding to promote optimal performance and providing enough calories to maintain body weight (BW). Weight loss is common in dogs that are hunted daily, especially if weather conditions are harsh.[1] In addition, warm and humid weather conditions in some areas of the country can significantly impact a hunting dog's ability to work and may adversely affect food intake and the ability to fulfill energy requirements.[1]

The nutrient needs of canine athletes have received increased attention in recent years, resulting in improved understanding of the changes associated with athletic conditioning in this species. The majority of published reports have studied racing greyhounds, endur-

TABLE 1. Major Dietary Ingredients of Commercial Diets Fed to English Pointers During the Quail-Hunting Season

Diet A	*Diet B*
Chicken	Chicken byproduct meal
Chicken byproduct meal	Ground corn
Cornmeal	Wheat flour
Ground grain sorghum	Chicken fat (preserved with mixed tocopherols)
Fishmeal	Brewer's rice
Chicken fat (preserved with mixed tocopherols)	Beet pulp
Ground whole grain barley	Fish meal
Dried beet pulp	Egg product
Natural chicken flavor	Flaxseed
Dried egg product	Poultry digest
Brewer's dried yeast	Brewer's dried yeast
Flax meal	Minerals and vitamins
Minerals and vitamins	

ance sled dogs, or dogs exercising on treadmills in a laboratory setting.[2–5] Much less is known about the nutritional needs of other types of working dogs, which include, but are not limited to, dogs used for hunting, herding, obedience competitions, agility events and tracking tests, and helping the disabled. For each of these categories, the intensity of training and amount of physical work that the dog is required to do can vary considerably. Regardless, working dogs typically have increased energy needs compared with normal adult dog maintenance requirements.[1] The magnitude of this increase and the best way to supply both energy and other essential nutrients to working dogs are not known. To examine the influence of diet on hunting performance, a study was conducted with a group of trained English pointers fed two commercial dog foods during an entire quail-hunting season.

MATERIALS AND METHODS

Twenty-three adult English pointers housed at a hunting plantation in southwest Georgia were selected for the study. The dogs were allotted into two experimental groups based on age and gender. Group A comprised 6 females and 4 males, with a mean age of 5.3 years (range: 1.3 to 11.0 years); group B comprised 9 females and 4 males, with a mean age of 5.1 years (range: 1.1 to 10.7 years). No littermates were used in this study. Furthermore, no information on the previous hunting performance of these dogs was available to allocate them to the respective experimental groups. Therefore allocation based on overall hunting performance was considered completely randomized. The dogs were subsequently assigned to two professional handlers who were employed by the plantation. These handlers were responsible for the daily care and management of the dogs throughout the study. Handler 1 was responsible for a total of 14 dogs representing both groups, while handler 2 was responsible for a total of 9 dogs. These handlers were blinded to the specific diet each dog received during the season. Each dog was housed in an individual 6 ft × 20 ft run and had continuous access to water.

Groups A and B were assigned to be fed one of two commercial diets.[1] The major ingredients, nutrient content, and caloric distribu-

TABLE 2. Nutrient Content and Caloric Distribution of Commercial Diets Fed to English Pointers During the Quail-Hunting Season*

Nutrient	*Diet A*	*Diet B*
Protein (%)	31.2	26.1
Fat (%)	21.4	17.2
Crude fiber (%)	2.1	3.7
Moisture (%)	6.7	8.3
Ash (%)	6.6	6.7
Carbohydrate (%)	31.9	38.0
Calcium (%)	1.19	1.5
Phosphorus (%)	0.97	1.07
Calcium:Phosphorus	1.23	1.40
Gross energy (kcal/kg)	5120	4660
Metabolizable energy (ME, kcal/kg)†	4470	4210
Protein (% of ME Calories)†	28.1	25.4
Fat (% of ME Calories)†	43.1	37.6
Carbohydrate (% of ME Calories)†	28.8	37.0

*Nutrient content was determined by laboratory analyses and is expressed on an as-fed basis.
†Metabolizable energy content (ME) and caloric distribution were calculated using the protein, carbohydrate, and fat content and the modified Atwater factors 3.8 kcal/kg, 3.8 kcal/kg, and 8.5 kcal/kg, respectively.

tions of each dog food are reported in Tables 1 and 2. The nutrient content of each diet reflects results from laboratory analyses conducted on representative samples of each diet using Association of Official Analytical Chemists procedures.[6] These diets were fed exclusively to the dogs for 8 weeks before the start and then throughout the quail-hunting season. The dogs were fed once daily during the study and did not receive any additional supplements or treats at any time. Total aldehyde levels within each diet were monitored throughout the study to assess diet quality and possible changes due to oxidative rancidity. Results showed that no oxidation occurred, implying that the quality of both diets was maintained throughout the hunting season. All dogs had been fed Diet B for two consecutive years before the initiation of this study.

Dogs were initially offered amounts of food calculated to maintain BW and body condition based on the National Research Council recommendation for estimating daily metabolizable energy (ME) requirements (ME = 200 $BW^{0.67}$) where BW is expressed in kilograms and 200 is an activity constant for very active dogs.[1,7] Handlers were instructed to adjust the food allotment of individual dogs as needed to maintain BW and body condition during the hunting season. The decision to adjust the food allotment was at the sole discretion of the handler. Although individual food intake could not be measured during this study, food consumption was monitored for each group on a monthly basis based on the number of 40-lb bags of food consumed during that period. Visual observations by the handlers revealed that daily food refusals were negligible during the hunting season, which would not affect the food consumption estimates.

All dogs were subjected to the normal training and hunting program of the plantation as shown in Figure 1. In southwest Georgia, the quail-hunting season extends from mid-November through February and is usually preceded by 2 months of individual training and physical conditioning. During each hunting session, a total of 8 dogs were typically used on a rotating basis (4 braces of 2 dogs each) to ensure that rested dogs were hunting. This standard approach used by handlers during the hunting session maximizes the number of finds, or points, indicating the presence of quail. In this study, the selection of the dogs for hunting and the amount of time they were allowed to hunt were based on the discretion of the two handlers. Throughout the season, the handlers, who were blinded to the dietary

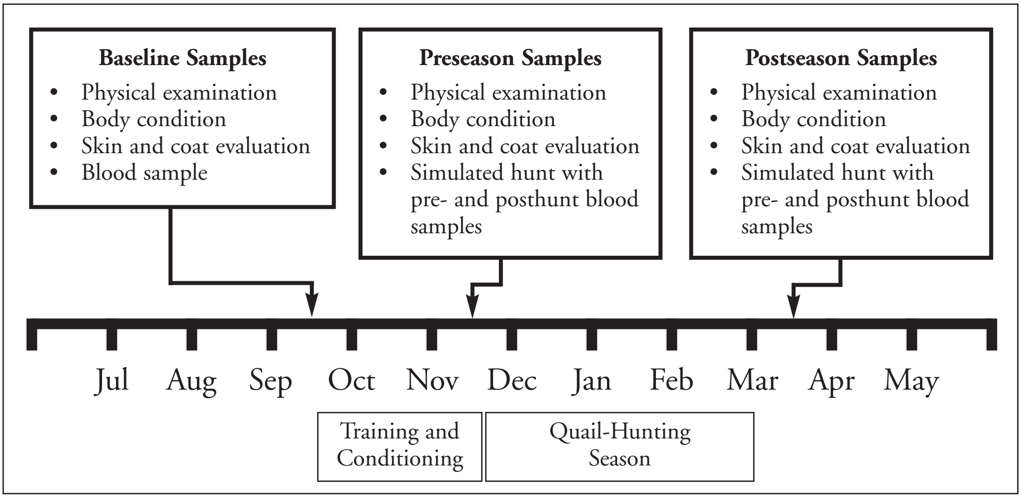

Figure 1. *Schedule of activities during the training, conditioning, and hunting periods.*

treatments, recorded the following information for individual dogs: dates and total time hunted, number of finds, number of flushes, general attitude of the dog, and reasons for cessation of hunting (e.g., fatigue, lack of interest, injury). These data were used to calculate the overall hunting performance of each dog by expressing their total number of finds per total hours hunted during the hunting season. All hunting was suspended from December 18th through December 31st.

Licensed veterinarians, who were also blinded to the dietary treatments, collected blood samples and conducted physical examinations at the initiation of the training period before dogs were switched to the test diets (September) and at the initiation (November) and termination (March) of the hunting season. Blood samples were also collected before and after a simulated hunt in November and March to evaluate metabolic responses during a controlled 40-minute exercise period. Blood samples were obtained via jugular puncture using a 1.5-inch, 22-gauge needle fitted with a splashguard. Samples were collected into appropriate venous blood collection tubes for subsequent hematology, serum chemistry, and thyroid analyses. Blood samples (excluding the hematology tube) were separated by centrifugation (1600 × g for 15 min) within 30 minutes of collection. The resulting serum and plasma were stored in labeled microcentrifuge tubes at 4°C for overnight shipment to a commercial diagnostic laboratory (Antec Diagnostics, Inc)[2] for analysis. All samples were subjected to standard veterinary diagnostic assays at the laboratory.

Body weights and subjective stool scores were also obtained weekly. Subjective stool scoring was conducted using a 5-point scale: 1 = liquid; 2 = soft, no shape; 3 = soft with shape; 4 = firm (ideal); 5 = extremely dry. Body condition and skin and coat health were subjectively evaluated in September, November, and March to coincide with the initiation of the training and hunting seasons and the termination of the hunting season, respectively. Body condition was scored using a 5-point scale: 1 = thin; 2 = underweight; 3 = ideal; 4 = overweight; 5 = obese. Skin and coat evaluations included subjective assessments of skin dander and epilation and coat shedding, shine, uniformity, density, and softness. Individuals blinded to the specific dietary assignments conducted the subjective evaluations for body condition and skin and coat health.

Because performance in a warm and humid environment is an important consideration for hunting dogs in the southern United States, a temperature–humidity index was computed for each day using weather data obtained from a local television station. This index was calculated using the day's high temperature and relative humidity to provide an indication of potential heat stress. The formula for computing this index has been previously reported.[8] For the purposes of this study, mild, high, and severe levels of heat stress were represented by the values 23.5 to 26, 26.0 to 29.0, and >29.0, respectively.

All statistical analyses were conducted using the general linear model procedure of the Statistical Analysis System.[9] For statistical analysis of BW, body condition, and hunting performance data, the hunting season was divided into six 2-week hunting periods. Total times and duration of hunting, number of finds, and finds per hour were calculated on an individual dog basis for each 2-week period because all dogs were not hunted equally during each period. Despite unequal usage during the hunting season, each dog was allowed to hunt at least one time during each 2-week period. These performance data were subsequently analyzed using a statistical model that included the main effects for diet and hunting period and their interaction. A significant period effect ($P < .01$) for total times hunted and total hours hunted reflected the unequal usage of dogs during the hunting season. Despite the period-specific differences, the diet × period interaction was not statistically different for any variable. Therefore, only diet effects are reported for each period and as an overall mean for the entire hunting season. For the blood components, the main effects of exercise (hunting) and diet, and their interaction, were evaluated on serum metabolites in the blood samples collected before and after the simulated hunts. These hunts were conducted at the pre- and postseason time points. Pre- and postseason results were not compared directly to determine possible seasonal changes in the serum metabolites. For all performance and blood variables, differences among treatment means were assessed by least-squares mean separation when the respective F-test for the Type III sums of squares was significant ($P < .10$). For all variables, arithmetic means and their respective standard deviations are reported for each treatment group.

RESULTS

All dogs in the study remained healthy and consumed typical amounts of food throughout the hunting season. No differences in daily food consumption were observed throughout the season with daily consumption ranging from 22.8 to 31.2 g/kg for dogs fed Diet A and 23.8 to 30.5 g/kg for dogs fed Diet B. For the season, daily food consumption of dogs fed Diet A and Diet B averaged 27.3 and 26.4 g/kg of body weight, respectively. Dogs fed Diet A maintained or gained weight and body condition throughout the hunting season, while dogs fed Diet B lost BW and body condition ($P < .05$; Figures 2 and 3). As a result, BW and body condition scores at the conclusion of the hunting season were higher ($P < .05$) for dogs fed Diet A compared with those fed Diet B.

Dogs fed Diet A demonstrated superior hunting performance ($P < .05$) compared with that of dogs fed Diet B based on total finds per hunt and the number of birds located per hour of hunting (Figures 4 and 5). These significant differences in hunting performance ($P < .05$)

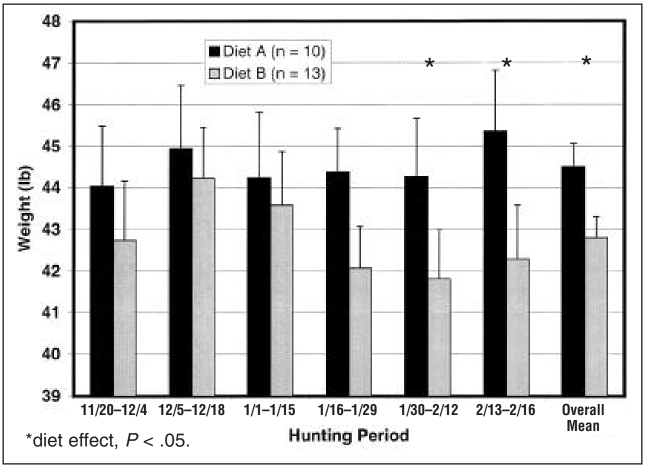

Figure 2. *Body weight of English pointers fed two commercial diets during the quail-hunting season.*

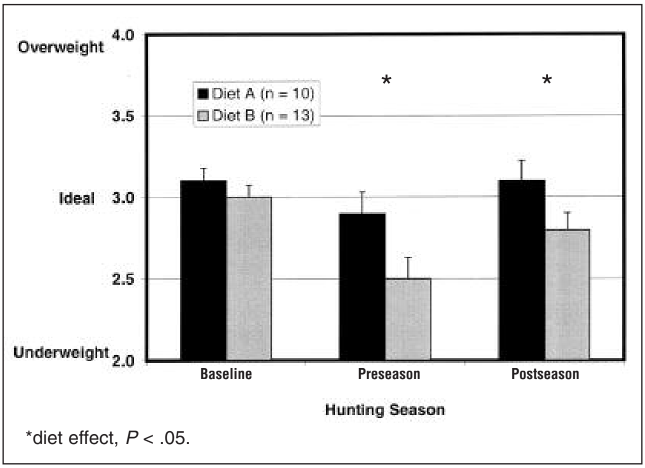

Figure 3. *Body condition scores of English pointers fed two commercial diets during the quail-hunting season.*

were not caused by increased hunting frequency or longer hunting duration. Hunting frequency during each 2-week period of the season averaged 3.9 and 3.6 hunts for dogs fed Diet A and Diet B. The most frequent use occurred during the last 2 weeks of the season when both groups hunted an average of 6.7 times within 14 days. The duration of hunting was equal for both groups, averaging 3.0 hours over all of the 2-week periods, with ranges of 1.7 to 5.1 hours/period for Diet A and 2.0 to 5.6 hours/period for Diet B. Dogs spent more total time hunting during the final 2-week period of the season (5.1 and 5.6 hours for Diet A and Diet B, respectively). The heat index was rated as high or severe based on the temperature–humidity index for 9 days during the hunting season (Figure 6). On each of these days, dogs fed Diet A maintained their superior performance based on more finds per hour compared with dogs fed Diet B. Similar performance responses were also observed during periods of mild heat stress.

Chemical profile and complete blood cell count results indicated no major diet-induced changes in the health status of the dogs during the hunting season. The values for all blood variables were within the range considered to be normal for adult healthy dogs throughout the study. However, several statistically significant differences occurred that might have physiologic significance for hunting dogs. Regardless of diet, the 40-minute bout of hunting during the preseason period resulted in significant increases in triglycerides, aspartate aminotransferase (AST), osmolality, blood urea nitrogen (BUN), hematocrit, and thyroxine; and decreases in serum values for phosphorus and chloride ($P < .10$; Tables 3 and 4). A significant ($P < .10$) interaction between diet and exercise (hunting) oc-

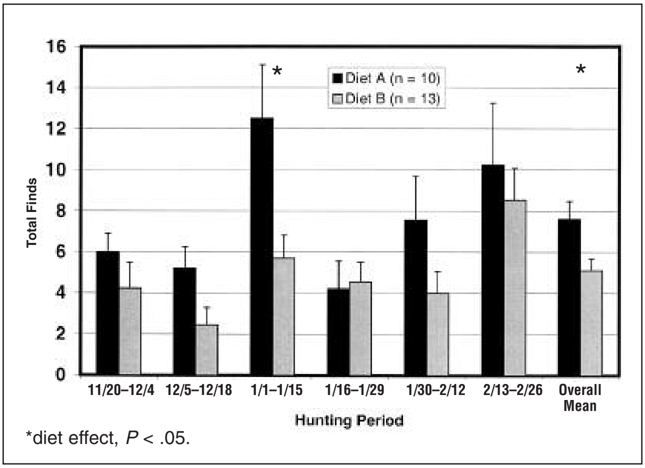

Figure 4. *Total finds per hunting period of English pointers fed two commercial diets during the quail-hunting season.*

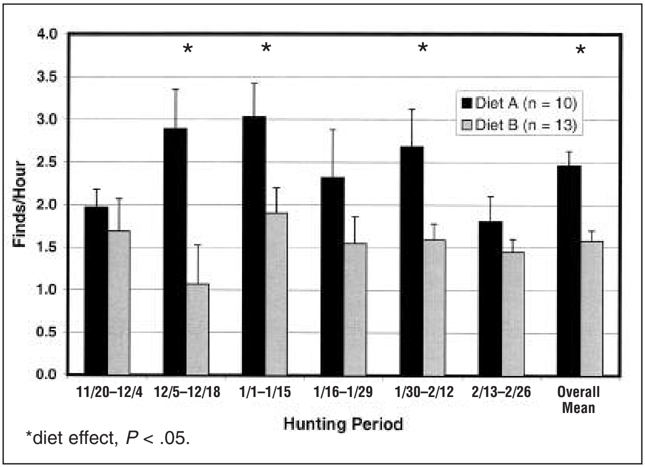

Figure 5. *Hunting performance (finds/hour) of English pointers fed two commercial diets during the quail-hunting season.*

curred for several parameters in the preseason period. Dogs fed Diet A had significantly reduced values for γ-glutamyl transferase (GGT) and fibrinogen in response to hunting. Conversely, hunting was associated with reductions in serum calcium and mean corpuscular hemoglobin concentration (MCHC) in dogs fed Diet B and an increase in serum levels of total protein, creatinine, BUN:creatinine, sodium, hemoglobin, red blood cells, and triiodothyronine. Although fewer differences were recorded during the postseason period, a main effect ($P < .10$) of hunting was seen in MCHC and mean corpuscular volume (MCV), and a significant ($P < .10$) main effect of diet was measured for serum albumin and MCV. Significant ($P < .10$) interactions between diet and hunting during the postseason were observed for red blood cells, serum osmolality, and AST levels.

No significant differences were seen in fecal stool scores despite the tendency for stools to be slightly softer for dogs fed Diet B compared with those fed Diet A. Most measures of skin and coat health were not different, with the exception of the postseason period in which dogs fed Diet A were judged to have significantly shinier and softer coats compared with those fed Diet B ($P < .05$; data not shown).

DISCUSSION

Assessment of performance in working dogs is by nature context specific. The evaluative criteria that are selected may reflect a dog's success rate in the chosen event, relative level of fitness, or metabolic response to training and exercise. Laboratory studies have measured canine fitness in terms of running speed or time to exhaustion on a treadmill, while field studies of sled dogs have used racing success, biochemical parameters, or susceptibility to injury as indicators of endurance

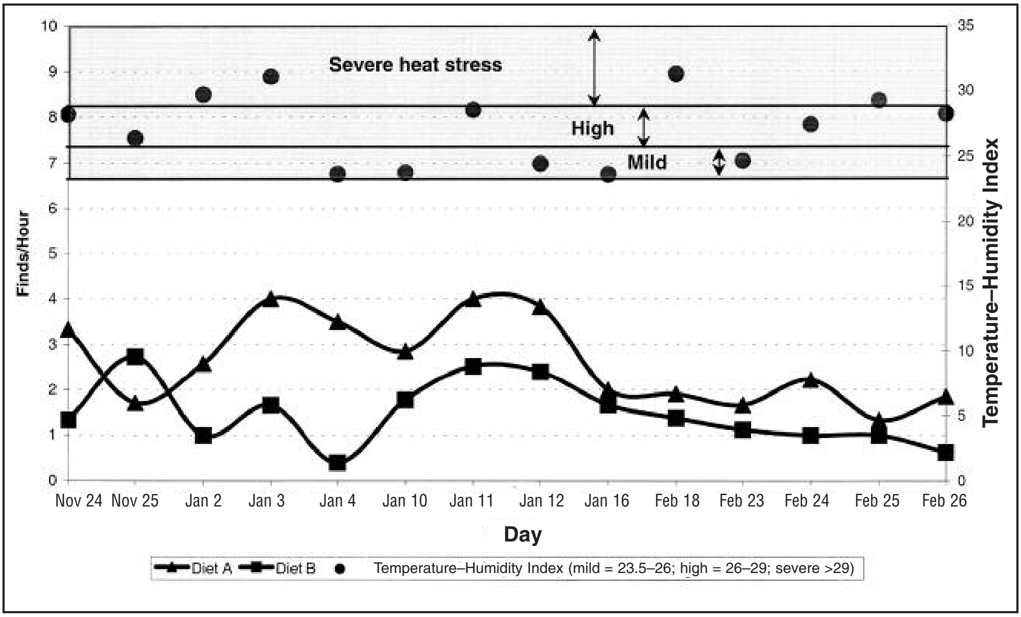

Figure 6. *Hunting performance (finds/hour) of English pointers during periods of mild to severe heat stress.*

performance.[2,3,10–12] Studies of greyhound racers typically assess running speed, heat tolerance, or blood biochemistry values as a measure of performance.[4,5] In the study reported here, working ability was measured using both a practical response criterion (hunting performance) as well as overall biochemical responses (complete blood chemistry and blood count data). In terms of the number of points or birds found during a hunting session, dogs fed Diet A performed better than did those fed Diet B. The criteria of number of finds and time hunting provide a rough, yet practical measure of each dog's hunting performance. Although such assessments are not easily standardized in a field setting, the two handlers were blinded to the dietary treatments. This control allowed comparisons to be made principally on each dog's hunting success during the season when the only different management procedure for each group was the diet that was fed.

In the study reported here, food intake during the hunting season did not change significantly in either group of dogs, but dogs fed Diet A maintained BW and body condition while those fed Diet B lost weight and condition. This difference cannot be explained by increased work frequency in dogs fed Diet B because there were no differences between groups in the total time selected to hunt or total number of hours hunted during the season.

Several dietary factors may have influenced the hunting ability and body condition of the dogs in this study. English pointers are highly active and do not typically carry additional body fat. Furthermore, these dogs typically lose a considerable amount of condition as the hunting season progresses. Weight loss, even when moderate, always comprises both fat and

TABLE 3. Effect of Diet and Exercise (40-minute simulated hunt) on Selected Blood Values in Hunting Dogs Fed Two Commercial Diets During Preseason Hunting

	Diet A		*Diet B*		
Variable	*Before Hunt Mean ± SD*	*After Hunt Mean ± SD*	*Before Hunt Mean ± SD*	*After Hunt Mean ± SD*	***Reference Range****
Triglyceride (mg/dL)†	27.1 ± 5.5	38.0 ± 8.1	23.5 ± 5.5	39.5 ± 11.3	29–291
Total protein (g/dL)§	6.0 ± 0.3	6.3 ± .03	5.9 ± 0.3	6.1 ± 0.4	5.0–7.4
Albumin (g/dL)	3.4 ± 0.2	3.5 ± 0.3	3.3 ± 0.2	3.4 ± 0.2	2.7–4.4
Hematocrit (%)†	47.5 ± 5.2	50.6 ± 5.3	45.9 ± 2.6	51.2 ± 3.3	36–60
Hemoglobin (g/dL)§	15.2 ± 1.8	16.0 ± 1.6	14.9 ± 1.0	16.2 ± 1.5	12.1–20.3
Red blood cells ($\times 10^6$/µL)§	6.3 ± 0.8	6.6 ± 0.8	6.2 ± 0.4	6.8 ± 0.5	4.8–9.3
MCHC (%)§	32.0 ± 0.6	31.7 ± 0.3	32.4 ± 0.5	31.6 ± 1.5	30–38
MCV (fL)‡	75.8 ± 3.5	77.3 ± 2.8	73.8 ± 2.3	75.2 ± 3.1	58–79
BUN (mg/dL)†	17.2 ± 5.9	20.5 ± 3.9	13.2 ± 2.7	18.9 ± 4.1	6–25
Creatinine (mg/dL)§	1.2 ± 0.2	1.3 ± 0.2	1.2 ± 0.1	1.3 ± 0.2	0.5–1.6
BUN:Creatinine§	13.8 ± 3.6	15.3 ± 3.0	11.4 ± 2.1	14.3 ± 2.6	4–27
AST (U/L)†	37.8 ± 14.2	47.9 ± 12.3	32.0 ± 8.7	43.9 ± 10.0	15–66
GGT (U/L)§	8.4 ± 1.3	5.3 ± 2.3	6.6 ± 2.6	5.3 ± 2.3	1–12
T4 (µg/dL)†,‡	1.8 ± 0.9	2.3 ± 0.6	1.2 ± 0.6	1.8 ± 0.5	1.0–4.0
T3 (ng/dL)§	88.8 ± 20.2	92.0 ± 27.4	72.1 ± 16.8	93.4 ± 26.5	45–150
Osmolality (mOsm/L)†	296.2 ± 2.5	299.4 ± 3.8	292.3 ± 2.8	298.8 ± 3.7	277–311
White blood cells‡	7.5 ± 2.1	8.5 ± 1.7	5.9 ± 1.0	6.4 ± 1.5	4.0–15.5
Phosphorus (mg/dL)†	4.1 ± 1.2	3.4 ± 0.8	4.3 ± 0.6	3.1 ± 1.0	2.5–6.0
Chloride (mg/dL)†	115.1 ± 2.8	112.4 ± 3.3	115.3 ± 3.4	112.5 ± 3.2	102–120
Sodium (mEq/L)§	149.1 ± 1.1	149.9 ± 2.0	147.8 ± 1.6	150.2 ± 1.6	139–154
Calcium (mg/dL)§	9.6 ± 0.5	9.3 ± 0.4	9.5 ± 0.4	9.2 ± 0.4	8.9–11.4
Fibrinogen (mg/dL)§	266.7 ± 102.1	204.8 ± 49.3	206.7 ± 36.4	174.2 ± 46.4	150–400

*Veterinary diagnostic analyses conducted by Antec Diagnostics (Farmingdale, NY 11735) using accepted commercial procedures.
†Significant exercise effect ($P < .10$).
‡Significant diet effect ($P < .10$).
§Significant diet × exercise interaction ($P < .10$).
AST = aspartate aminotransferase; BUN = blood urea nitrogen; GGT = γ-glutamyl transferase; MCHC = mean corpuscular hemoglobin concentration; MCV = mean corpuscular volume; SD = standard deviation; T3 = triiodothyronine; T4 = thyroxine.

lean body tissue.[1,13,14] A loss of lean tissue in dogs that were not overweight would be expected to negatively impact body condition and possibly stamina. Although body composition data were not collected in this study, previous research conducted by these investigators showed that the effect of treadmill exercise on body composition can be significantly affected by level of dietary fat.[15] Both lean body mass and body fat increased in exercising pointers fed a diet containing 17% fat, while dogs fed a diet containing 13% fat lost lean body mass and body fat in response to treadmill exercise.[15]

In the study reported here, the weight loss of dogs fed Diet B may be explained by differences in the energy density and caloric distri-

TABLE 4. Effect of Diet and Exercise (40-minute simulated hunt) on Selected Blood Values in Hunting Dogs Fed Two Commercial Diets During Postseason Hunting

	Diet A		*Diet B*		
Variable	*Before Hunt Mean ± SD*	*After Hunt Mean ± SD*	*Before Hunt Mean ± SD*	*After Hunt Mean ± SD*	***Reference Range****
Triglyceride (mg/dL)	38.7 ± 13.6	41.0 ± 7.1	39.0 ± 23.0	45.7 ± 10.8	29–291
Total protein (g/dL)	6.6 ± 0.4	6.6 ± 0.4	6.5 ± 0.4	6.4 ± 0.5	5.0–7.4
Albumin (g/dL)[‡]	3.5 ± 0.2	3.4 ± 0.2	3.3 ± 0.2	3.2 ± 0.2	2.7–4.4
Hematocrit (%)	52.3 ± 4.3	52.0 ± 5.5	49.6 ± 4.8	50.3 ± 3.2	36–60
Hemoglobin (g/dL)	15.8 ± 1.4	16.3 ± 1.8	15.2 ± 1.2	15.9 ± 1.0	12.1–20.3
Red blood cells ($\times 10^6$/µL)[§]	6.3 ± 0.6	6.6 ± 0.7	6.2 ± 0.6	6.7 ± 0.5	4.8–9.3
MCHC (%)[†]	30.1 ± 0.6	31.3 ± 0.6	30.7 ± 1.6	31.6 ± 0.7	30–38
MCV (fL)[†,‡]	82.8 ± 3.4	79.3 ± 3.2	79.5 ± 3.2	75.5 ± 3.2	58–79
BUN (mg/dL)	19.5 ± 3.5	20.1 ± 4.8	18.3 ± 4.3	19.3 ± 3.2	6–25
Creatinine (mg/dL)	1.3 ± 0.3	1.2 ± 0.2	1.2 ± 0.3	1.2 ± 0.2	0.5–1.6
BUN:Creatinine	15.5 ± 4.1	17.2 ± 4.2	15.5 ± 2.4	16.8 ± 2.3	4–27
AST (U/L)[§]	32.7 ± 9.2	54.8 ± 32.9	32.5 ± 10.0	42.2 ± 12.3	15–66
GGT (U/L)	5.8 ± 6.8	6.9 ± 8.7	7.0 ± 7.4	4.0 ± 2.7	1–12
T4 (µg/dL)	2.6 ± 0.9	2.8 ± 1.3	2.0 ± 0.7	2.2 ± 0.9	1.0–4.0
T3 (ng/dL)	106.6 ± 25.9	116.7 ± 37.9	101.6 ± 19.6	95.2 ± 19.5	45–150
Osmolality (mOsm/L)[§]	296.1 ± 2.5	302.2 ± 4.9	295.0 ± 3.2	299.0 ± 4.0	277–311
White blood cells	8.1 ± 1.8	8.3 ± 1.8	7.6 ± 1.6	8.0 ± 1.9	4.0–15.5
Phosphorus (mg/dL)	6.0 ± 2.2	3.3 ± 0.9	5.9 ± 1.8	3.1 ± 0.9	2.5–6.0
Chloride (mg/dL)	115.9 ± 5.2	116.2 ± 2.1	115.8 ± 3.2	115.5 ± 4.1	102–120
Calcium (mg/dL)	10.0 ± 0.3	9.6 ± 0.4	9.7 ± 0.4	9.3 ± 0.3	8.9–11.4
Sodium (mEq/L)	148.4 ± 1.5	151.3 ± 2.1	148.2 ± 1.9	149.9 ± 2.4	139–154
Fibrinogen (mg/dL)	221.5 ± 79.3	242.0 ± 97.7	199.2 ± 86.4	170.4 ± 55.5	150–400

*Veterinary diagnostic analyses conducted by Antech Diagnostics (Farmingdale, NY 11735) using accepted commercial procedures.
[†]Significant exercise effect ($P < .10$).
[‡]Significant diet effect ($P < .10$).
[§]Significant diet × exercise interaction ($P < .10$).
AST = aspartate aminotransferase; BUN = blood urea nitrogen; GGT = γ-glutamyl transferase; MCHC = mean corpuscular hemoglobin concentration; MCV = mean corpuscular volume; SD = standard deviation; T3 = triiodothyronine; T4 = thyroxine.

bution of the two foods. The calculated ME content of Diet A was 4470 kcal/kg compared with 4210 kcal/kg in Diet B (Table 2). The slight increase in energy supplied to dogs consuming Diet A may have been sufficient to support both weight and body condition despite increased energy needs during periods of hard work. The energy density of a food directly affects the quantity of food that must be fed to meet an animal's energy requirement. If the ME content of a food is too low to support increased work, the quantity of food that must be consumed may exceed the physical capacity of the gastrointestinal tract. In addition, the consumption of an excessive quantity of food can lead to an increased rate of passage through the gastrointestinal tract and decreased digestibility, further exacerbating an energy deficit.

Because fat is a highly available energy source, an increase in the fat content of the diet increases both energy density and diet digestibility. The apparent digestibility of the fats that are included in most pet foods is usually higher than the digestibility coefficients of the dietary protein or carbohydrate fractions.[16,17] The two foods in this study differed substantially in fat content. Diet A contained 21.4% fat compared with 17.2% in Diet B (Table 2). Caloric distribution provides a more accurate estimate of the proportion of ME supplied by carbohydrate, protein, and fat. Forty-three percent of the ME of Diet A was provided as fat compared with 37.6% of ME calories in Diet B. The higher proportion of fat in Diet A and greater energy density may explain the difference in BW in the dogs in this study. The lower energy density of Diet B coupled with a lower proportion of dietary fat may have possibly caused this food to be more bulk-limiting as the energy needs of the dogs gradually increased during the hunting season. If gut fill were attained before energy needs were met, Diet B would cause a gradual loss of weight if it continued to be consumed throughout the hunting season.

The availability of fat as a metabolic fuel may also affect performance during strenuous work. Dogs are efficient aerobic athletes, performing best when fed a diet that supplies a large proportion of its energy as fat. An early study showed that when working sled dogs were fed a high-carbohydrate diet, they performed poorly and developed signs of injury while racing.[2] When the dogs were switched to a diet containing increased levels of fat and protein, performance improved and the lameness resolved. These results were corroborated by recent studies showing that feeding a high-fat diet to sled dogs before and during athletic training enhanced their ability to mobilize and use fat as a fuel and improved their aerobic work capacity.[18,19] Controlled studies of dogs running on treadmills have also shown that endurance performance and olfactory sensitivity are positively correlated with intake of dietary fat and diet digestibility.[10,15] Because the dogs fed Diet A in this study were consuming a higher percentage of calories as fat, Diet A was assumed to have supplied the extra fuel that was needed for physical work for these dogs and contributed to their enhanced performance.

Dietary protein is also an important consideration for canine athletes. Current evidence indicates that aerobic training imposes an increased need for dietary protein in dogs.[3,20] In all animals, athletic conditioning results in adaptive physiologic changes that facilitate efficient delivery of oxygen and nutrients to working muscles. These changes include increases in blood volume, red blood cell mass, capillary density, and mitochondrial volume and occur in the activity and total mass of metabolic enzymes.[21,22] This increased tissue mass and the need for gluconeogenic amino acids during exercise necessitate increased protein intake. In the study reported here, protein contributed 28% of ME calories in Diet A and 25.4% of calories in Diet B. Although both of these foods exceed the American Association of Feed Control Officials minimum protein requirement for adult dogs at maintenance, Diet B may have been marginal or limiting in protein for dogs undergoing physical training.[23]

The protein content of the diet may also impact the capacity of the blood to oxygenate tissue and transport energy-containing nutrients needed by working muscles. When fed a diet containing 28% of ME calories as protein, racing sled dogs developed anemia and reduced hematocrit levels compared with those of dogs fed 32% or more protein.[21] More recently, a study showed that when fed 35% of calories as protein, sled dogs maintained a larger plasma volume and red blood cell mass during training compared with those of dogs fed diets containing less than 35% protein.[12] Dogs fed lower amounts of protein were also more susceptible to leg and foot-pad injuries. Although not as high as the protein content used in studies of endurance-trained sled dogs, the slightly higher proportion of protein in Diet A of the study reported here compared with that in Diet B may have been sufficient for these hunting dogs. Although all values were within the normal range for healthy dogs, a slight reduction may become significant during periods of increased physical activity based on increased needs for oxygen and nutrient transport.

A final consideration when selecting the most appropriate diet for hunting dogs is the impact of extreme weather conditions. Unlike sled dogs, which typically run in very cold climates, hunting dogs may experience high and low extremes in temperature and humidity. Although the quail-hunting season in Georgia occurs during the late fall and winter, it can still be quite warm and humid as evidenced by the 14 days of mild to severe heat stress during the season (Figure 6). Despite the increased environmental temperature and relative humidity, dogs fed Diet A had more finds per hour compared with dogs fed Diet B on these days.

Exercise and exposure to high ambient temperatures and humidity all cause an increase in the amount of energy that must be used to cool the body.[24] Dogs rely primarily on respiratory evaporation to dissipate excess body heat and maintain normal body temperature. As a species, the dog is especially vulnerable to heat stress and hyperthermia because evaporative cooling is limited to evaporation from respiration (panting). Working dogs in humid environments experience slight increases in energy needs yet, paradoxically, often exhibit a reduction in appetite.[25] Common folklore among trainers and breeders of hunting dogs is that feeding a high-fat diet can predispose dogs to heat stress. However, this belief was not supported by the performance data in the study reported here. The increased fat in Diet A did not negatively affect working ability or stamina under the warm and humid conditions. These results are supported by previous work showing that feeding a diet containing 13% fat produced higher rectal temperatures in dogs after 1 hour of treadmill exercise compared with the rectal temperature of dogs fed a diet containing 17% fat.[15] These data suggest that an increased level of dietary fat may benefit the exercising dog during periods of heat stress by lowering the core body temperature.

All of the blood values measured in this study remained within the normal range for healthy adult dogs before and after the hunting season. Most of the differences that were observed were in response to hunting and may reflect normal metabolic changes associated with exercise. However, for several parameters, exercise-induced changes were significantly influenced by the diet. These parameters included serum protein, hemoglobin, red blood cells, MCHC, GGT, sodium, calcium, and fibrinogen during the preseason and red blood cells, AST, and osmolality during the postseason. Differing responses to exercise between the two diet groups may have been caused by dietary influences on the ability to mobilize energy-providing nutrients, adapt to increased needs for oxygen, or maintain acid–base balance and hydration. Although undue emphasis should not be placed on changes that remain within the expected normal range, alterations in blood chemistry and complete blood cell count profiles may provide veterinary practitioners with additional information regarding the most appropriate diet for working dogs during periods of increased physical activity.

CONCLUSION

Dogs are exceptional aerobic athletes, and those that are trained for endurance events perform best when fed diets that are high in fat and contain moderately increased protein. In the study reported here, the food that contained a higher proportion of fat and protein supported superior hunting performance in English pointers used to hunt bobwhite quail. The two diets that were fed are commercially available and commonly used by breeders, trainers, and other dog enthusiasts.

The results of this study suggest that the food selected for conditioned hunting dogs can directly affect their performance. Factors that should be considered when selecting a food include the diet's fat and protein contents, ingredient quality, energy distribution, and overall caloric density. Although controlling a field study to the same degree as a laboratory experiment is impossible, this study provides valuable information to trainers, handlers, and clinicians concerned with promoting the best performance and health in their dogs. Additional studies by the authors will continue to elucidate the influence that dietary factors may have on the working ability, performance, and health of other types of working dogs.

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