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Cover Page Footnote

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Running Title: Energy Content of Seeds of Common Sunflowers in the Diet of Scaled Quail

Abstract

We analyzed the energy content of seeds of common sunflowers (*Helianthus annuus*) obtained from the crops of scaled quail (*Callipepla squamata*) collected from plains-mesa sand-scrub habitat in Eddy and Lea counties, New Mexico. Seeds were dried for 48 hours at 60°C to remove moisture and then analyzed for gross caloric value (i.e., energy content) in an oxygen bomb calorimeter. Energy content of seeds of common sunflowers from New Mexico was greater than that of many seeds previously reported from the diet of scaled quail and other granivorous birds and comparable to previous measurements of seeds of the same species made in Kansas.

Introduction

Conservation and management of birds requires knowledge of their food preferences, and of the energy content of their preferred foods. Feeding habits of scaled quail (*Callipepla squamata*) are well-studied (Lehman and Ward 1941; Schemnitz 1961; Ault 1981; Rollins 1981; Ault and Stormer 1983; Campbell-Kissock *et al.* 1985; Medina 1988), including several studies conducted in southeastern New Mexico (Davis and Banks 1973; Davis *et al.* 1975; Griffing and Davis 1976; Best and Smartt 1985; Hunt and Best 2001b). No study has measured the energy content of food of free-living scaled quail, although one study (Saunders and Parrish 1987) conducted in Kansas measured the assimilated energy of some potential food items by captive scaled quail. Studies have measured energy content of some known and potential food items of other birds such as mourning doves (*Zenaida macroura*—Schmid 1965; Shuman *et al.* 1988) in conjunction with determination of how well captive mourning doves metabolized various food items; some of the items measured are potential food for scaled

quail. No study of energy content of foods of scaled quail has been conducted with birds from sand-scrub habitat of New Mexico.

A study of feeding habits of scaled quail in southeastern New Mexico determined that seeds of common sunflowers (*Helianthus annuus*) made up the largest portion (14.3%) of the total mass of crop contents, and were present in 36.9% of the crops of mourning doves (Hunt and Best 2001b). Common sunflowers are also reported to be an important food item of other birds, such as northern bobwhites (*Colinus virginianus*—Hunt and Best 2001a) and mourning doves (Hunt 1999). Although energy content of seeds of wild common sunflowers from Kansas have been measured (Robel and Harper 1965), no such measurements have been conducted on seeds from sand-scrub habitat of New Mexico. We used an oxygen bomb calorimeter to determine the energy content of seeds of common sunflowers from Eddy and Lea counties in New Mexico.

Methods and Materials

Scaled quail were collected at the Waste Isolation Pilot Plant site in New Mexico in conjunction with long-term studies of lead poisoning of game birds (Best *et al.* 1992a; 1992b) and studies of feeding habits of game birds in southeastern New Mexico (Hunt 1999; Hunt and Best 2001a; Hunt and Best 2001b). Most of the study area is in eastern Eddy County, but it also extends into western Lea County. All scaled quail were collected in uncultivated, shinnery oak-honey mesquite (*Quercus havardii-Prosopis glandulosa*) habitat, part of the plains-mesa sand-scrub vegetation type (Dick-Peddie 1993). Several studies of the feeding ecology of scaled quail have been conducted in this area (Davis and Banks 1973; Davis *et al.* 1975; Griffing and Davis 1976; Best and Smartt 1985; Hunt and Best 2001b). There are several human-made stock

tanks on the study site, which is heavily grazed by cattle.

In late summer and autumn 1981, 58 scaled quail were collected by shooting as encountered. Collected birds were placed on ice within 10 minutes of shooting to minimize effects of post-mortem digestion (Dillery 1965; Farner 1960; Sedinger 1986); no effect of digestion on crop contents was observed. Crops were removed, placed into plastic vials, and frozen. Contents of crops were later thawed, separated by type of food, and placed into envelopes for drying. Food items were dried for 48 hours at 60°C to remove moisture. Food items were identified by comparison with samples of plants collected at the study site, and by using identification manuals (Davis 1993; Martin and Barkley 1961). Seeds used in this analysis were unbroken and unhulled.

Samples of seeds of *Helianthus annuus* were analyzed for gross caloric value (i.e., energy content) in an oxygen bomb calorimeter (Model 1341, Parr Instrument Company, Moline, Illinois). Samples of seeds from 13 individual scaled quail with crops that contained enough seeds for analysis were selected; each sample weighed 0.5-1.0 g. Seeds were combusted in the oxygen bomb; after combustion, the bomb was washed and bomb washings were titrated with sodium carbonate to allow adjustment of results for nitrate content. Results are reported in J/kg; kcal/g are given in parentheses for comparisons with previous studies.

Results

The 13 samples analyzed contained an average of 23.8 J/kg [5.7 kcal/g] — range, 21.3-24.7 J/kg [5.1-5.9 kcal/g]; standard deviation, 0.8 J/kg [0.2 kcal/g] (Table 1). This figure is similar to that previously obtained for *Helianthus annuus* in Kansas (Robel and Harper 1965) and greater than many tested food items in the diet of other seed-eating game birds.

Discussion

Although no study has demonstrated that scaled quail are selective in food choices, other species of granivorous birds, including quail, are known to be selective (Schmid 1965; Conley and Blem 1978; Shuman *et al.* 1988; Hayslette and Mirarchi 2001; Larson *et al.* 2012), although criteria for their selection are imperfectly understood. Among suggested criteria are shape, color, fiber content (Conley and Blem 1978), protein content (Larson *et al.* 2012), nutrient content (Hayslette and Mirarchi 2001), and energy

Table 1. Gross caloric value (energy content) of seeds of common sunflowers (*Helianthus annuus*) in the crops of scaled quail (*Callipepla squamata*) collected from Eddy and Lea counties, New Mexico, summer and autumn, 1981.

<u>Sample No.</u>	<u>Energy in J/kg (kcal/g)</u>
SQ002-81	23.8 (5.7)
SQ003-81	24.3 (5.8)
SQ008-81	24.7 (5.9)
SQ009-81	23.0 (5.5)
SQ015-81	23.4 (5.6)
SQ016-81	23.4 (5.6)
SQ017-81	23.0 (5.5)
SQ020-81	23.0 (5.5)
SQ021-81	24.7 (5.9)
SQ029-81	23.8 (5.7)
SQ031-81	21.3 (5.1)
SQ041-81	24.7 (5.9)
SQ042-81	24.7 (5.9)

content (Schmid 1965; Shuman *et al.* 1988). Although no study has demonstrated that scaled quail preferentially select common sunflowers over other food items, Davison (1958) categorized common sunflowers as a “choice” food plant for northern bobwhites, meaning it was digestible, nutritious, and readily eaten when encountered.

Our study demonstrates that seeds of common sunflowers have an energy content comparable to or greater than food items from previous studies. For example, Robel and Harper reported an average of 24.7 J/kg (5.9 kcal/g) for seeds of common sunflowers, and 23.0 J/kg (5.5 kcal/g) for seeds of giant ragweeds (*Ambrosia trifida*) collected in Kansas. A study of potential food items for greater prairie-chickens (*Tympanuchus cupido*—Heffron and Parrish 2005) listed 14 different commercial feeds and seeds that had a lower energy content than that which we measured for common sunflowers; the greatest energy content in that study was for hulled domestic sunflower-seed chips (23.0 J/kg [5.5 kcal/g]). A study of seeds of Texas doveweeds (*Croton texensis*) in crops of mourning doves conducted at the same study site as the current study (Hunt *et al.* 2019) reported an average energy content of 21.8 J/kg (5.2 kcal/g). In a study of 9 food items collected from crops of mourning doves in North Dakota, Schmid (1965) found only 2 that had a greater energy content—seeds of flax (*Linum usitatissimum*, 26.4 J/kg [6.3 kcal/g]) and field mustard

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(*Sinapis arvensis*, 25.1 J/kg [6.0 kcal/g]). Other seeds tested from North Dakota had less energy content; examples include wild plants such as green foxtail (*Setaria viridis*, 18.4 J/kg [4.4 kcal/g]) and cultivated crops such as corn (*Zea mays*, 17.1 J/kg [4.1 kcal/g]) and wheat (*Triticum aestivum*, 16.7 J/kg [4.0 kcal/g]). Likewise, Shuman *et al.* (1988) tested 8 varieties of seeds that were considered to be potential food items for mourning doves in Kansas, and found only 1 that had greater energy content—thistle (*Cirsium*, 25.9 J/kg [6.2 kcal/g]). Other seeds analyzed in Kansas had less energy content; examples include Maximillian sunflower (*Helianthus maximiliani*, 23.4 J/kg [5.6 kcal/g]), proso millet (*Panicum millaceum*, 18.8 J/kg [4.5 kcal/g]), and timothy (*Phleum pratense*, 19.7 J/kg [4.7 kcal/g]).

Common sunflowers and other sunflowers are associated with disturbance (Whitson *et al.* 1999). Much of southeastern New Mexico is heavily grazed by cattle, and much of the landscape has been highly modified by usage for extraction of petroleum and natural gas (Hunt 2004), so that common sunflowers grow abundantly. Abundance of common sunflowers, coupled with the relatively great energy content of the seeds, helps explain their prevalence in the diet of scaled quail (Hunt and Best 2001*b*) and other granivorous birds of the area.

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