IMPACT OF HABITAT TYPE ON FORAGE QUALITY OF SEEDLING OAK LEAVES IN CENTRAL WISCONSIN

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Abstract.—The objectives of this study were to determine if relative feed value or crude protein in seedling oak leaves was different between three central Wisconsin habitat type groupings. Seedling oak leaves of two species were collected from oak sites that represented either fully stocked or understocked conditions from three possible habitat type groupings: (1) *Acer-Tilia-Fraxinus/Circaea/Acer-Quercus/Viburnum-Geranium* variant, (2) *Acer rubrum/Desmodium*, and (3) *Pinus/Euphorbia/Pinus/Vaccinium-Gaultheria*. The leaves were analyzed for crude protein, acid detergent fiber, neutral detergent fiber, and relative feed value. Northern pin oak (*Q. ellipsoidalis*) had higher levels of crude protein and relative feed value than northern red oak (*Q. rubra*). *Pinus/Euphorbia/Pinus/Vaccinium-Gaultheria* sites had the highest crude protein and the lowest relative feed value, although the relative feed value was still very high. Generally, oak appears to have very good forage characteristics.

INTRODUCTION

The population of white-tailed deer (*Odocoileus virginianus*), hereafter referred to as deer, is unsustainably high in some parts of Wisconsin (Wisconsin Department of Natural Resources 2011). Preferential deer browse on oak (*Quercus* spp.) can result in undesirable species shifts under some stand conditions (Strole and Anderson 1992, Stromayer and Warren 1997). These changes can be large enough that deer are referred to as a "keystone herbivore" (Waller and Alverson 1997). Species shifts are the result of suppression of oak seedling growth below that of competitors that are not as desirable to deer (Russell et al. 2001).

Difference in palatability of species alters feeding preference by deer (Strole and Anderson 1992). Research on oak palatability to livestock and wildlife generally shows that oak (and other tree species) contains higher levels of crude protein (CP) than many other types of forage during some portions of the year (Forwood and Owensby 1995). Levels of CP in oak have been shown to be 11 percent (*Q. infectoria*; Parlak et al. 2011), between 6.7 and 14.5 percent based on time of year (*Q. coccifera*; Koukoura 1988), and 6.3 to 10.3 percent (*Q. macrocarpa*; Forwood and Owensby 1995). Some of the higher CP levels of the year (Forwood and Owensby 1995, Parlak et al. 2011) occur in August, the sampling time for this project.

In Wisconsin, oak is easier to regenerate on poor quality sites (Demchik et al. 2013, unpublished survey[2]; Schwartz and Demchik 2012) than on good quality sites (Johnson et al. 2002). As a result, high quality oak has undergone a long-term decline in Wisconsin (Perry et al. 2008). The stronger competitive advantage of oak on poor sites may partly explain this difference, but it is also possible that the forage is less palatable on poor quality sites. The objective of this study was to determine if

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relative feed value (RFV; an index of forage quality) or CP of seedling oak leaves differed between three central Wisconsin habitat type groupings.

METHODS

Available sites on publicly owned property were selected for this study to represent at least three fully stocked and three understocked sites for each of three central Wisconsin habitat type groupings (Kotar and Burger 1996):

- **ATiFrCi** (*Acer-Tilia-Fraxinus/Circaea*)/**AQVb-Gr** (*Acer-Quercus/Viburnum-Geranium* variant),
- **ArDe** (*Acer rubrum/Desmodium*), and
- **PEu** (*Pinus/Euphorbia*)/**PVG** (*Pinus/Vaccinium-Gaultheria*)

Generally, stand quality would be, from best to worst, ATiFrCi/AQVb-Gr > ARDe > PEu/PVG. We combined ATiFrCi with AQVb-Gr and PEu with PVG for reasons detailed in Schwartz (2012). Criteria for site selection were that the stand was ≥50 years old and >2 hectares in size, and had >40 percent stocking of overstory oak (see Schwartz 2012 for details; Table 1). On each site, 30 leaves from seedling oaks were collected August 12-16, 2012. Only one leaf per seedling was harvested to avoid unnecessarily damaging the seedlings and to get a more representative sample. Species of oak leaf harvested was based on those available on the site. Within a site, species of leaf harvested was the same (Table 1). The samples were oven dried at 66 °C for 4 days. Chemical analyses for CP, acid detergent fiber (ADF), neutral detergent fiber (NDF), and RFV were completed by DHIA Laboratories in Minnesota. Unbalanced analysis of variance in Minitab® (Pennsylvania State University, State College, PA) was used for analysis of data.

RESULTS

Overstory stocking (high or low stocking) had no significant impact on any parameter of foliar nutrition of the leaves. Therefore, this factor was eliminated. For both CP and RFV, habitat type (P = 0.02, P = 0.007; Table 2) and species (P = 0.03, P = 0.01, Table 3) were significantly different; however, the interaction of habitat type and species was not significantly different. PVG/PEu had higher CP than the other habitat types, yet lower RFV than ArDe but not ATiFrCi/AQVb-Gr. Northern pin oak (*Q. ellipsoidalis*) leaves had higher CP and higher RFV than northern red oak (*Q. rubra*). Because ADF and NDF are used to calculate RFV, statistical comparisons were not made for those two factors; however, the data are included in Tables 2 and 3.

Table 1.—Species of oak and number of sites in each of three central Wisconsin habitat type groupings, 2012: ATiFrCi (*Acer-Tilia-Fraxinus/Circaea*)/AQVb-Gr (*Acer-Quercus/Viburnum-Geranium* variant), ArDe (*Acer rubrum/Desmodium*), and PEu (*Pinus/Euphorbia*)/PVG (*Pinus/Vaccinium-Gaultheria*)

Habitat type	Species	Number of sites
PEu/PVG	*Q. ellipsoidalis*	5
	Q. rubra	5
ArDe	*Q. ellipsoidalis*	3
	Q. rubra	4
ATiFrCi/AQVb-Gr	*Q. ellipsoidalis*	3
	Q. rubra	6

Table 2.—Crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), and relative feed value (RFV) for oak seedling leaves collected in 2012 from three central Wisconsin habitat type groupings: ATiFrCi (*Acer-Tilia-Fraxinus/Circaea*)/AQVb-Gr (*Acer-Quercus/Viburnum-Geranium* variant), ArDe (*Acer rubrum/Desmodium*), and PEu (*Pinus/Euphorbia*)/PVG (*Pinus/Vaccinium-Gaultheria*)

Habitat types	Plots	CP (%)	ADF (%)	NDF (%)	RFV
PEu/PVG	10	12.0±0.7	31.2±2.0	46.1±2.1	131.3±9.1
ArDe	7	10.9±0.7	28.4±2.3	38.7±3.3	162.9±17.9
ATiFrCi/AQVb-Gr	9	10.6±0.6	30.5±1.7	42.2±2.1	144.8±10.6

Table 3.—Crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), and relative feed value (RFV) for *Q. ellipsoidalis* and *Q. rubra* seedling leaves collected in central Wisconsin, 2012

Species	Number of plots	CP (%)	ADF (%)	NDF (%)	RFV
Q. ellipsoidalis	11	11.8±0.7	28.7±1.8	40.3±2.1	155.0±18.3
Q. rubra	15	10.7±0.4	31.3±1.3	44.6±2.1	136.8±21.9

DISCUSSION

One of the original reasons that I decided to complete this short study was that we have seen oak successfully recruit on poor quality sites (Schwartz 2012, Schwartz and Demchik 2012); however, oak on richer sites struggles to succeed (Demchik et al. 2013, unpublished survey[2]). One possible reason was that the nutritional quality was lower, resulting in lower preference by deer. This study does not seem to support that explanation. Crude protein was higher on PVG/PEu sites than on ArDe and ATiFrCi/AQVb-Gr sites, and even though RFV is lower on PVG/PEu sites, the quality is still very high (Jeranyama and Garcia 2004). When RFV was calculated for oak leaves from the data in two other papers that had measured oak ADF and NDF, gall oak (*Q. infectoria*) in Turkey (Parlak et al. 2011) showed a range of RFV from 82 to 96 (depending on sampling month) and Pyrenean oak (*Q. pyrenaica*) in Spain showed a range of 124 to 163 (Ammar et al. 2010). Our data showed higher RFV than Parlak et al. (2011) but values comparable to Ammar et al. (2010). Although levels of tannins were not measured (high tannin levels can reduce forage usability to livestock and wildlife), this level of RFV is comparable to good quality cattle forage. The high RFV and CP on the habitat type with the worst site quality (PVG/PEu) suggest that forage quality issues are not an important factor in the higher levels of success in regeneration seen on PVG/PEu sites. Furthermore, these data suggest that the preferential deer browsing on oak is due to high overall palatability of the genus.

Also surprisingly, northern pin oak had both higher RFV and higher CP than northern red oak. As the interaction of species by habitat types was not significant, the uneven representation of northern red oak and northern pin oak on different habitat types was not the origin of this effect. The sample year, 2012, was a severe drought year in central Wisconsin; this drought may have had a disproportional impact on northern red oak. Curtis (1959) ranked northern red oak as less drought tolerant than the other associated oak species. The impact of northern red oak's inferior drought tolerance when compared to northern pin oak (a very drought-adapted species) is impossible to determine from our data set. Northern red oak may simply have lower forage value than northern pin oak or it may be a relic of the exceptionally dry summer of the sample year.

Overall, it appears that oak's higher success at regenerating cut sites on PVG/PEu sites when compared to other habitat types is not related to the forage value of the leaves. Oak on all three habitat type groupings were very high in RFV and CP.

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