Nutrient Analysis of Two Browse Species

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Highlight

In current twigs of American beautyberry and rusty blackhaw, fiber content increased during spring and remained high for the remainder of the year. Old twigs usually contained more fiber than current twigs. Levels of protein, nitrogen-free extract, and cell contents—the most digestible fractions—were highest in spring, and new twigs contained higher levels than old twigs. Leaves, particularly those of beautyberry, were more nutritious than twigs or fruit. Beautyberry fruit was most succulent and nutritious when it ripened in early autumn.

This paper reports the nutrient composition of twigs, leaves, and fruit of American beautyberry (*Callicarpa americana*) and of twigs and leaves of rusty blackhaw (*Viburnum rufidulum*). These deciduous shrubs are common in southern forests, where they are eaten by deer and other animals.

To compare methods of analysis, plant samples were assayed both by standard proximal analysis (Maynard and Loosli, 1962) and by their solubility in detergent solutions. The latter determinations are thought to be the more meaningful in animal nutrition studies (Van Soest, 1963).

Methods

The terminal 4 inches of the current year's twigs, the distal 4 inches of the previous year's twigs, and the leaves, when present, were sampled monthly from American beautyberry and rusty blackhaw. In addition, fruit of American beautyberry was picked monthly in late summer and autumn to obtain immature, ripe, and overripe fruit. Collections were made from April 1965 through April 1966, usually during the first week of the month. Samples were composited from 5 to 10 individual plants. They were collected at the Stephen F. Austin Experimental Forest near Nacogdoches, Texas.

Samples were ovendried at 45 C. Plant tissue was then ground in a Wiley mill and analyzed at the Fertilizer and Feedstuffs Laboratory, Louisiana Agricultural Experiment Station, Louisiana State University, Baton Rouge. Crude protein, crude fat, ash, crude fiber, and nitrogen-free extract were determined by standard proximal analysis. Cell wall and cellular constituents were determined by the procedure of Van Soest and Wine (1967); acid detergent fiber and acid detergent lignin, by the technique of Van Soest (1963); and cellulose, by procedures of Crampton and Maynard (1938). The nutrient contents of the forage samples are expressed as percents of ovendry weight.

Results

Chemical Composition of Twigs

Seasonal Trends.—In rusty blackhaw and American beautyberry, stem elongation ceases and terminal buds are formed after a rapid flush of growth in early spring (Halls and Alcaniz, 1965). During the period of very rapid growth, current twigs of rusty blackhaw were lowest in fibrous constituents such as cell wall contents, crude fiber, acid detergent fiber, lignin, and cellulose (Fig. 1). Fibrous contents increased as twigs became less succulent, and, by the time the terminal buds appeared and twig elongation ceased, fiber levels were reached that remained high for the remainder of the year. Dry matter content of current twigs varied widely but generally increased from early spring to summer. It was highest in late summer, frequently a drought period in east Texas. Fibrous constituents of old twigs varied little throughout the year. Fig. 1 shows changes in fibrous constituents in current and old twigs of rusty blackhaw. Similar trends occur in beautyberry.

In both species, protein, nitrogen-free extract, and cell contents of current twigs gradually diminished from early spring until early summer and then changed little for the remainder of the year. The proportions of these constituents in old twigs remained relatively constant throughout the year.

Comparing Current and Old Twigs.—Current twigs of rusty blackhaw, including those sampled after elongation ceased, contained higher proportions of protein, crude fat, ash, nitrogen-free extract, and cell content than did 1-year-old twigs (Table 1). The cellulose content was about the same in current and old twigs, but current twigs contained slightly more lignin. Crude fiber, cell wall content, and acid detergent fiber content were significantly greater in old than in current twigs.

The dry matter content of both current and old twigs of rusty blackhaw varied throughout the year, but the average dry matter values for new and old twigs were not significantly different.

Current twigs of American beautyberry sampled after the cessation of annual growth had higher protein, ash, nitrogen-free extract, and cell contents than old twigs. Old twigs had larger proportions of crude fiber, cell wall content, acid detergent fiber, acid detergent lignin, and cellulose.

The current twigs of the two species had similar

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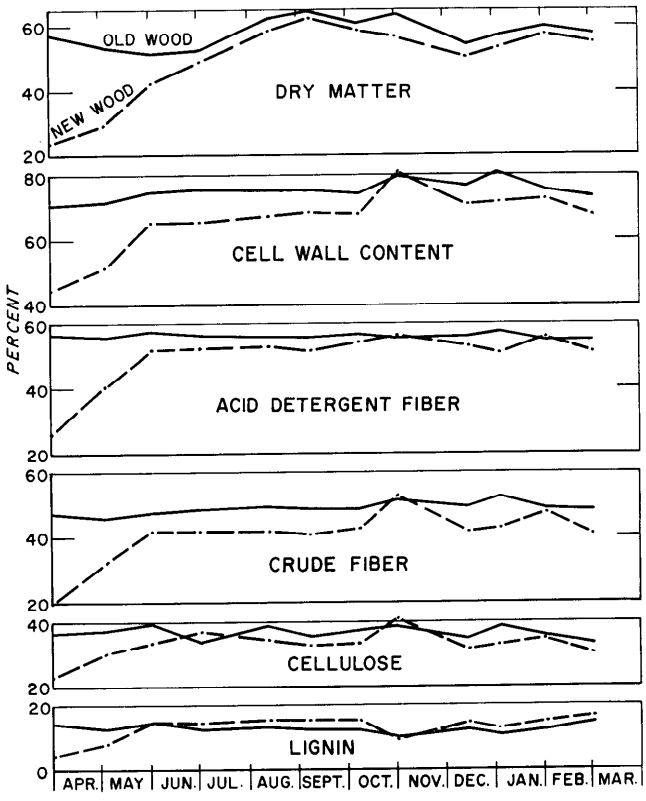

FIG. 1. Monthly changes in dry matter content as a percent of fresh weight and in various measures of fibrous constituents as percents of ovendry weight in twigs of rusty blackhaw.

nutrient contents, except for a higher protein ($P < 0.01$) and lower fat ($P < 0.01$) content in beautyberry.

In both species, current twigs are the only ones that appear to be useful food to animals, and they, only briefly in the spring when, paradoxically, demand for browse is least because of the great abundance of other food.

Chemical Composition of Leaves

The protein content of leaves of both species gradually decreased from early spring until autumn leaf drop. Leaf dry matter of both species fluctuated throughout the summer. The crude fat content of blackhaw leaves increased somewhat during the growing season. The other measured leaf components varied little during and after June, when the leaves were fully developed.

Beautyberry leaves had higher protein ($P < 0.01$) and lignin ($P < 0.05$) contents but lower nitrogen-free extract ($P < 0.01$) content than did blackhaw leaves (Table 2). Other measured components were present in similar proportions in both species. Higher protein content of leaves and a growth form in which they are more readily accessible probably make beautyberry leaves, if palatable, a more desirable forage than blackhaw leaves.

The higher levels of nitrogen-free extract, cell contents, protein, fat, and ash in leaves indicate that they are more nutritious than twigs.

Table 1. Means and standard errors for expressions of chemical composition of twigs. (Values other than dry matter are percentages of ovendried weight.)

Fraction	Rusty Blackhaw		American Beautyberry	
	Current Twigs	Old Twigs	Current Twigs	Old Twigs
	%	%	%	%
Dry matter	54.3 ± 1.6	57.9 ± 1.3	54.1 ± 2.0	61.2 ± 2.2
Crude protein	3.6 ± 0.2†	3.0 ± 0.1	5.9 ± 0.3†	4.2 ± 0.3
Crude fat	3.2 ± 0.2†	2.2 ± 0.2	1.9 ± 0.2	1.5 ± 0.2
Ash	5.2 ± 0.2*	4.6 ± 0.2	4.7 ± 0.2	3.8 ± 0.2
Crude fiber	43.6 ± 1.1	49.0 ± 0.5†	43.6 ± 1.0	54.1 ± 1.8†
Nitrogen-free extract	44.4 ± 0.7†	41.3 ± 0.5	43.9 ± 0.7†	36.4 ± 1.2
Cell wall content	69.9 ± 1.3	75.1 ± 0.8†	70.5 ± 0.8	78.1 ± 1.4†
Cell content	30.1 ± 1.3†	24.9 ± 0.8	29.5 ± 0.8†	21.9 ± 1.4
Acid detergent fiber	53.0 ± 0.6	55.9 ± 0.2†	53.7 ± 0.5	60.3 ± 1.2†
Acid detergent lignin	14.4 ± 0.6*	12.9 ± 0.4	14.5 ± 0.4	17.9 ± 0.8†
Cellulose	34.4 ± 0.9	36.5 ± 0.6	34.7 ± 1.0	38.7 ± 1.4*

† Means of current and old twigs significantly different ($P < 0.01$).

* Means of current and old twigs significantly different ($0.01 < P < 0.05$).

Table 2. Means and standard errors for expressions of chemical composition of rusty blackhaw leaves and American beautyberry leaves and fruit. (Values other than dry matter are percentages of ovendried weight.)

Fraction	Rusty Blackhaw Leaves %	American Beautyberry Leaves %	American Beautyberry Fruit %
Dry matter	40.2 ± 2.2	35.2 ± 1.4	32.1 ± 2.7
Crude protein	8.1 ± 0.7	14.8 ± 0.9	6.8 ± 0.3
Crude fat	7.3 ± 0.8	8.6 ± 0.6	8.6 ± 1.4
Ash	9.0 ± 0.2	8.9 ± 0.3	5.5 ± 1.2
Crude fiber	14.5 ± 0.6	15.1 ± 0.5	32.9 ± 3.0
Nitrogen-free extract	61.1 ± 0.4	53.4 ± 1.1	46.2 ± 2.2
Cell wall content	31.7 ± 1.9	31.5 ± 1.7	52.7 ± 3.7
Cell content	68.3 ± 1.9	68.5 ± 1.7	47.3 ± 3.7
Acid detergent fiber	24.5 ± 1.3	24.3 ± 1.6	36.6 ± 2.8
Acid detergent lignin	6.2 ± 0.2	7.1 ± 0.3	13.4 ± 1.0
Cellulose	21.3 ± 1.0	18.5 ± 0.9	19.2 ± 2.2

Chemical Composition of Fruit

American beautyberry bears fruit abundantly, and the berries persist for several months. In August, before the berries ripened, proportions of dry matter and of all fiber fractions were high. When they ripened in September to early November, the berries were succulent. Levels of all fiber components dropped, while levels of cell content, nitrogen-free extract, and crude fat increased. In December, when berries were overripe, proportions of fiber and ash increased and those of cell content, crude fat, and nitrogen-free extract decreased. Protein content did not vary substantially in the fruit samples.

Fruit of American beautyberry appears to contain more fiber and less of several desirable nutrients than do leaves (Table 2). Most of the fiber in the fruit is probably in the hard coats of the four small seeds, which may pass intact through many animal digestive tracts. The fleshy portion, on the other hand, is probably readily digestible. Analyses of the fleshy portion and the seeds together may not indicate the true value of the fruit.

Comparison of Measurements

Van Soest (1963) noted two weaknesses of the proximal analysis. One, the nitrogen-free extract fraction, which is assumed to contain the digestible carbohydrates, also includes most of the hemicellulose and lignin as well as some cellulose. Two, the crude fiber fraction, which is assumed to contain the indigestible carbohydrates, is sometimes more digestible than the nitrogen-free extract. Cell content, cell wall content, acid detergent fiber, and acid detergent lignin values of grasses and legumes appear, therefore, to have nutritional significance for domestic ruminants. The present study is the first to compare the results of proximal and acid detergent analyses for southern browse plants.

Fibrous components measured by proximal analysis and by acid detergent techniques are different, although the seasonal changes for each fraction are similar (Fig. 1). In current twigs, crude fiber values were 81 to 83% of those for acid detergent fiber and 62% of those for cell wall content (Table 3). Van Soest and Moore (1966) found even larger differences between crude fiber and acid detergent fiber contents. Cellulose content estimated by the Crampton and Maynard (1938) technique was only about 90% of that determined by subtracting acid detergent lignin content from acid detergent fiber content.

Both nitrogen-free extract from proximal analysis and cell contents from the acid detergent analysis represent remainders after other components have been removed. Because cell wall content is the more conservative measure, cell content is the smaller expression of readily digestible components. Its value was only about two-thirds of that for nitrogen-free extract in current twigs, and even less in old twigs (Table 3).

Digestion trials will be needed to precisely evaluate the relative merits of the two systems of analysis. Since deer utilize little fiber (Short, 1963), cell contents may prove a better indicator than nitrogen-free extract of readily digestible material in plant tissue. Short and Remmenga (1965) and Short (1966) found meaningful inverse relations between cellulose content of forage and energy and dry-matter utilization by deer. Therefore, the acid detergent fiber fraction, which represents the combined lignocellulose portion of forages, may usefully predict forage quality for deer.

Both systems of analysis indicate that leaves were

Table 3. Comparative values of different measures of the nutrient content of twigs. Measures compared were percentages of ovendried weight.

Comparison	Rusty Blackhaw Current Twigs %	Rusty Blackhaw Old Twigs %	American Beautyberry Current Twigs %	American Beautyberry Old Twigs %
Crude fiber/acid detergent fiber	83	88	81	90
Cellulose/acid detergent fiber–lignin	89	85	89	91
Crude fiber/cell wall contents	62	65	62	69
Cell contents/nitrogen-free extract	68	60	67	60

the most nutritious portions of the two species studied. Leaves were highest in nitrogen-free extract, cell contents, protein, and fat. American beautyberry fruit may also be useful when it ripens in September to early November. Among twigs, only the current ones of the two species appear to have any forage value, and they, only during rapid elongation in the spring. Blair and Epps (1967) have found that the extreme tips of blackhaw twigs have significantly higher protein contents than other portions of the twigs. By browsing only the terminal buds and tips of twigs, deer might obtain forage of higher quality than that indicated by the present study.

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