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The Nutritive Value of Common Pasture Weeds and Their Relation to Livestock Nutrient Requirements

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Introduction

Weeds constantly invade crop fields and pastures; therefore, it is important to know the potential quality of individual weed species in making management decisions concerning weed control. It is frequently assumed that weeds have low nutritive value and livestock will not eat weeds, so expensive and time-consuming measures are often used for their control.[12] Some weeds are toxic or poisonous to livestock, and certain weeds are unpalatable – causing a reduction in total intake.[9] Several weed species have thorns or spines that can injure the grazing animal's mouth and/or irritate its eyes, which may lead to pinkeye.[9] Other weeds can cause the milk and meat of livestock to have a negative taste or odor. Weeds also compete with cultivated crops and forages for moisture, light, and nutrients, but many weeds are nutrient-rich and digestible.[9] The objective of this review paper is to recognize the nutritional values of weeds commonly found in pastures.[2]

Nutritive Value

Invitro Dry Matter Digestibility

Crop harvesting methods allow for weeds to be removed from the crop, but the usual method of mowing forage crops causes weeds to be harvested along with the forages, which can cause a reduction in quality.4 Digestibility is the extent to which forage is absorbed as it passes through an animal's digestive tract.1 Many winter and summer annual and perennial weeds have high invitro dry matter digestibility (IVDMD) – an estimate of animal digestion – at the vegetative stage that is even higher than some cultivated forages.

In a study conducted by Marten et al.,[13] dandelion (*Taraxacum officinale*), white campion (*Silene alba*), perennial sowthistle (*Sonchus arvensis*), Jerusalem artichoke (*Helianthus tuberosus*), hoary asylum (*Berteroa incana*), and Canada thistle (*C arvense*) at their vegetative and bud stages had IVDMD greater than or equal to alfalfa (*Medicago sativa*) (table 1). Redroot pigweed (*Amaranthus retroflexus*) and common ragweed (*Ambrosia artemisiifolia*) had greater IVDMD than alfalfa, while common lambsquarters (*Chenopodium album*), yellow foxtail (*Setaria glauca*), and barnyardgrass (*Echinochloa crus-galli*) had similar IVDMD to alfalfa[12] (table 2). In a second study done by Marten and Anderson,[12] common ragweed, velvetleaf (*Abutilon theophrasti*), redroot pigweed, and barnyardgrass had greater IVDMD when compared to oats (*Avena sativa*) (data not shown).

The digestibility of some weeds tends to decrease more rapidly than cultivated forages as the plant matures.[2] There are some exceptions, like the winter annual henbit (*Lamium amplexicaule*) and the winter or summer annual Carolina geranium (*Geranium carolinianum*), which maintained high IVDMD at later maturity stages[2] (table 3). The summer annual species bur gherkin (*Cucumis anguria*) and morningglories (*Ipomoea*) kept constant digestibility across growth stages[3] (table 4). In a study by Marten et al.,[13] Jerusalem artichoke, Canada thistle, and perennial sowthistle consistently had greater IVDMD than alfalfa across sampling dates (table 1).

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Table 1. Invitro digestible dry matter concentration of two perennial forages and weeds[a]

Species	1981				1982		
	May 18	June 1	June 15	June 29	May 19	June 1	July 27
	— — — — — — — — — — — — % — — — — — — — — — — —						
Alfalfa	79[c]	69[e]	62[g]	49[h]	78[b]	68[c]	69[g]
Smooth bromegrass	78[k]	66[m]	59[n]	57[o]	76[j]	67[l]	68[b]
Quackgrass	78[j]	69[k]	63[m]	59[n]	75[j]	69[k]	63[b]
Dandelion	82[g]	84[i]	—	—	78[g]	77[i]	74[b]
White campion	—	—	—	6[l]	80[b]	75[e]	67[g]
Swamp smartweed	—	—	54[b]	49[b]	—	58[b]	34[b]
Perennial sowthistle	—	—	82[e]	66[g]	—	79[b]	—
Jerusalem artichoke	86[b]	81[b]	70[b]	66[b]	81[b]	81[b]	71[b]
Curly dock	—	—	—	—	77[b]	64[b]	50[b]
Hoary alyssum	89[c]	76[g]	64[h]	58[i]	—	—	—
Canada thistle	—	—	76[d]	64[g]	79[b]	78[b]	72[d]

[a]Adapted from Marten, G. C., C. C. Sheaffer, and D. L. Wyse. 1987. Forage nutritive value and palatability of perennial weeds. *Agronomy Journal*. 79:980-986.
[b]Vegetative; [c]Early bud; [d]Bud; [e]Late bud; [f]Early bloom; [g]Mid-bloom; [h]Full bloom; [i]Seed; [j]Joint; [k]Boot; [l]Early head; [m]Head; [n]Anthesis; [o]Green seed.

Table 2. Quality of alfalfa occurring in a newly established stand compared to seven annual weeds occurring in a weed nursery on July 16, 1971[a]

Species	Invitro digestible dry matter (IVDDM)	Acid detergent fiber (ADF)	Crude protein (CP)
	— — — — — — — — — % — — — — — — — — —		
Alfalfa[b]	72	24	27
Redroot pigweed[c]	73	21	25
Common lambsquarters	68	22	25
Common ragweed	73	25	25
Pennsylvania smartweed	51	22	24
Yellow foxtail	69	30	20
Giant foxtail	62	33	18
Barnyardgrass	70	33	18

[a]Adapted from Marten, G. C., and R. N. Andersen. 1975. Forage nutritive value and palatability of 12 common annual weeds. *Crop Science* 15:821-827.
[b]Alfalfa was seeded on May 14, 1971.
[c]Weed nursery was seeded naturally in late summer and autumn of 1970.

Table 3. Crude protein (CP) and invitro dry matter digestibility (IVDMD) of common weeds and forages at three stages of maturity[a]

Weeds	Vegetative		Flower/boot		Fruit/head	
	CP	IVDMD	CP	IVDMD	CP	IVDMD
	%					
Herbaceous weeds						
Carolina geranium	19	78	19	70	11	68
Curly dock	30	73	19	54	16	51
Cutleaf evening primrose	20	72	14	69	11	52
Henbit	—	—	20	78	16	75
Virginia pepperweed	32	86	26	72	17	63
Grasses						
Cheat	23	81	18	69	14	61
Little barley	24	82	18	78	14	62
Virginia wildrye	23	80	19	74	7	60
Wild oats	23	75	—	—	—	—
Forages						
Hairy vetch	30	80	29	77	26	77
Ladino clover	27	81	22	85	23	83
Rye	28	79	24	81	13	70
Tall fescue	22	78	17	73	13	67

[a]Adapted from Bosworth, S. C., C. S. Hoveland, and G. A. Buchanan. 1985. Forage quality of selected cool-season weed species. *Weed Science* 34:150-154.

Crude Protein

Protein is essential in all livestock diets, but protein requirement varies with each type of animal. In research conducted by Bosworth et al.,[2] all of the winter/summer annual weeds and the cultivated forages at all three maturity stages evaluated had sufficient crude protein (CP) – except for Virginia Wildrye (*Elymus virginicus* L.) – (table 3) to meet the requirements for mature beef cows (10.5 percent CP); first-calf beef heifers (10.5 percent CP); and pregnant, replacement beef heifers (8.8 percent CP) at all reproductive stages.[7] All the winter annual weeds and cultivated forages (table 3) at the vegetative stage would meet the CP needs of dairy heifers (16 percent CP); dry, pregnant dairy cows (18 percent CP); lactating dairy cows (19 percent CP); young goats (14 percent CP); does (14 percent CP); bucks (11 percent CP); mature ewes (15 percent CP); and finishing and replacement lambs (11.6 percent CP).[10,16]

Summer/winter annual weeds and forages at the vegetative stage (table 5) in the Bosworth et al. study[3] had adequate CP for all types of beef cattle (10.5 percent CP),[7] whereas the concentration of crabgrass (*Digitaria*) CP (table 4) is sufficient to meet the requirements of dairy heifers, young goats, does, bucks, mature ewes, and finishing and replacement lambs.[16] The summer annual/perennial species coffee senna (*Cassia occidentalis*), prickly sida (*Sida spinosa*), crowfootgrass (*Dactyloctenium aegyptium*), Texas panicum (*Panicum texanum*), yellow foxtail, bermudagrass (*Cynodon* spp.), and pearl millet (*Pennisetum glaucum*) (table 4) have inadequate CP levels for low-producing, lactating dairy cows (19 percent CP).[16] All the summer annual/perennial weeds and forages at the vegetative stage in the Bosworth et al. study[3] (table 4) meet the CP needs for all goats and sheep except crabgrass, which would not fulfill the CP requirements for mature lactating ewes when suckling twins (15 percent CP).[10]

Table 4. Crude protein (CP) and invitro dry matter digestibility (IVDMD) of weeds and forages at three stages of maturity[a]

Weeds	Vegetative		Flower/boot		Fruit/head	
	CP	IVDMD	CP	IVDMD	CP	IVDMD
	----------% ----------					
Herbaceous weeds						
Bur gherkin	—	—	17	75	14	79
Coffee senna	17	81	22	75	15	67
Common purslane	—	—	19	80	—	—
Cypressvine morningglory	20	80	—	—	13	77
Florida beggarweed	22	74	17	65	13	55
Hemp sesbania	31	70	14	66	11	52
Ivyleaf morningglory	20	80	—	—	11	78
Jimsonweed	25	72	21	66	17	59
Prickly sida	17	80	18	70	12	56
Redroot pigweed	24	73	17	71	11	64
Sicklepod	22	84	14	76	17	71
Tall morningglory	20	82	—	—	14	76
Grasses						
Crabgrass	14	79	8	72	6	63
Crowfootgrass	16	67	8	54	9	43
Fall panicum	19	72	9	63	7	54
Texas panicum	16	74	11	62	8	52
Yellow foxtail	18	73	12	66	14	57
Forages						
Bermudagrass	16	58	7	51	8	43
Pearl millet	17	59	6	60	8	60

[a]Adapted from Bosworth, S. C., C. S. Hoveland, G. A. Buchanan, and W. B. Anthony. 1980. Forage quality of selected warm-season weed species. *Agronomy Journal* 72:1050-1054;

Winter/summer annuals or perennial herbaceous weeds had similar CP at the vegetative stages, but winter annual grassy weeds and cultivated forages had higher CP than summer annual grassy weeds and cultivated forages at the vegetative stage (tables 3, 4). In another study by Marten et al.[13] where CP concentrations of weeds were compared to alfalfa, the weeds white campion, Jerusalem artichoke, curly dock (*Rumex crispus*), and Canada thistle had similar or greater CP than alfalfa at the vegetative stage (table 7). Temme et al.[17] saw that the CP content of common lambsquarters remained greater even at the bud and flower stages, while shepherds purse (*Capsella bursa-pastoris*) still had elevated CP at the green-seed stage (table 6).

Neutral Detergent Fiber

Neutral detergent fiber (NDF) is the measure of total cell-wall constituents, including hemicellulose, cellulose, lignin, and insoluble ash in a plant; it is often used to predict intake potential of the plant by livestock.[1] As NDF increases, nutritive value declines because fiber is increasing. Research by Marten et al.[13] showed that smooth bromegrass (*Bromus inermis*) and quackgrass (*Elytrigia repens*) consistently had greater NDF than alfalfa and the herbaceous weeds tested (table 5). Marten and Anderson[12] revealed that the grassy weeds yellow foxtail, green foxtail (*Setaria viridis*), giant foxtail (*Setaria faberi*), and barnyardgrass, along with oats, had greater cell-wall constituents than herbaceous

Table 5. Neutral detergent fiber concentration of two perennial forages and nine weeds[a]

Species	1981				1982		
	May 18	June 1	June 15	June 29	May 19	June 1	July 27
	%						
Alfalfa	31[b]	45	51	64	30	42	35
Smooth bromegrass	49	65	67	66	47	63	56
Quackgrass	46	59	66	64	41	53	56
Dandelion	26	30	—	—	27	33	25
White campion	—	—	—	58	35	46	48
Swamp smartweed	—	—	44	44	—	35	40
Perennial sowthistle	—	—	31	45	—	27	—
Jerusalem artichoke	22	34	47	49	24	29	32
Curly dock	—	—	—	—	24	33	33
Hoary alyssum	29	42	52	60	—	—	—
Canada thistle	—	—	41	50	28	32	34

[a]Adapted from Marten, G. C., C. C. Sheaffer, and D. L. Wyse. 1987. Forage nutritive value and palatability of perennial weeds. *Agronomy Journal* 79:980-986.

[b]Same maturity stages as indicated for each species and date in table 1.

Table 6. Quality at two growth stages of weeds in spring-sown alfalfa[a]

	Harvest date in July	Growth stage	Crude protein (CP)	Invitro digestible dry matter (IVDDM)	Neutral detergent fiber (NDF)	Acid detergent fiber (ADF)
----------	----------	----------	%			
Common lambsquarters	2	Bud	22	73	22	17
Common lambsquarters	7	Flower	18	67	27	19
Shepherds purse	2	Green seed	19	55	37	29
Shepherds purse	7	Seed	16	53	41	34
Pennsylvania smartweed	2	Flower	18	47	24	19
Pennsylvania smartweed	7	Late flower	15	44	32	19
Redroot pigweed	2	Flower	18	74	22	16
Redroot pigweed	7	Early seed	15	73	27	20
Yellow foxtail	2	Early seed	17	63	52	27
Yellow foxtail	7	Seed	14	60	54	30
Common ragweed	2	Vegetative	26	77	21	17
Common ragweed	7	Vegetative	21	70	26	21
Alfalfa	7	Early bloom	20	70	28	23

[a]Adapted from Temme, D. G., R. G. Harvey, R. S. Fawcett, and A. W. Young. 1979. Effects of annual weed control on alfalfa forage quality. *Agronomy Journal* 71:51-54.

weeds. These same grassy weeds and oats usually had three times as much hemicellulose as the herbaceous weeds. Dandelion, Jerusalem artichoke, and curly dock had lower NDF than alfalfa in the Marten et al. study[13] (table 5). Temme et al.[17] found that common lambsquarters, Pennsylvania smartweed (*Polygonum pensylvanicum*), redroot pigweed, and common ragweed had NDF concentrations similar to or slightly lower than alfalfa, but shepherds purse and yellow foxtail were greater (table 6).

Acid Detergent Fiber

Acid detergent fiber (ADF) is a measure of the same cell-wall constituents measured for NDF, excluding hemicelluloses.[12] Acid detergent fiber has been used to estimate the digestibility of a plant. Several studies have shown that certain herbaceous weeds have less ADF than alfalfa. Redroot pigweed, common lambsquarters, and Pennsylvania smartweed had less ADF than alfalfa when studied by Marten and Anderson[12] (table 2). Temme et al.[17] had similar results where common lambsquarters, Pennsylvania smartweed, redroot pigweed, and common ragweed had similar or lower ADF percentages than alfalfa (table 6). Marten and Andersen's results[12] showed that common ragweed had a greater ADF concentration than alfalfa, but a similar IVDMD (table 2); they rationalized that the fiber in ragweed and other herbaceous weeds must be less lignified and more digestible than alfalfa fiber.

Mineral Composition

The calcium-to-phosphorus ratio (Ca:P) of forage is often discussed when examining forage quality and animal performance. An acceptable Ca:P ratio is between 1:1 and 7:1, as long as there is enough phosphorus (P) to meet the animal's nutritional requirements.[14,15] High Ca:P ratios have been blamed for animal disorders such as milk fever, impaired feed conversion, and poor breeding performance.[13] Cutleaf evening primrose (*O. laciniata*) had Ca:P ratios greater than 7:1 at all maturity stages, while Carolina geranium and ladino clover (*Trifolium repens* L.) had Ca:P ratios exceeding 7:1 only at the later growth stages, according to data from Bosworth et al.[2] Among the summer annual herbaceous weeds, sicklepod (*Senna obtusifolia*), coffee senna, hemp sesbania (*Sesbania exaltata*), Florida beggarweed (*Desmodium tortuosum*), prickly sida, and bur gherkin had Ca:P ratios greater than 7:1.[3] Canada thistle was the only weed in the Marten et al. study[13] that had Ca:P ratios that might cause problems. Marten and Anderson[12] reported a Ca:P ratio of 7:1 for velvetleaf and a 7.7:1 ratio for giant ragweed (*Ambrosia trifida*). These weeds with Ca:P ratios exceeding 7:1 would be a problem only if they were the lone feed source for the animal, which would rarely occur in normal pasture or hay production.

Animal Utilization

Palatability

Quality of a weed or forage has no value if the animal will not eat it. Cattle tend to eat mostly grasses in a pasture, leaving herbaceous weeds and shrubs untouched. Sheep graze broadleaf plants before grasses and shrubs, while goats will eat the shrubs not grazed by sheep or cattle. Therefore, combining cattle, sheep, and goats in a pasture can lead to increased utilization and profitability.[4]Several factors affect the palatability of a plant, including texture, leafiness, fertilization, moisture content, pests, and compounds in the plant.[1] Many studies do not include palatability trials to observe if the plants will actually be consumed. Marten et al.[13] did include a palatability study and found that most herbaceous weeds were less palatable than alfalfa or smooth bromegrass. The lambs used in their study basically rejected Jerusalem artichoke, curly dock, hoary asylum, and Canada thistle, which may be due to physical characteristics such as spines and hairs on most of these species.[13] Giant foxtail, wild mustard (*Synapis arvensis*), giant ragweed, and cocklebur (*Xanthium strumarium*) were less palatable than oats when tested by Marten and Anderson,[12] with a very low percentage (35.0 percent, 2.5 percent, 0.0 percent, and 0.0 percent, respectively) being consumed after 12 days. Holst et al.[8] found that goats and sheep would readily consume nodding thistle (*Carduus nutans*) when it reached a height of about 12 inches. The goats ate the flowering nodding thistle even when there was abundant pasture available to the animals.[8] Palatability is a key factor in determining the quality of weeds because there is no nutritive value for animals if they will not eat the species.

Grazing Management

When grazing pastures containing weeds, management is very important to achieve successful weed utilization and suppression. Researchers have tested the effects of different grazing systems and different animal types on weed suppression and animal utilization. De Bruijn

Table 7. Crude protein concentration of two perennial forages and nine weeds[a]

Species	1981				1982		
	May 18	June 1	June 15	June 29	May 19	June 1	July 27
	%						
Alfalfa	27[b]	20	15	14	26	20	21
Smooth bromegrass	16	11	8	7	23	14	18
Quackgrass	17	13	9	7	27	18	19
Dandelion	17	12	—	—	20	13	20
White campion	—	—	—	11	26	15	14
Swamp smartweed	—	—	17	14	—	22	17
Perennial sowthistle	—	—	16	13	—	21	—
Jerusalem artichoke	27	18	11	10	29	19	22
Curly dock	—	—	—	—	28	17	20
Hoary alyssum	20	14	12	7	—	—	—
Canada thistle	—	—	17	15	28	19	18

[a]Adapted from Marten, G. C., C. C. Sheaffer, and D. L. Wyse. 1987. Forage nutritive value and palatability of perennial weeds. *Agronomy Journal* 79:980-986.
[b]Same maturity stages as indicated for each species and date in table 1.

and Bork[5] researched Canada thistle management in temperate pastures using three different cattle-grazing systems, including season-long, low-intensity/high-frequency rotational grazing, and high-intensity/low-frequency rotational grazing. Season-long grazing sustained the amount of Canada thistle in the pastures and even increased the thistle in some cases, which resulted in a lower forage yield. High-intensity/low-frequency rotational grazing resulted in the greatest suppression of Canada thistle, with lower thistle-shoot density and biomass. Most Canada thistle shoots were eliminated with two intense defoliations over two to three years with the high-intensity/low-frequency rotational grazing, due to cattle defoliation and trampling. The remaining Canada thistle shoots were mostly vegetative and of high quality, with greater nitrogen and moisture and lower ADF.[5] The high-intensity/low-frequency rotational grazing pastures still had the lowest Canada thistle density a year after grazing ended, with the season-long grazing pastures having the lowest grass production.

A study conducted in Waynesville, N.C. – located in the Appalachian region of the United States – tested the effectiveness of cattle grazing alone, and with goats, on hill-land pasture dominated by herbaceous weeds and brush.[11] The experiment utilized 30 mature does per 2.5 acres, or cattle with goats (17 does and two to three steers per 2.5 acres, each steer weighing approximately 500 pounds). Managed grazing by the cattle and goats increased herbaceous vegetative cover of the pastures (from 65 percent to 86 percent) after four grazing seasons. The grass species tall fescue (*F. arundinacea*) and Kentucky bluegrass (*Poa pratensis*) in the pastures were increased from 16 percent to 63 percent in pastures grazed by goats, and from 13 percent to 54 percent in cattle and goat pastures.[11] Multiflora rose (*R. multiflora* Thunb.) bushes were drastically defoliated over the four grazing seasons, leaving few plants remaining in the pastures.

Hay Quality

Weeds can often make up a large percentage of a hay crop, especially in early spring when winter annual weeds are thriving.[2] At the first hay cutting, many winter annual weeds such as curly dock, Virginia pepperweed (*Lepidium virginicum*), and cutleaf evening primrose may be mature, which may cause hay quality to decline.[2] Bosworth et al.[3] indicated that if some of the higher quality but less palatable summer annual weeds – sicklepod, coffee senna, hemp sesbania, prickly sida, and jimsonweed (*Datura stramonium*) – were included in hay, they could still provide a nutritious food source. Conversely, Marten et al.[13] indicated that the incorporation of unpalatable species like Canada thistle, hoary asylum, Jerusalem artichoke, curly dock, perennial sowthistle, or swamp smartweed (*Polygonum coc-*

cineum) into pastures or hayfields may cause forage intake to decrease.

The amount of weeds contained in hay is an important factor to consider when determining hay quality. Dutt et al.[6] conducted research examining the quality of weedy and weed-free hay and the effects of individual weed species on hay quality. The weedy hay in one experiment contained 15 percent weeds – dandelion, yellow rocket (*Barbarea vulgaris*), and white cockle (*Silene latifolia* ssp. *alba*) – with the remaining 85 percent consisting of grass and alfalfa. There were no differences in animal intake or digestibility between the weedy and weed-free hay, but crude protein was slightly decreased in the weedy hay.

Another test showed that weedy hay containing 20 percent yellow rocket had lower crude protein, digestibility, and intake as compared to hay with no yellow rocket.[6] The goats actually picked out the alfalfa and grass in the hay and left the yellow rocket behind.

Conclusion

Winter/summer annual/biennial/perennial weeds are an inevitable component of pastures and hay fields. This literature review showed that herbaceous weeds and a few grassy weeds, such as barnyardgrass, can have invitro dry matter digestibility that is greater than or equal to high-quality species like alfalfa. The digestibility of many weeds decreases more rapidly than cultivated forages, with exceptions including some winter/summer annual/perennial herbaceous weeds, which maintained high IVDMD throughout maturity stages.

These studies revealed that grassy weeds have more neutral detergent fiber and acid detergent fiber than herbaceous weeds and alfalfa, and some herbaceous weeds have lower NDF and ADF than even alfalfa.

Crude protein is essential in all livestock diets, but the required amount is dependent upon livestock type and stage of life. Most winter/summer annual/perennial weeds and forages satisfy the CP needs of beef cattle. Dairy cattle require more CP than beef cattle, goats, and sheep, so some weeds and forages may not meet their needs. Protein decreases with maturity, so some summer annual or perennial weed and forage species, especially grasses, would not satisfy the CP needs of high-producing beef cattle, all dairy cattle, sheep, and goats at the flower/boot and fruit/head stages.

At all three maturity stages evaluated, winter annual herbaceous weeds, grassy weeds, and cultivated forages had similar or slightly greater CP than the summer annual/perennial herbaceous weeds, grassy weeds, and forages. Producers and researchers should be knowledgeable about the nutritive value of winter/summer annual/biennial/perennial weeds and forages so they can make the best management decisions for their particular operation or study.

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