The Chemical Composition of Medusahead and Downy Brome[1]

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INTRODUCTION

MEDUSAHEAD, *Elymus caput-medusae* L., an exotic winter annual grass, was introduced into northeastern Washington and probably adjacent Idaho over 50 years ago (6). Official records show its presence in southwestern Idaho 15 years ago, but ranchers in this area assert that it was present 25 to 30 years ago. Prior to 1950 it was known to infest a few thousand acres in southwestern Idaho and its distribution from 1945 to 1950 appeared rather static.

Since 1950, medusahead has become alarmingly aggressive. Estimates of the infested area in southwestern Idaho have increased from 20,000 acres in 1952[4] to 700,000 acres in 1958.[5] In a decade its position has changed from a minor problem to one of major concern to the range livestock industry. This problem is three-fold: first, it suppresses desirable vegetation due to its competitive ability; second, it is unpalatable to livestock at all stages of growth; and third, the dead vegetation decomposes slowly, thereby forming a persisting dense duff layer on the soil surface. In addition, as the plant matures it develops long barbed awns which cause mechanical injury to the eyes, noses, and mouths of grazing animals.

Medusahead is invading vast acreages formerly dominated by perennial grass species and more recently by downy bromegrass, *Bromus tectorum* L. The latter, although not a desirable range grass, provides considerable early spring forage. The growth habits, life cycles, and ecological adaptation of these two species appear to be similar. They typically grow in association until medusahead becames dominant and eventually exclusive.

No previous research has been reported on the composition of medusahead. Palatability differences of the two species stimulated studies on their comparative chemical composition and on methods to improve livestock utilization of medusahead. Such studies might reveal factors which could influence palatability and nutritive value. Data on the chemical composition of downy brome and many other grass species were previously available (4).

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[4]Anonymous. Noxious Weeds in the Columbia Basin. Noxious Weed Control Task Force. Columbia Basin Inter-Agency Committee. 1952.

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MATERIALS AND METHODS

Samples for these studies were obtained from an area in Nez Perce County in northern Idaho. The native grasses in this area had been replaced by medusahead and downy brome due to over-grazing and possibly persisting infestations of grasshoppers[6]. In this area, these grasses now exist in both mixed and adjacent pure stands.

To provide materials for these studies, respective pure stands were divided into grazing-protected and non-protected blocks. Replicated plots within each block were fertilized at 0, 20, and 160 pounds of nitrogen per acre in the fall, to provide sample areas the following year. The protected blocks provided materials for the chemical composition analyses while the unprotected medusahead block provided materials for grazing and silage studies.

Chemical composition samples were obtained from each of 3 replicated plots and combined for each nitrogen rate, at 5 harvest dates. The plants were severed at the soil surface. Thus, as the season advanced, the samples were composed of leaves; leaves and culms; and leaves, culms, and inflorescences. The sampling dates and stages of development for medusahead were: May 9—leaf, May 23—heading, June 6—flowering, June 21—late dough, and July 3—mature. Downy brome matures earlier and its development at these dates was: May 9—heading, May 23—flowering, June 6—late dough, June 21—mature, and July 3—mature.

Sub-samples for moisture determinations were placed in moisture tins and immediately brought to the laboratory where they were weighed, dried to constant weight at 100°C. and re-weighed. The remainder of each sample was autoclaved 5 minutes at 5 pounds pressure to inactivate enzymes. The material was then dried in a convection oven at 60°C. ground in a Wiley mill, and stored in sealed containers. Prior to analysis the ground material was further dried 48 hours in a vacuum oven. Duplicate determinations for crude fat, crude protein, crude fiber, lignin and ash were made according to official methods (1).

RESULTS AND DISCUSSION

The results of the chemical analyses of medusahead and downy brome obtained from the non-fertilized plots are given in Tables 1 and 2, respectively. The results for crude protein, crude fat, crude fiber, lignin, and ash are present on a dry-weight basis.

At comparable harvest dates, medusahead contained a higher percentage of moisture than downy brome. Typically downy brome matures earlier than medusahead. In this study downy brome preceded medusahead by at least one growth stage throughout the season. At comparable stages of development, the two species were approximately equal in moisture content. As expected, moisture content decreased as the plants matured.

When collected at the same date, medusahead contained more

[6]Portman, Roland, Correspondence and Grasshopper Survey Reports. Department of Entomology, University of Idaho.

Table 1. The percentage composition of medusahead, *Elymus caput-medusae* L., at five stages of development. All percentages other than moisture are expressed on a dry weight basis.

	Stage of growth				
	Leaf 5–9–58	Heading 5–23–58	Flowering 6–6–58	Dough 6–21–58	Mature 7–3–58
Moisture	66.8	62.7	50.3	34.9	—
Protein	10.4	8.8	6.8	6.5	7.3
Fat	2.6	2.3	1.8	1.6	1.0
Crude fiber	26.8	27.4	31.2	28.1	30.5
Lignin	6.1	9.7	8.6	10.0	7.9
Ash	13.9	13.7	12.8	14.7	14.5

Table 2. The percentage composition of downy brome, *Bromus tectorum* L., at five stages of development. All percentages other than moisture are expressed on a dry weight basis.

	Stage of growth				
	Heading 5–9–58	Flowering 5–23–58	Late dough 6–6–58	Mature	
				Early 6–21–58	Late 7–3–58
Moisture	64.6	49.0	30.3	8.2	—
Protein	8.0	8.8	7.1	4.6	4.7
Fat	1.5	2.0	1.8	1.3	1.2
Fiber	31.3	24.5	27.2	35.6	39.6
Lignin	8.4	8.5	9.7	11.2	11.4
Ash	8.1	8.7	8.7	9.9	8.0

than or as much crude protein as downy brome. When compared at equivalent stages of development, however, the two species are relatively comparable in protein content. Generally, the protein content of both species decreased as the plants matured. The protein content of medusahead is comparable to that of many other grass species (4). In the absence of data on protein quality, it appears that medusahead would be comparable in nutritive value to many desirable grass species.

At the same harvest dates medusahead contained more crude fat and generally less lignin than downy brome. The crude fiber content, althongh variable, was higher in downy brome as the plants reached maturity. Both species decreased in crude fat content and increased in lignin as the plants matured. The percentages of crude fiber and lignin for medusahead are not high when compared to downy brome or to many desirable forage grasses.

The ash of medusahead was found to comprise 13 to 15 percent of the dry matter. This was significantly higher than the ash content of downy brome. This amount of ash is also greater than that reported for many other grasses or forages. It was of interest, therefore, to characterize more fully the components of the ash of medusahead. Samples of medusahead and downy brome collected in 1957 and prepared in the same manner as previously outlined were used

Table 3. The ash and mineral constituents of medusahead and downy brome collected May 8, 1957. All results are reported on the basis of the dry weight of the whole plant.

	Medusahead	Downy brome
Total ash	15.5%	9.6%
Phosphorus	0.22	—
Calcium	0.66	—
Magnesium	0.16	—
Potassium	1.20	—
Water insoluble ash	14.0	6.5
Silica	11.3	4.4
Alkalinity of ash	44.7[a]	46.9
Alkalinity of soluble ash	7.4	18.9
Alkalinity of insoluble ash	34.6	27.5

[a]Alkalinity of ash is expressed as the number of ml. of 1N HCL to neutralize the ash of 100 gms. of sample.

in this portion of the study. The results of these analyses, expressed on a dry weight basis, are given in Table 3.

The ash content of the 1957 samples of downy brome and medusahead were 9.6 and 15.5 per cent, respectively. Analyses for phosphorus (2), magnesium and calcium (7), and a flame photometric determination of potassium showed these elements made up a relatively small portion of the ash of medusahead. Alkalinity of total ash determinations (3) showed little difference between the two species. However, when ash alkalinity was determined, most of the ash of medusahead was found to be insoluble in dilute HCl. Fractionation of the total ash into water soluble and non-soluble components (3) showed that about 90 per cent of the ash of medusahead was insoluble in water. Microscopic examination of the ash showed what appeared to be silicified cell wall material. Determination of the silica content (5) revealed that over 70 per cent of the ash or about 11 per cent of the dry matter of medusahead was silica. Comparable figures for downy brome were 47 and 4.4 percent. This high silica content of medusahead may contribute to its resistance to decomposition.

Similar chemical analyses were conducted on vegetation from the nitrogen fertilized plots. Because of the similarity of the results, these data are omitted. Briefly, for both species; the nitrogen treatments produced significant (at the 5 per cent level) increases in moisture and protein contents at all collection dates, while the differences in crude fat, crude fiber, and lignin were non-significant.

The influence of nitrogen application on forage utilization was determined by giving free access to grazing cattle and horses. They consumed 90 per cent of the medusahead on the 160-pound nitrogen plots, 40 per cent on the 20-pound nitrogen plots, and a non-discernible quantity on the check plots. Nitrogen fertilization increased utilization, but even at the excessive rate of 160 pounds per acre, 10 per cent of the plants developed viable seed. Thus the nitrogen treatments resulted in some medusahead control but did not produce benefits commensurate with the cost.

Samples for silage were collected from the non-protected check plots on May 23, June 6, 13, and 20. These samples were conditioned with the following silage additives: none, molasses, beet pulp, and molasses plus beet pulp. After 4 months the samples were placed in a pen containing 40 hungry sheep that were accustomed to a ration containing silage. All the samples were rejected. Therefore, to date, there appears to be no satisfactory method whereby medusahead can be utilized by animals. This rejection or avoidance by animals may be influenced by the high silica content or there may be other undetermined factors involved.

SUMMARY

The moisture, crude protein, crude fat, crude fiber, and lignin contents of medusahead (*Elymus caput-medusae*) were comparable to that of downy brome and many desirable grass species. The ash content of medusahead, however, was found to be much greater than that of downy brome and of many other grasses. The ash of medusahead contained silica amounting to over 10 per cent of the dry weight of the plant. The high silica content of medusahead is the basis for its harshness and may partially explain its unattractiveness to livestock. The high silica content may also be the reason why the plant is slow to decompose in the field. Nitrogen fertilization increased forage consumption by cattle and horses. Medusahead silage, whether pure or modified with additives, was unacceptable to sheep.

LITERATURE CITED

1. ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS. Official Methods of Analysis, 8th Ed. Washington, D. C. 1955.
2. BOLIN, D. W., and STAMBERG, O. E. Rapid digestion method for determination of phosphorus. Ind. Eng. Chem. Anal. Ed. 16:345. 1944.
3. JOSLYN, M. A. Methods in Food Analysis Applied to Plant Products. Academic Press, N. Y. 1950.
4. NATIONAL ACADEMY OF SCIENCES—NATIONAL RESEARCH COUNCIL. Composition of Cereal Grains and Forages. Pub. 585. Washington, D. C. 1958.
5. PIPER, C. S. Soil and Plant Analysis. Interscience Pub. Inc. New York. 1947.
6. ST. JOHN, H. Flora of Southeastern Washington and of Adjacent Idaho. Students Book Corp., Pullman, Washington. 1937.
7. UNITED STATES SALINITY LABORATORY STAFF. Diagnosis and improvement of saline and alkali soils. U. S. Dept. Agr. Handbook No. 60. 1954.