Physical and Chemical Composition of Grass Sorghum as Related to Palatability[1]

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PALATABILITY in a forage plant is a difficult and elusive characteristic to measure because it is known to vary with most of the factors and conditions which affect plant growth and development. Moreover, objective measurement is frequently limited to a subjective definition, i.e., preference of the grazing animal, which reduces objective data to a set of empirical values.

The difficulty of measurement, nevertheless, does not change the real importance of such information for the breeding and improvement of forage crops because palatability may greatly influence the amount of forage ingested and thus affect the rate, total gain, and net cost of beef production (5).

With certain reservations, differences do exist in plants which reflect qualitative aspects of forage yield. To improve forage utilization, the plant breeder is primarily interested in measuring and selecting those factors which might contribute to improvement of palatability. Such factors may be quite general, such as succulence or tenderness in tall fescue (*Festuca arundinacea* Schreb.) (4), or quite specific for certain forage plants, such as coumarin in sweetclover (*Melilotus officinalis* Lam.) (3).

The present study was undertaken to determine animal preference for common elements of composition as related to palatability in grass sorghum. Presentation and discussion are given for direct aspects of physical composition including percent dry weight of leaves, plant weight, plant height and forage yield; for common estimates of mineral composition, including percent total ash, potassium, calcium, and phosphorus; for standard estimates of feed analysis including crude protein (N × 6.25), carbohydrates (N.F.E.), crude fiber, and crude fat (ether extract); for related elements of sugar synthesis including percent moisture, juiciness, reducing sugar, and total sugar; and for related elements of polysaccharide synthesis including soluble saccharides, starch, pentosan, and hexosan.

METHODS AND MATERIALS

Commercial and experimental seed stocks of different varieties of sudangrass (× *Sorguhm sudanense* (Piper) Stapf.) and related sorghums were studied for palatability preference of the grazing animal by planting in single-row plots 20 feet long and 3 feet apart with 5 replications, and grazing the experimental area at a level of 4 steers per acre at early flowering of the mid-season varieties to about 50% utilization.

Percent grazing was determined as the percent of dry weight grazed forage from 10-stalk samples from 3 replicates of each variety, taken before and after grazing. Ungrazed samples were separated by hand to obtain the dry weight percent of leaves. Plant weight, plant height, and total yield were calculated from these samples.

Differences in percent grazing probably reflect maturity effects but these differences are minimized by limiting the differences in maturity to the approximate grazing period.

Ungrazed samples were ground in a Wiley mill, and subsamples analyzed for constituents of mineral and feed composition according to standard methods of the Association Official Agricultural Chemists (1).

Percent moisture was determined in a standard drying oven, percent juice by expressing 10-gram samples of green tissue at 10,000 psi in a Carver press, and sugars by AOAC gravimetric methods from the dry weight samples.

Percent soluble saccharides were determined by the difference of starch from N.F.E. Hexosan was determined by difference between values established for crude fibers and those for pentosan.

RESULTS AND DISCUSSION

Preliminary studies of grass sorghum (2) indicated that substantial differences in animal preference among standard varieties do exist, reflecting factors of selection for grazing preference. Results of the current study (1958–1960) of the palatability preference of varieties are presented as variety means in Tables 1 through 5 for different factors of physical and chemical composition. Assuming random distribution of replicates and years, simple correlations were computed for the variety means and the residual component. On the lower portion of each table, the residual correlation to the first variable, and the variety correlation matrix, are presented.

The calculated percent dry weight of grazed forage, percent dry weight of leaves, plant weight in grams, plant height in inches and total yield in tons dry weight per acre for varieties, are presented in Table 1. Percent grazed forage, as a measure of animal preference, produced a highly significant correlation of .9108 to percent dry weight of leaves with negative correlations to plant weight, height, and total yield of dry forage. Residual correlations to plant height and yield are found significant but relatively low. Selection for leafiness appears to be the major factor of physical composition contributing to palatability.

Table 1. Percent grazed forage as related to physical composition of the plant.

Variety	Grazed, %	Leaves, %	Weight, grams	Height, inches	Yield, tons
Piper	40	33	14	58	4.42
Sudax	50	36	25	63	5.69
Tift	52	37	18	55	4.87
Ga. 337	52	45	17	53	4.27
Tx. 372	53	36	13	55	3.96
Greenleaf	55	43	14	52	3.42
Ston. Sel.	56	46	21	56	4.22
Okla. 8	58	43	14	54	3.59
Lahoma	66	48	15	53	4.39
Blackland	75	58	15	50	3.69
$r_{1.2\ldots}$	Residual	.0079	-.1181	-.3214**	-.4017**
$r_{1.2\ldots}$	Variety	.9108**	-.1682	-.6601*	-.4015
$r_{2.3..}$			-.1339	-.7137**	-.4753
$r_{3.4.}$				.6853	.7859**
$r_{4.5}$					.8117**

*, ** Significant and highly significant correlation, respectively.
($r_{1.2\ldots}$) % dry weight of grazed forage as correlated to % dry weight of leaves; to plant weight in grams; to plant height in inches; and to forage yield as tons per acre of dry weight.
($r_{2.3..}$) % dry weight of leaves as correlated to plant weight, plant height, and yield.
($r_{3.4.}$) Plant weight in grams as correlated to plant height and to yield.
($r_{4.5}$) Plant height in inches as correlated to yield.

Variety effects related to common constituents of mineral composition are summarized in Table 2. Positive correlations of .9158 and .9141 are obtained for total ash and potassium, respectively. Correlated values of calcium and phosphorus are lower and less consistent. It is assumed that the high correlation of palatability to potassium reflects the preference of the grazing animal for the more tender, succulent, and turgid plant tissue of one variety as compared to another. Residual correlations of these factors are significant for total ash, potassium, and phosphorus, and generally support the trend of variety means.

Varietal effects for factors of chemical composition as commonly expressed in feed analyses are summarized in Table 3. Positive correlations of .8207 and .7958 for crude protein and crude fat, and negative correlations of —.7376

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Table 2. Percent grazed forage as related to mineral composition of the plant.

Variety	Grazed, %	Total ash, %	Potash, % K	Calcium, % Ca	Phosphorus, % P
Piper		6.75	2.19	0.69	0.12
Sudax		6.86	2.56	0.68	0.14
Tift		7.03	2.44	0.58	0.13
Ga. 337		7.02	2.33	0.82	0.14
Tx. 372		7.45	2.36	0.67	0.15
Greenleaf		8.11	2.51	0.85	0.15
Ston. Sel.		7.69	2.36	0.84	0.14
Okla. 8		7.83	2.49	0.74	0.14
Lahoma		8.61	2.84	0.95	0.15
Blackland		8.86	3.05	0.79	0.15
$r_{1.2...}$	Residual	.4300**	.4861**	.1484	.3176**
$r_{1.2...}$	Variety	.9138**	.9141**	.5064	.7176**
$r_{2.3..}$			.8247**	.6607*	.0921
$r_{3.4.}$				.4021	.6217*
$r_{4.5}$					.5510

*, ** Significant and highly significant correlation, respectively.
($r_{1.2...}$) % dry weight of grazed forage as correlated to % of total ash; to % K; to % Ca; and to % P.
($r_{2.3..}$) % total ash as correlated to K, Ca, and P.
($r_{3.4.}$) % K as correlated to Ca and P.
($r_{4.5}$) % Ca as correlated to P.

Table 3. Percent grazed forage as related to feed consumption of the plant.

Variety	Grazing, %	% crude protein	% carbohydrates	% crude fiber	% crude fat
Piper	40	9.78	43.76	31.59	1.88
Sudax	50	9.86	43.89	28.80	2.47
Tift	52	10.84	42.46	29.88	2.61
Ga. 337	52	10.73	43.26	28.79	2.65
Tx. 372	53	10.58	43.91	28.09	2.71
Greenleaf	55	11.37	41.64	28.48	2.79
Ston. Sel.	56	10.95	40.71	29.50	2.69
Okla. 8	58	12.41	40.64	28.78	2.77
Lahoma	66	12.23	40.29	29.81	2.99
Blackland	75	12.07	40.87	28.46	2.83
$r_{1.2...}$	Residual	.2966**	-.3649**	.2295**	-.1276
$r_{1.2...}$	Variety	.8207	-.7376*	-.7536**	.7958**
$r_{2.3..}$			-.8748*	-.4822	.7812**
$r_{3.4.}$				.2373	-.2078
$r_{4.5}$					-.8345**

*, ** Significant and highly significant correlation, respectively.
($r_{1.2...}$) % dry weight of grazed forage as correlated to % crude protein (N × 6.25); to % carbohydrates (N. F. E.); to crude fiber; to crude fat (ether extract).
($r_{2.3..}$) % dry weight of crude protein as correlated to carbohydrates; to crude fiber; to crude fat.
($r_{3.4.}$) % carbohydrates as correlated to crude fiber; and to crude fat.
($r_{4.5}$) % crude fiber as correlated to crude fat.

and —.7536 for carbohydrates (N.F.E.) and crude fiber are found in respect to varieties. This response pattern is more or less that expected from general concepts of palatability in feed and food products. Residual correlations of these factors are of a moderate order, supporting the inherent relationships of palatability as apparent by the trends of the variety means. High protein and crude fat are related to succulence while high carbohydrates and crude fiber are related to the maturity and "toughness" of the plant tissue.

Varietal effects for certain elements of sugar and polysaccharide synthesis are summarized in Tables 4 and 5. These results show that selective grazing of varieties is positively correlated with percent moisture, percent juice and percent total sugar (Table 4). Although large differences in reducing sugar are observed between varieties, these differences are not found correlated with palatability. Varietal differences in soluble saccharides, starch, and pentosan (Table 5) are small and nonsignificant, while the differences in hexosan are relatively large and highly significant. Grazing animals thus indicate a preference for varieties with a high level of sugar and a low level of hexosan.

SUMMARY

Experiments were designed to measure the palatability or grazing preference of steers for different varieties of grass sorghum and relate this preference to factors of physical, mineral, feed, and elements of carbohydrate composition.

Table 4. Percent grazed forage as related to sugar synthesis.

Variety	Grazed, %	Moisture, %	Juice, %	Reducing sugar, %	Total sugar, %
Piper	40	58	38	3.29	8.31
Sudax	50	71	50	6.28	13.06
Tift	52	64	42	3.62	12.14
Ga. 337	52	70	62	6.66	14.19
Tx. 372	53	68	66	7.44	12.45
Greenleaf	55	67	64	1.95	12.89
Ston. Sel.	56	70	68	5.98	13.75
Okla. 8	58	73	57	2.78	12.65
Lahoma	66	70	60	2.39	11.13
Blackland	75	74	61	9.65	15.17
$r_{1.2...}$	Residual	.1700	.3971	-.2535	.8435**
$r_{1.2...}$	Variety	.7561**	.5520	.3373	.5971
$r_{2.3..}$			.6979**	.4195	.8102**
$r_{3.4.}$				.3531	.6764**
$r_{4.5}$					.6200**

*, ** Significant and highly significant correlation, respectively.
($r_{1.2...}$) % dry weight of grazed forage as correlated to % of moisture; to % juice in the stem tissue; to % dry weight of reducing sugar; and to % dry weight of total sugar.
($r_{2.3..}$) % moisture as correlated to juice; reducing sugar; and to total sugar.
($r_{3.4.}$) % juice as correlated to reducing sugar; and to total sugar.
($r_{4.5}$) % reducing sugar as correlated to total sugar.

Table 5. Percent grazed forage as related to polysaccharides.

Variety	Grazed, %	% soluble saccharides	Starch, %	Pentosan, %	Hexosan, %
Piper	40	20.04	23.76	21.42	10.20
Sudax	50	22.11	21.81	22.45	6.37
Tift	52	21.54	20.90	20.82	9.09
Ga. 337	52	21.14	22.16	19.99	8.82
Tx. 372	53	22.31	22.00	21.72	6.39
Greenleaf	55	19.73	21.92	20.97	7.54
Ston. Sel.	56	20.11	20.63	23.20	5.90
Okla. 8	58	20.05	20.62	20.69	8.11
Lahoma	66	20.43	19.92	20.90	7.93
Blackland	75	18.82	22.09	23.20	5.40
$r_{1.2..}$	Residual	-.3801	.1467	-.2096	.0910
$r_{1.2...}$	Variety	-.4991	-.4861	-.1979	-.5978
$r_{2.3..}$			-.5805	.2117	.7896**
$r_{3.4.}$				.4643	.2647
$r_{4.5}$					.7664**

*, ** Significant and highly significant correlation, respectively.
($r_{1.2...}$) % dry weight of grazed forage as correlated to % soluble saccharides; to % starch and to % pentosan and to % hexosan.
($r_{2.3..}$) % soluble saccharides as correlated to starch; pentosan; and to hexosan.
($r_{3.4.}$) % starch as correlated to pentosan; and to hexosan.
($r_{4.5}$) % pentosan as correlated to hexosan.

Leafiness, as measured by the percent leaf weight, was found to be the most highly correlated factor of physical composition.

Potassium as percent total dry weight was found the most highly correlated element of mineral composition.

From feed analyses, the percent crude protein and fat were positively correlated with palatability and the percent carbohydrates (mostly starch) and crude fiber were negatively correlated with palatability.

In terms of carbohydrate synthesis, total sugar was positively correlated with palatability and hexosan was negatively correlated with palatability.

Palatability in grass sorghum, as measured in this study, is therefore found to be generally related to factors of leafiness, succulence, and tenderness and to be specifically related to the content of total sugar.

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