# WHEAT SILAGE FOR STEERS AND LAMBS

by

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# INTRODUCTION

Wheat has the largest acreage of any cereal crop grown in the United States. At its present price, wheat would not be competitive with corn or milo as a feed grain. Nevertheless, there have been periods in recent years when wheat was priced competitively with other feed grains and this probably will occur again.

Experiences of beef cattle and sheep feeders and research data indicate that feeding high levels of wheat grain decreases ration consumption. One solution to this problem has been to limit the amount of wheat fed to beef cattle and sheep to approximately 50% of the ration. Another alternative would be to harvest all or a portion of the wheat plant as forage. This might increase the quantity of wheat that could be effectively fed and, thus, increase its use in livestock rations.

Non-nutritional advantages of harvesting wheat for silage include: (1) allowing earlier harvest to remove the crop from the field and lessen the chance of loss due to weather, (2) providing a winter-spring crop that would fit into a double cropping system and (3) providing a silage crop for the summer months, thus permitting greater use of silo capacity.

Research reported herein was conducted to evaluate the effect of type of wheat and stage of maturity at harvest on silage quality and nutritive value. The relative feeding value of nine wheat silages compared with corn or sorghum silages for beef cattle and lambs was determined in a series of growing, finishing and metabolism trials.

# REVIEW OF LITERATURE

## I. Morphological Development of the Wheat Plant

The following discussion concerns the physical development of the wheat plant during its later stages of growth (from the text of Peterson, 1965).

A period of very rapid growth in which the stems and leaf sheaths of the plant elongate rapidly is known as the "stem extension" or "jointing" stage. The lowest internode of a stem begins to lengthen first, followed by the internodes above it. The uppermost internode, within the sheath of the uppermost leaf, is the last one to lengthen. Like the others, it has a growing region at its base; but it differs from them in that it bears the head. The head is thus pushed upwards within the leaf-sheath, which is called the flag leaf. As the head grows in size, it distends the sheath of the flag leaf. At this time, the plant is recognized as being in the "boot" stage of development. Emergence of the head from the flag leaf is known as the "heading" stage. It takes approximately 30 days to go from stem extension to heading. A few days after the head emerges from the sheath, flowering begins with fertilization following.

Although the grain ripening process is gradual, a number of stages are recognizable. The following names are commonly used with these stages of maturity: pre-milk, milk, soft-dough, hard-dough and ripe.

In the "pre-milk" stage, lasting usually for 1 to 2 weeks after fertilization, the grain increases rapidly in size. The plant is green, but the lower leaves have begun to die; beginning with the first or bottom leaf and progressing upwards.

During the "milk" stage a white, milk-like fluid can be expressed from the grain.

The "soft-dough" stage is recognized when the water content of the grain has decreased to the point where the material pressed out of it is no longer a liquid but has the consistency of meal or dough.

In the "hard-dough" stage, little of the green color of the plant remains; most of the plant parts are yellow. Although the grain is soft, its contents can not be expressed from it.

The "ripe" stage follows a few days after the hard-dough stage. The plant is now completely yellow and the grain is firm.

In most wheat-growing areas, the time needed from flowering through ripening is about 30 to 40 days.

## II. Feeding Wheat Grain to Ruminants

Feeding high levels of wheat in ruminant rations has been a problem because wheat is such a quickly digested grain. The following is a review of the data associated with the use of wheat grain in beef cattle finishing rations. Relative gain, feed intake and efficiency of gain were summarized from research with similar wheat and control rations in an attempt to clarify certain feeding concepts of wheat.

Some of the earliest research conducted with wheat was at the Fort Hays Experiment Station in Kansas (Haney et al., 1904 and Haney et al., 1906). These workers found that cattle fed wheat consistently consumed less feed but were more efficient than those fed corn.

Heinemann (1957) summarized 25 trials from 1895 to 1956 and stated, "Usually on a pound-for-pound basis, cracked wheat, when fed at relatively limited levels, has had fully the value of cracked corn for fattening cattle." A summary of nine trials (Morrison, 1956) showed that corn-fed cattle gained slightly faster than those fed wheat, but feed required per unit of gain was 9% less for the wheat-fed cattle.

More recently Varner et al. (1971) reported results of six trials comparing rations of corn, wheat or a combination of 50% corn and 50% wheat. There were no significant differences in daily gain among the three rations. Daily feed intake was highest for the corn ration and lowest for the wheat ration (10.1 kg and 9.0 kg per day, respectively). This is in agreement with data previously reported by Taylor et al. (1944); Taylor et al. (1945); and Lofgreen et al. (1970).

Differences do exist in feeding characteristics between types or varieties of wheat. Fulton (1970) compared Gage and Scout wheat varieties in two steer finishing trials. Cattle fed Gage gained faster and more efficiently than cattle fed Scout.

III. Cereal Silages

Data from Great Britain (Cannell et al., 1968; Lawes et al., 1971) indicates that the quality of whole-crop cereal silage is dependent upon the stage of maturity at which it is harvested. Dry matter digestibility and crude protein content were highest at the earlier maturities and, as the cereal crop continued to ripen, both dry matter digestibility and protein content decreased.

Miller et al. (1967) fed barley silage harvested in the boot, milk and dough maturities to lactating dairy cows. Daily feed intake was higher for milk and dough than for boot. Digestibilities of dry matter and nitrogen-free extract were lower for dough silage than for boot or milk silages. Molar percent rumen propionate was highest and acetate lowest in cows fed milk silage. Research findings of Edwards et al. (1968) and Polan et al. (1968) followed a similar trend. They reported that crude fiber and ash content decreased as stage of maturity increased. In addition, crude fiber digestibility was greater for boot silage than milk or dough silages.

Whole crop barley harvested in the milk, soft dough or hard dough maturities was fed to lactating dairy cows (Fisher et al., 1972). Forage dry matter intake was significantly lower for those cows consuming milk silage than those receiving the more mature silages.

McCullough et al. (1967) fed lactating dairy cows to determine the average daily intake of wheat silage cut at the boot, milk or dough stages. Cows receiving boot silage had a 20% higher dry matter intake than cows fed milk and dough silages.

Corn silage and boot wheat silage were fed to lactating dairy cows (Baxter et al., 1971). Dry matter digestibility and intake were significantly higher for cows fed corn silage.

Lassiter et al. (1958) compared corn silage with oat silage in a digestion trial with dairy cows. The oat silage contained slightly more crude protein (11.5 vs. 7.9%) and crude fiber (28.4 vs. 23.7%) than the corn silage. Crude protein digestibility (62.9 vs. 48.2%) and crude fiber digestibility (60.9 vs. 58.8%) was highest for the oat silage.

Perry et al. (1957) wintered steers on alfalfa, wheat or oat silages. Results showed average daily gain highest for steers consuming alfalfa silage and lowest for those fed wheat silage. Steers fed alfalfa silage had the highest dry matter consumption; those fed oat or wheat silages had similar consumptions. Oat silage-fed steers required more feed per unit of gain than steers receiving alfalfa or wheat silages.

A summary of two trials (Neumann et al., 1963) showed oat silage to be superior to oat hay for wintering calves. Steers fed silage gained faster and were more efficient than steers fed hay. In a similar trial, Whetzal et al.(1967) fed steers corn, oat or sorghum silages. Corn silage supported a 27.6% faster gain than oat silage. Steers fed oat silage were less efficient than those fed corn or sorghum silages.

## IV. Roughage Levels in Beef Cattle Finishing Rations

After reviewing the research on roughage levels in finishing rations, a few general trends are common to most of the data. More consistent performance with less digestive problems was seen when a minimum amount of roughage was fed. There were also less liver condemnations in cattle finished with roughage-containing rations. The minimum amount of roughage needed in the ration varied from 5 to 20 percent.

Eudaly et al. (1967) compared six roughage levels, from 0 to 10%, in rations for finishing steers. These workers showed that as the level of roughage increased; daily feed intake increased. Daily gain and efficiency were not affected by roughage levels.

Roughage (corn cobs or hay) levels ranging from 0 to 12.5% were used in steer finishing rations (Knox et al., 1964 and Vance et al., 1970). No differences in steer feedlot performance were observed among the roughage levels.

Using finishing steers, Woods et al. (1969) showed that the optimum roughage level was approximately 10% of the ration. Steers fed a ration of corn grain and 10% corn silage gained faster and more efficiently than steers consuming corn grain and 15 or 25% corn silage rations.

Two finishing trials (Pope et al., 1962 and Pope et al., 1963) were conducted using rations that were either all-concentrate or 25% cottonseed hulls. In the first trial steers fed the all-concentrate ration gained slightly faster and required 13% less feed per unit of gain than steers fed the 25% roughage ration. In the second trial there was a small reduction in feed intake and an increase in effiency in steers receiving the all-concentrate ration.

Williams et al. (1968) and White (1968) fed roughage levels of 0 (ground shelled corn) and 20% (ground ear corn) to finishing steers. Steers receiving ground ear corn gained significantly faster and consumed more feed than steers receiving the all-concentrate ration.

Roughage levels of 10 or 20% alfalfa were fed to fattening steers (Hale et al., 1970). Steers fed the 10% ration gained faster, required less feed per unit of gain and had a higher dressing percentage and carcass grade than those fed the 20% ration. This agrees with data reported by Embry et al. (1964) and Conrad et al. (1966).

Robertson et al. (1970) fed rations containing four roughage levels to finishing steers. They observed that as the level of ground forage in the ration increased above 20%; daily gain, efficiency and dressing percentage decreased.

## EXPERIMENTAL PROCEDURE AND RESULTS

### Description and Analyses of Experimental Silages

Parker (awned, hard, red winter) and Blue Boy (awnless, soft, red winter) were the wheat varieties used in this research. Nine wheat silages were evaluated. Head silage (taking only the upper half of the plant) was made from each variety in the mid to late dough maturity. The other seven silages were all made from the whole plant: Parker was harvested in boot, milk, dough and ripe stages; Blue Boy in boot, milk and dough stages.

Whole-plant corn and forage sorghum were harvested for silage in the hard-dent stage of maturity.

The corn, forage sorghum and two wheat-head silages were stored in upright, concrete stave silos. These four direct-cut silages were harvested with a forage harvester equipped with a 5.06 cm recutter screen. Water was added to the wheat-head forages at the silo blower to raise their moisture content six to seven percentage units so the ensiled material would be 60 to 65% moisture in the silo.

The seven whole-plant wheat silages were stored in 208 liter metal drums lined with polyethylene bags. Boot and milk maturities were swathed and field-wilted to approximately 55 to 65% moisture before harvest. Dough and ripe maturities were direct-cut and water was added to the ripe forage to raise its moisture content to approximately 65% before ensiling.

Harvest date, dry matter and yield of the nine wheat silages are shown in Table 1.

Forage or silage samples were taken when the wheats were harvested and daily or weekly throughout each of the experiments reported herein. Samples of each silage were composited, mixed and sub-sampled. Aliquots

TABLE 1. HARVEST DATE, DRY MATTER CONTENT AND YIELD OF THE WHEAT SILAGES

| Silage | Harvest date | Dry matter at harvest | Yield[a] |
|---|---|---|---|
| | 1972 | % | Metric ton/ha. |
| Parker, whole-plant | | | |
| Boot | May 16 | 41.6 | 3.64 |
| Milk | May 31 | 35.0 | 4.33 |
| Dough | June 9 | 50.9 | ---[c] |
| Ripe | June 27 | 89.9 | 3.68 |
| Blue Boy, whole-plant | | | |
| Boot | May 16 | 45.3 | 3.08 |
| Milk | June 2 | 32.5 | 4.25 |
| Dough | June 12 | 48.9 | 4.33 |
| Parker-head[b] | June 8,9,10 | 42.7 | 2.51 |
| Blue Boy-head[b] | June 11,12 | 42.6 | 3.16 |

[a]Adjusted to 60% moisture basis.

[b]Mid to late dough maturity.

[c]Missing data.

were dried to a constant weight at 50°C and ground to pass a 40 mesh screen. Proximate analyses were carried out on ration components (A.O.A.C., 1970). Analysis of cell wall constituents (CWC), acid detergent fiber (ADF) and lignin were determined for the forage samples using the technique of Goering and Van Soest (1970). Silage pH was established by extraction with distilled water (Barnett, 1954). Silage samples were extracted by adding 100 g of silage to 250 ml of .1N $H_2SO_4$ and aliquots of the supernatant analyzed for total and individual volatile fatty acids by gas chromatography (Parks, 1970).

Proximate analyses and percent dry matter for all silages are presented in Table 2; Van Soest analyses, in Table 3 and silage pH and fatty acid concentrations, in Table 4.

Experiment 1 - Steer Growth Trial

This experiment was designed to compare the feeding value of wheat-head silages with corn silage for growing steers. Silage treatments were: (1) whole-plant corn silage, (2) Blue Boy-head wheat silage and (3) Parker-head wheat silage. Sixty-three Angus steers averaging 234 kg were used in a 122-day growing trial beginning October 6, 1972. Three pens of seven steers each were randomly assigned by weight to each of the three silage treatments.

Ration composition (dry matter basis) was 86% of the appropriate silage and 14% supplement. Compositions of the supplements are in Table 5: Supplement A was fed with the corn silage; supplement B with the two wheat-head silages. All rations were formulated to contain 12.5% crude protein and all were mixed and fed ad libitum, twice daily. Each steer was wormed and implanted with 36 mg of stilbestrol at the start of the trial. Steers were confined to non-sheltered, concrete pens.

TABLE 2. SILAGE PROXIMATE ANALYSES

| Silage | Dry matter | Crude protein | Ether extract | Ash | Crude fiber | Nitrogen-free extract |
|---|---|---|---|---|---|---|
| | % | %, Dry matter basis | | | | |
| Parker-head[a] | 36.6 | 13.2 | 2.7 | 9.1 | 23.7 | 51.3 |
| Blue Boy-head[a] | 35.7 | 13.6 | 3.0 | 8.9 | 23.8 | 50.7 |
| Corn[a] | 33.4 | 8.7 | 2.2 | 6.4 | 22.5 | 60.2 |
| Forage sorghum[b] | 30.6 | 8.5 | 2.9 | 7.9 | 20.7 | 60.0 |
| Parker, whole-plant[b] | | | | | | |
| Boot | 43.0 | 14.0 | 2.8 | 17.1 | 33.7 | 32.4 |
| Milk | 32.6 | 12.9 | 3.1 | 13.4 | 34.0 | 36.6 |
| Dough | 32.0 | 12.9 | 2.4 | 10.9 | 28.9 | 44.9 |
| Ripe | 30.1 | 10.3 | 1.8 | 8.9 | 30.7 | 48.3 |
| Blue Boy, whole-plant[b] | | | | | | |
| Boot | 40.4 | 14.6 | 2.9 | 16.7 | 30.5 | 35.3 |
| Milk | 31.0 | 12.0 | 2.8 | 11.0 | 33.7 | 40.5 |
| Dough | 32.0 | 11.7 | 2.5 | 8.8 | 26.3 | 50.7 |

[a]Determinations made on composite samples from Experiment 1.

[b]Determinations made on composite samples from Experiment 4.

TABLE 3. SILAGE VAN SOEST ANALYSES

| Silage | Cell wall constituents | Acid detergent Fiber | Acid detergent Lignin |
|---|---|---|---|
| | %, Dry matter basis | | |
| Forage sorghum[b] | 50.7 | 30.1 | 5.3 |
| Parker-head[a] | 48.0 | 31.5 | 5.1 |
| Blue Boy-head[a] | 49.6 | 31.2 | 5.9 |
| Corn[a] | 55.7 | 28.8 | 4.5 |
| Parker, whole-plant[b] | | | |
| Boot | 62.4 | 44.3 | 7.0 |
| Milk | 62.8 | 42.8 | 8.2 |
| Dough | 60.3 | 37.1 | 7.0 |
| Ripe | 66.6 | 40.0 | 8.1 |
| Blue Boy, whole-plant[b] | | | |
| Boot | 60.2 | 41.5 | 5.8 |
| Milk | 61.5 | 42.2 | 7.7 |
| Dough | 56.9 | 34.5 | 6.9 |

[a]Determinations made on composite samples from Experiment 1.

[b]Determinations made on composite samples from Experiment 4.

TABLE 4. SILAGE pH AND FATTY ACID CONCENTRATION

| Silage | pH | Fatty acids molar %[a] | | |
|---|---|---|---|---|
| | | Lactate | Acetate | Butyrate |
| Forage sorghum[c] | 3.90 | 3.4 | 1.1 | .1 |
| Parker-head[b] | 4.30 | 1.9 | 1.8 | .6 |
| Blue Boy-head[b] | 4.31 | 2.6 | 1.6 | .4 |
| Corn[b] | 4.22 | 2.6 | 1.5 | .3 |
| Parker, whole-plant[c] | | | | |
| Boot | 5.10 | 1.8 | 4.1 | trace |
| Milk | 4.18 | 2.9 | 2.7 | .4 |
| Dough | 4.21 | 3.8 | 1.4 | .1 |
| Ripe | 5.08 | 1.1 | 4.0 | 1.0 |
| Blue Boy, whole-plant[c] | | | | |
| Boot | 4.19 | 2.9 | 2.6 | .5 |
| Milk | 4.34 | 3.3 | 3.0 | 1.1 |
| Dough | 4.11 | 3.9 | 1.3 | .1 |

[a]Dry matter basis.

[b]Determination made on composite samples from Experiment 1.

[c]Determination made on composite samples from Experiment 4.

TABLE 5. COMPOSITIONS OF THE SUPPLEMENTS FED IN THE STEER GROWTH TRIAL (EXPT. 1) AND STEER DIGESTIONS STUDY (EXPT. 2)

| Ingredient | Supplement A | Supplement B |
|---|---|---|
| | %, Dry matter basis | |
| Soybean meal | 87.60 | --- |
| Milo, rolled | 6.72 | 91.44 |
| Dicalcium phosphate | 1.28 | 1.61 |
| Limestone | .58 | 3.12 |
| Salt | 2.14 | 2.14 |
| Fat | 1.00 | 1.00 |
| Trace minerals | .36 | .36 |
| Aureomycin[a] | .25 | .25 |
| Vitamin A[b] | + | + |
| Calculated analysis (dry matter basis) | | |
| Crude protein, % | 43.50 | 9.43 |

[a]Formulated to supply 70 mg per steer per day.

[b]Formulated to supply 30,000 I.U. per steer per day.

Beginning and ending weight for each steer were taken after 15 hrs without feed or water; 28-day intermediate weights were taken before the a.m. feeding to follow the performance progress.

Steer performance is shown in Table 6. Steers fed the corn silage ration gained faster ($P<.05$), consumed more ration dry matter ($P<.05$) and required less feed per unit of gain ($P<.05$) than steers fed the two wheat-head silage rations. Average daily gain and feed consumption were greater ($P<.05$) for steers fed Blue Boy-head silage than those fed Parker-head silage.

Statistical analyses of the data appear in Appendix Table 1.

Experiment 2 - Steer Digestion Study

The purpose of this study was to measure the digestibility and nitrogen retention for the three silage rations fed in Experiment 1. Silage treatments and ration and supplement compositions were the same as those described in Experiment 1. Six steers weighing 260 kg were used; two steers received each of the silage rations during 10-day preliminary and 6-day collection periods.

Steers were fed in digestion crates for separation of urine and feces. Urine was collected in plastic buckets containing 50 ml of 50% HCl to maintain acidity. Urine collections were diluted with water to the next highest kg and a 10% aliquot sample stored in glass bottles. Daily fecal collections were weighed and a 10% aliquot sample frozen. At the end of the 6-day collection period, feces and urine samples were each composited for laboratory analyses. Approximately 200 g of the fecal material was placed in an aluminum pan and dried at $60^{o}C$ for 48 hours in a forced air oven. Feces were then ground through a 40 mesh screen in a Wiley mill in preparation for chemical analyses. Samples of the silages

TABLE 6. EFFECT OF TYPE OF SILAGE ON GROWTH OF STEERS (EXPT. 1) AND RATION DIGESTIBILITY AND NITROGEN RETENTION (EXPT. 2)

| Item | Ration | | |
|---|---|---|---|
| | Whole-plant corn | Blue Boy-head | Parker-head |
| | Experiment 1 | | |
| No. of steers | 21 | 21 | 20[f] |
| Initial wt, kg | 235.3 | 233.8 | 234.7 |
| Final wt, kg | 341.5 | 318.3 | 313.7 |
| Avg. daily gain, kg | .87[a] | .69[b] | .64[c] |
| Avg. daily feed, kg[d] | | | |
| Silage[e] | 6.06 (18.1) | 5.64 (15.8) | 5.23 (14.3) |
| Supplement | .98 | .92 | .86 |
| Total | 7.04[a] | 6.56[b] | 6.09[c] |
| Feed/kg gain, kg[d] | 8.09[a] | 9.49[b] | 9.48[b] |
| | Experiment 2 | | |
| Dry matter digestibility, % | 70.1 | 66.9 | 66.7 |
| Crude protein digestibility, % | 68.8 | 68.1 | 68.9 |
| N retained, % of intake | 13.6 | 6.8 | 20.9 |

[a,b,c]Means on the same line with different superscripts differ significantly ($P<.05$).

[d]Dry matter basis.

[e]Values in parentheses are silage intakes expressed on an as-fed moisture basis.

[f]One steer removed for failure to consume the ration.

and supplements were taken daily during the collection period and a composite sample of each was handled in the same manner as the fecal samples. Urine, dry feces and feed samples were analyzed for nitrogen by the Kjeldahl method as outlined by A.O.A.C. (1965). Dry matter determination on both the feces and feed was according to A.O.A.C. (1960).

Results are shown in Table 6. None of the differences in digestibility or nitrogen retention were significant ($P<.10$).

Experiment 3 - Lamb Growth Trial

The objective of this trial was to determine the feeding value of seven whole-plant wheat silages and whole-plant forage sorghum silage in rations for growing lambs. The eight silage treatments were: (1) forage sorghum; Parker wheat ensiled in the (2) boot, (3) milk, (4) dough and (5) ripe stages and Blue Boy wheat ensiled in the (6) boot, (7) milk and (8) dough stages. Forage harvesting and ensiling procedures are described previously in Description and Analyses of Experimental Silages. Forty-eight crossbred wether and ewe lambs weighing 30.0 kg were randomly allotted by weight and sex to each of the eight silage rations. There were six lambs per ration in two pens of three lambs each.

All rations contained 86% silage and 14% supplement (dry matter basis) and all were formulated to be equal in crude protein (12.5%), minerals, vitamins and additives. Compositions of the supplements are shown in Table 7. Lambs were fed ad libitum, twice daily.

The trial started December 27, 1972 and lasted 56 days. Initial and final weights of the lambs were taken after 15 hrs without feed or water; 14-day intermediate weights were taken before the a.m. feeding.

Performance of the lambs is shown in Table 8. Lambs fed the Parker milk silage ration were removed from the trial because they would not

TABLE 7. COMPOSITIONS OF THE SUPPLEMENTS FED IN THE LAMB GROWTH TRIAL (EXPT. 3) AND LAMB DIGESTION STUDY (EXPT. 4)

| Ingredient | Ration no. and silage | | | | |
|---|---|---|---|---|---|
| | 1<br>Forage sorghum | 2 & 6<br>Parker & Blue Boy boot | 3 & 4<br>Parker milk & dough | 7 & 8<br>Blue Boy milk & dough | 5<br>Parker ripe |
| | %, Dry matter basis | | | | |
| Soybean meal | 87.95 | --- | 9.45 | 27.35 | 40.43 |
| Milo, rolled | --- | 83.27 | 74.20 | 56.55 | 43.98 |
| Dicalcium phosphate | 1.45 | 1.77 | 1.60 | 1.20 | .90 |
| Limestone | --- | 4.37 | 4.10 | 4.30 | 4.10 |
| Salt | 1.80 | 1.80 | 1.80 | 1.80 | 1.80 |
| Molasses, dried | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 |
| Trace minerals | .38 | 0.38 | .38 | .38 | .38 |
| Aureomycin[a] | .57 | .57 | .57 | .57 | .57 |
| Vitamin A[b] | .29 | .29 | .29 | .29 | .29 |
| Vitamin D[b] | + | + | + | + | + |
| Vitamin E[b] | + | + | + | + | + |
| Calculated analysis (dry matter basis) | | | | | |
| Crude protein | 43.20 | 9.58 | 13.14 | 19.86 | 24.80 |

[a]Formulated to supply 22 mg per lamb per day.

[b]Formulated to supply 3,000 I.U. of vitamin A, 300 I.U. of vitamin D, and 3 I.U. of vitamin E per lamb per day.

TABLE 8. EFFECT OF STAGE OF MATURITY AND VARIETY OF WHEAT SILAGE ON GROWTH OF LAMBS (EXPT. 3)

| Item | Ration no. and silage | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 6 | 3 | 7 | 4 | 8 | 5 |
| | | Boot | | Milk | | Dough | | Ripe |
| | Forage sorghum | Parker | Blue Boy | Parker | Blue Boy | Parker | Blue Boy | Parker |
| No. of lambs | 6 | 6 | 6 | ---[a] | 6 | 6 | 6 | 6 |
| Initial wt, kg | 30.3 | 29.5 | 30.0 | --- | 30.1 | 29.7 | 30.0 | 29.9 |
| Final wt, kg | 38.4 | 32.1 | 33.5 | --- | 32.3 | 33.2 | 34.8 | 33.1 |
| Avg. daily gain, kg | .15[b] | .05[d] | .06[c,d] | --- | .04[d] | .06[c,d] | .09[c] | .06[d] |
| Avg. daily feed, kg[f] | 1.06[b] | .74[d] | .86[c] | --- | .71[d] | .89[c] | .91[c] | .86[c] |
| Feed/kg gain, kg[f] | 7.37[b] | 18.15[c] | 13.56[b,c] | --- | 18.00[c] | 14.62[b,c] | 10.67[b,c] | 14.98[b,c] |

[a]All lambs were removed from the experiment for failure to consume the ration.

[b,c,d,e]Means on the same line with different superscripts differ significantly ($P<.05$).

[f]Dry matter basis.

consume the ration. Average daily gain and feed intake were greatest ($P<.05$) for lambs fed sorghum silage. Lambs receiving Blue Boy dough silage gained faster ($P<.05$) than those receiving Blue Boy milk, Parker boot or Parker ripe silages. Lambs fed Parker boot and Blue Boy milk silages consumed less ration dry matter ($P<.05$) than lambs fed any of the other four wheat silages.

Statistical analyses of the data appear in Appendix Table 2.

Experiment 4 - Lamb Digestion Study

The purpose of this study was to measure the digestibility and nitrogen retention in lambs of the eight silage rations fed in Experiment 3. Silage treatments and rations were the same as those previously described in Experiment 3.

Twenty-four crossbred wether lambs were randomly allotted to the eight rations. Three lambs received each ration during two consecutive 12-day preliminary and 6-day collection periods. All lambs were fed approximately 700 g of dry matter daily of the appropriate ration.

Lambs were fed in digestion crates designed for separation of urine and feces and were shorn before the study to reduce wool contamination of urine and feces. Procedures used to collect and analyze the urine, feces and ration components were the same as previously described in Experiment 2. During both 6-day collection periods, some rations were not completely consumed by the lambs. Each day's feed refusals were weighed, sampled and handled in the same manner as previously described for the ration samples.

Ration digestibility and nitrogen retention data are shown in Tables 9 and 10. Results of the two collection periods are averaged for presentation.

TABLE 9. EFFECT OF STAGE OF MATURITY AND VARIETY OF WHEAT SILAGE ON RATION DIGESTIBILITY IN LAMBS (EXPT.4)

| Item | Ration no. and silage | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 6 | 3 | 7 | 4 | 8 | 5 |
| | | Boot | | Milk | | Dough | | Ripe |
| | Forage sorghum | Parker | Blue Boy | Parker | Blue Boy | Parker | Blue Boy | Parker |
| DM intake, kg | 687.8 | 536.8 | 591.9 | 490.0 | 639.9 | 652.8 | 645.9 | 643.8 |
| DM intake, % of DM fed | 100.0 | 79.6 | 96.7 | 75.6 | 96.5 | 97.1 | 97.3 | 94.8 |
| | Apparent digestion coefficients, % | | | | | | | |
| Dry matter | 65.6[a] | 61.0[b] | 59.2[b,c] | 56.8[c] | 59.3[b,c] | 59.9[b] | 60.1[b] | 57.0[c] |
| Crude protein | 70.4[a] | 65.8[c] | 65.4[c] | 65.2[c] | 69.2[a,b] | 68.4[a,b,c] | 68.4[a,b,c] | 66.4[b,c] |
| Crude fiber | 56.7[b] | 68.8[a] | 66.9[a] | 57.1[b] | 56.9[b] | 49.3[c] | 46.9[c] | 48.3[c] |
| Ether extract | 67.3 | 64.7 | 64.2 | 66.6 | 58.9 | 59.2 | 53.3 | 60.0 |
| Nitrogen-free extract | 71.3[a] | 61.0[d] | 62.0[d] | 57.1[e] | 61.6[d] | 65.5[b,c] | 67.9[b] | 62.7[b,c] |
| Total dig. nutrients | 64.3[a] | 56.2[c] | 56.2[c] | 53.8[c] | 57.0[b,c] | 56.4[c] | 58.2[b] | 54.8[c] |

[a,b,c,d,e]Means on the same line with different superscripts differ significantly ($P<.05$).

TABLE 10. EFFECT OF STAGE OF MATURITY AND VARIETY OF WHEAT SILAGE ON NITROGEN RETENTION IN LAMBS (EXPT. 4)

| Item | Ration no. and silage | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 6 | 3 | 7 | 4 | 8 | 5 |
| | | Boot | | Milk | | Dough | | Ripe |
| | Forage sorghum | Parker | Blue Boy | Parker | Blue Boy | Parker | Blue Boy | Parker |
| N intake, g/day | 15.3 | 11.7 | 13.6 | 11.6 | 13.6 | 13.6 | 13.5 | 12.9 |
| N intake, % of N fed | 100.0 | 79.1 | 97.1 | 85.9 | 97.1 | 97.1 | 97.1 | 95.6 |
| Fecal N, g/day | 4.5 | 4.0 | 4.7 | 4.0 | 4.2 | 4.3 | 4.3 | 4.3 |
| Urinary N, g/day | 9.5 | 9.7 | 8.1 | 8.2 | 9.4 | 8.9 | 8.5 | 8.9 |
| N retained, g/day | 1.33[a] | -1.52[d] | .77[b,c] | - .45[c,d] | .93[b,c] | .43[b,c] | .77[b,c] | -.35[c,d] |
| N retained, % of intake | 8.7 | 13.0 | 5.7 | 3.9 | 6.8 | 3.2 | 5.7 | 2.7 |

[a,b,c]Means on the same line with different superscripts differ significantly (P<.05).

Dry matter, nitrogen-free extract and total digestible nutrients digestion coefficients were highest ($P<.05$) for lambs fed sorghum silage. Lambs fed Blue Boy dough or Parker boot and dough silages had higher ($P<.05$) dry matter digestibilities than those fed Parker milk or ripe silages. Crude protein digestibility was highest for the forage sorghum, Blue Boy milk and dough or Parker dough silages. Crude fiber digestibility decreased ($P<.05$) as maturity increased. Differences in nitrogen-free extract and total digestible nutrient digestibilities among the silages are indicated in Table 9.

Nitrogen retention was highest ($P<.05$) for lambs fed sorghum silage. Lambs consuming the Parker dough or Blue Boy boot, milk or dough silages retained more nitrogen ($P<.05$) than those fed Parker boot silage.

Statistical analyses of these data appear in Appendix Table 3.

Experiment 5 - In Vitro Dry Matter Disappearance (IVDMD) Study

Silage in vitro dry matter disappearance (IVDMD) was determined by the two-stage method of Barnes (1969), with the following modifications: four-tenths g of silage dry matter was weighed into a polyethylene tube and 30 ml of a solution containing two parts McDougal's buffer and one part rumen fluid was added to each tube. The air space in each tube was saturated with $CO_2$ and the tubes incubated at $39^{o}C$. One ml of 5% mercuric chloride was used to stop digestion at specified time intervals.

Tubes were then centrifuged at 18,000 RPM for eight minutes. After decanting the supernatant, 10 mls pepsin-HCl solution was added and allowed to digest for 24 hrs. Tubes were recentrifuged, the supernatant decanted and the tubes and undigested residue dried at $50^{o}C$ to a constant weight. Three IVDMD replications were conducted. In each replication, duplicate samples of the silages were digested for 3, 6 or 48 hours.

IVDMD of the silages fed in Experiments 1 and 4 is presented in Table 11.

There were no significant differences in 3, 6, or 48-hr IVDMD among silages fed in Experiment 1; however, differences ($P<.05$) between replications occurred at all 3 hours.

Of the eight silages fed in Experiment 4, Blue Boy dough had the highest ($P<.05$) 3-hr IVDMD; Parker ripe and forage sorghum the lowest ($P<.05$). Three-hr IVDMD of Blue Boy milk and dough or Parker milk and dough silages was higher ($P<.05$) than that of Parker boot and ripe or forage sorghum silages.

Six-hr IVDMD was highest ($P<.05$) for the Blue Boy dough silage; lowest ($P<.05$) for the Parker ripe silage. Six-hr IVDMD was higher ($P<.05$) for Blue Boy milk silage than Blue Boy boot, forage sorghum or Parker boot and ripe silages.

Forage sorghum silage had the highest ($P<.05$) 48-hr IVDMD; Parker milk and ripe silages the lowest ($P<.05$). Forty-eight-hr IVDMD of Blue Boy boot silage was higher ($P<.05$) than that of Blue Boy milk or Parker boot, milk and ripe silages.

Statistical analyses of the data appear in Appendix Tables 4 and 5.

Experiment 6 - Steer Finishing Trial

Beef cattle fed most finishing rations require some roughage for maximum feedlot performance. Corn silage is an effective roughage; however, little is known about the effectiveness of wheat-head silage as a source of roughage. The purpose of this trial was to evaluate source (corn or wheat-head silages) and level (10 or 20% of the ration) of roughage in beef cattle finishing rations.

TABLE 11. SILAGE IN VITRO DRY MATTER DISAPPEARANCE[a]

| Silage | IVDMD % | | |
|---|---|---|---|
| | 3 hr | 6 hr | 48 hr |
| Experiment 1: | | | |
| Parker head | 31.5 | 33.8 | 59.8 |
| Blue Boy head | 30.5 | 34.4 | 62.1 |
| Corn | 28.9 | 31.1 | 63.5 |
| Experiment 4: | | | |
| Forage sorghum | $18.1^{f,g}$ | $22.4^{e,f}$ | $63.0^{b}$ |
| Parker, whole-plant | | | |
| Boot | $20.6^{e,f}$ | $20.7^{f,g}$ | $54.6^{d,e}$ |
| Milk | $25.3^{c,d}$ | $25.8^{c,d,e}$ | $49.6^{f,g}$ |
| Dough | $25.8^{c,d}$ | $26.7^{c,d}$ | $55.2^{c,d,e}$ |
| Ripe | $15.3^{g}$ | $17.5^{g}$ | $48.6^{g}$ |
| Blue Boy, whole-plant | | | |
| Boot | $23.0^{d,e}$ | $23.5^{d,e,f}$ | $58.6^{c}$ |
| Milk | $26.4^{c}$ | $27.6^{c}$ | $52.0^{e,f}$ |
| Dough | $29.8^{b}$ | $31.9^{b}$ | $57.2^{c,d}$ |

[a]Each value represents the mean of six observations.

$^{b,c,d,e,f,g}$Means in the same column with different superscripts differ significantly ($P<.05$).

Sixty Angus, Hereford and crossbred yearling steers averaging 330 kg were allotted by breed and weight to 12 pens of five steers each. Three pens were randomly assigned to each of these roughage treatments: (1) 10% corn silage, (2) 20% corn silage, (3) 10% wheat-head silage and (4) 20% wheat-head silage.

Ration and supplement compositions are shown in Table 12. Rations were formulated to contain 12.2% crude protein; mixed and fed ad libitum twice daily. Each steer was wormed and implanted with 36 mg of stilbestrol at the beginning of the 123-day finishing trial (February 15 to June 18, 1973). Steers received a 35% silage ration at the start of the trial. Silage was reduced to 20% after 5 days and to 10% in rations one and three after another 5 days.

Steers were confined to non-sheltered concrete pens. Initial and final weights were taken after 15 hrs without feed or water. Twenty-eight day weights were taken before the a.m. feeding to monitor performance throughout the trial. Final live weights were adjusted to a 62.51% dress and feedlot performance was calculated on that basis.

Performance of the steers is presented in Table 13. Performance by pens of cattle fed the same rations was quite variable. There were no significant differences in rate and efficiency of gain, feed intake or carcass characteristics among steers fed the four rations.

Statistical analyses of the data for the preceeding six experiements were by analysis of variance as described by Steele and Torrie (1960). When statistical significance occurred, Duncan's Multiple Range test as described by Steele and Torrie (1960) was used to determine differences between treatment means.

TABLE 12. COMPOSITIONS OF RATIONS AND SUPPLEMENTS FED IN THE STEER FINISHING TRIAL (EXPT. 6)

| Item | Ration no. and roughage treatment | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| | Corn silage | | Wheat silage | |
| | 10% | 20% | 10% | 20% |
| | %, Dry matter basis | | | |
| **Ration ingredients** | | | | |
| Corn, cracked | 41.25 | 36.25 | 41.25 | 36.25 |
| Milo, steam-flaked | 41.25 | 36.35 | 41.25 | 36.25 |
| Corn silage | 10.0 | 20.0 | --- | --- |
| Wheat silage | --- | --- | 10.0 | 20.0 |
| Supplement | 7.5 | 7.5 | 7.5 | 7.5 |
| **Supplement ingredients** | | | | |
| Soybean meal | 27.6 | 35.4 | 10.4 | 0.6 |
| Milo, rolled | 47.2 | 42.3 | 62.6 | 74.4 |
| KCl | 2.7 | .8 | 3.8 | 1.9 |
| Dicalcium phosphate | .5 | .7 | .5 | 1.4 |
| Limestone | 9.7 | 8.5 | 10.4 | 9.4 |
| Salt | 3.4 | 3.4 | 3.4 | 3.4 |
| Fat | 1.0 | 1.0 | 1.0 | 1.0 |
| Trace minerals | .8 | .8 | .8 | .8 |
| Aureomycin[a] | .5 | .5 | .5 | .5 |
| Vitamin A[b] | .1 | .1 | .1 | .1 |
| Urea | 6.5 | 6.5 | 6.5 | 6.5 |
| **Calculated (dry matter basis)** | | | | |
| Crude protein, % | 36.5 | 39.7 | 29.9 | 26.4 |

[a]Formulated to supply 70 mg per steer per day.

[b]Formulated to supply 30,000 I.U. per steer per day.

TABLE 13. EFFECT OF SOURCE AND LEVEL OF ROUGHAGE ON STEER FEEDLOT PERFORMANCE (EXPT. 6)

| | Ration no. and roughage treatment | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| | Corn silage | | Wheat silage | |
| Item | 10% | 20% | 10% | 20% |
| No. of steers | 15 | 15 | 15 | 15 |
| Initial wt, kg | 329.1 | 327.2 | 330.5 | 327.4 |
| Final wt, kg[a] | 468.4 | 476.8 | 472.0 | 465.1 |
| Avg. daily gain, kg | 1.13 | 1.22 | 1.15 | 1.12 |
| Avg. daily feed, kg[b] | 7.89 | 8.45 | 8.26 | 8.42 |
| Feed/kg gain, kg[b] | 7.02 | 6.96 | 7.32 | 7.53 |
| Dressing % | 62.9 | 62.4 | 62.3 | 62.3 |
| Quality grade[c] | 10.53 | 10.47 | 10.40 | 10.53 |
| Yield grade[d] | 3.12 | 3.17 | 3.03 | 2.87 |

[a]Adjusted to 62.51% dress.

[b]Dry matter basis.

[c]Quality grade assigned: 10.0 indicates low choice; 11.0 indicates average choice.

[d]2.50 + (2.5 X adj. fat thickness) + (.2 X %K.K.) + (.0038 X hot carcass wt.) - (.32 X L.E.A.).

# DISCUSSION

Objectives of this research were to characterize wheat silage, evaluate its potential use in beef cattle feeding programs and measure the effect of variety and stage of maturity on wheat silage quality and nutritive value.

Chemical analyses of the seven whole-plant wheat silages indicated that as stage of maturity increased, crude protein and crude fiber content decreased; nitrogen-free extract increased. This agrees with reports by Polan et al. (1968), Edwards et al. (1968) and Lawes et al. (1971).

Results of the steer growth trial showed corn silage to be superior in feeding value to either of the two wheat-head silages. Similarly, Whetzal et al. (1967) fed steers corn, oat or sorghum silages and found corn silage supported a 21.6% faster and 24.1% more efficient gain than oat silage. Lassiter et al. (1958) fed growing heifers corn or oat silage rations and those fed corn silage had the fastest daily gain. Perry et al. (1958) wintered steers on alfalfa, wheat or oat silages and those fed alfalfa silage produced the highest daily gain.

Steers fed Blue Boy-head silage gained faster and consumed more dry matter than those fed Parker-head silage. Efficiency of gain was similar for both groups, so difference in gain was due to differences in intake.

In the lamb growth trial, lambs fed forage sorghum silage had the highest daily gain, feed intake and efficiency of gain. Lyons (1938) observed that dairy cows produced more milk when fed sorghum silage compared to oat silage.

Results of the lamb digestion study showed crude fiber digestibility decreased as maturity increased. Polan et al. (1968) obtained similar results with barley silage. Crude protein digestibility tended to be highest for dough stage silages and lowest for boot stage silages. In contrast, Meyer et al. (1957) observed that crude protein digestibility decreased as stage increased. In the study reported herein, dry matter and nitrogen-free extract digestibilities and total digestible nutrients were not influenced by variety or stage. However, Polan et al. (1968) reported dry matter and nitrogen-free extract digestibilities were lower in dough stage barley silage than in boot or milk stage barley silages. Also, Meyer et al. (1957) showed total digestible nutrient content decreased as stage increased.

Lambs fed Parker milk silage were removed from the growth trial because they would not consume their ration. In the digestion trial, lambs fed Parker milk silage had the highest feed refusal and lowest dry matter intake. Conway and Bolsen (1973) fed these same eight silages to yearling steers and measured voluntary intake for 12 days. Steers fed Parker milk silage had the lowest dry matter intake. Fisher et al. (1972) fed three stages of barley silage (milk, soft-dough or hard-dough) to lactating dairy cows and those fed milk silage had the lowest dry matter intake.

In the two growing trials, as feed intake increased, daily gain increased. Steers and lambs fed Blue Boy silage had a higher dry matter consumption than those fed Parker silage. These differences in intake are possibly due to the presence of awns in Parker silages and the absence of awns in Blue Boy silages. Conway and Bolsen (1973) observed that steers fed the Blue Boy silages from the lamb growth trial consumed more dry matter than those fed the Parker silages. This agrees with results

reported by Krall (1973) who fed growing steers Nugaines-head wheat silage for only 6 weeks before awns caused sore mouths and termination of the trial.

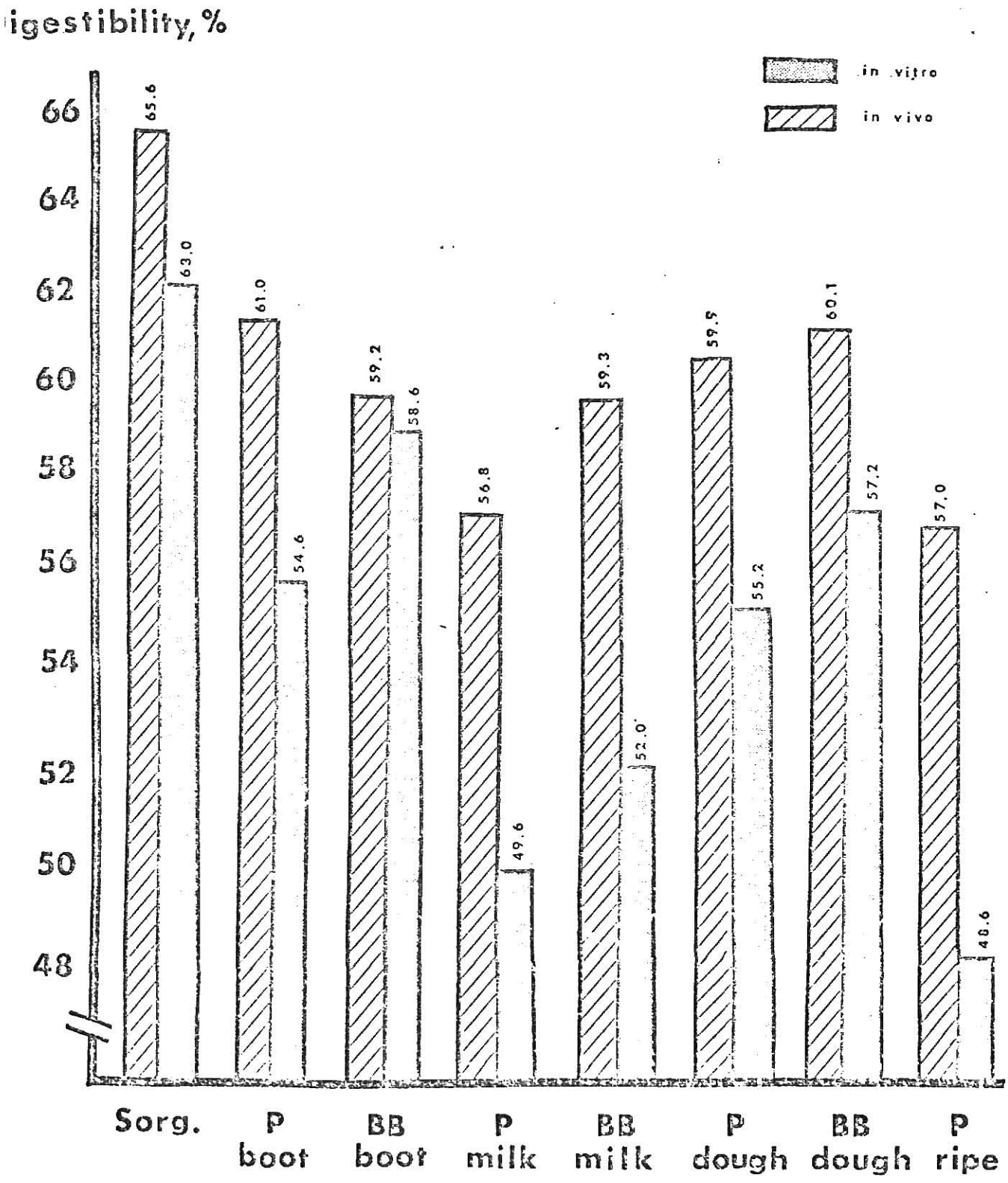
The in vitro dry matter disappearance study showed differences in how rapidly the silages were fermented. Parker boot and ripe, Blue Boy boot and forage sorghum silages had lower 3-hr IVDMD than the other four silages fed in the two lamb trials. This suggests that possibly the grain in wheat milk and dough silages was more rapidly fermented than grain in forage sorghum silage. After 48 hrs, forage sorghum had the highest IVDMD; Parker ripe, the lowest.

Forty-eight hr in vitro and in vivo digestibilities of the lamb trial silages and silage rations, respectively, are shown in Figure 1. Both digestion coefficients ranked the silages and silage rations in a similar order from the most digestible (forage sorghum) to the least digestible (Parker ripe).

In the steer finishing trial, level of roughage (10% vs. 20%) did not affect feedlot performance. In contrast, Embry et al. (1964), Conrad et al. (1966) and Hale et al. (1970) reported that steers fed a 10% roughage ration gained faster and more efficiently than those fed a 20% roughage ration. Type of roughage used (corn silage vs. wheat-head silage) did not affect steer performance.

Based on rate and efficiency of gain, these data are summarized as follows: first, in steer growing rations, Blue Boy-head silage had 82% the feeding value of corn silage and Parker-head silage had 79% the feeding value; second, in lamb growing rations, whole-plant Blue Boy dough silage had 64.5% the feeding value of forage sorghum silage and whole-plant Parker dough silage had 45% the feeding value and third,

Figure 1. In Vitro (48 hr) and In Vivo Digestibilities of the Silages Fed in Experiments 3 and 4.



wheat-head silages were as effective as corn silage in providing the roughage in steer finishing rations.

## SUMMARY

Steer growth and digestion trials, lamb growth and digestion trials, an *in vitro* dry matter disappearance (IVDMD) study and a steer finishing trial were conducted to determine the effect of variety and stage of maturity on wheat silage quality and nutritive value.

In the steer growth trial, 63 steers were used to evaluate: whole-plant corn silage (CS); Blue Boy-head (BBH) or Parker-head (PH) wheat silages. Head silages contained the upper one-half of the plant in the mid to late dough stage. Percents dry matter (DM) and crude protein (CP), respectively, of the silages were; CS, 33.4, 8.74; BBH, 35.7, 13.61, and PH, 36.6, 13.20. Ration compostions (dry matter basis) were 86% silage and 14% supplement and all were formulated to contain 12.5% CP. Steers fed the CS ration gained faster ($P<.01$), consumed more ration DM ($P<.01$) and were more efficient ($P<.01$) than those fed the BBH or PH rations. Gain and DM consumption were greater ($P<.05$) for steers fed BBH silage than those fed PH silage. In the steer digestion trial, two steers received each of these three silage rations during a 10-day preliminary and 6-day collection period. Percent ration DM and CP digestibilities, respectively, were: CS, 70.1, 68.8; BBH, 66.9, 68.1 and PH, 66.7, 68.9. Nitrogen retention was highest in steers fed PH silage and lowest in those fed BBH silage. Forty-eight hr IVDMD (%) for the three silages was: CS, 63.5; BBH, 62.1 and PH, 59.8.

For the lamb growth and digestion trials, whole-plant wheat was harvested and ensiled at four stages: boot, milk, dough and ripe. Parker (P) was ensiled in all four stages; Blue Boy (BB), in the boot, milk and dough. Silage CP content decreased and soluble carbohydrate content increased as maturity increased. In the lamb growth trial,

the seven wheat silages and a forage sorghum silage (FS) were each fed to two pens of three lambs. Rations contained 86% silage and 14% supplement (DM basis). Lambs fed P-milk silage were removed from the trial for failure to consume their rations. Gain and intake were greatest ($P<.05$) for lambs fed the FS ration. Lambs fed BB-dough silage gained faster ($P<.05$) than those fed BB-milk, P-boot or P-ripe silage. Lambs receiving P-boot and BB-milk silages consumed less DM ($P<.05$) than those receiving any of the other four wheat silages. In the lamb digestion trial, three lambs received each of these eight rations during two 12-day preliminary and 6-day collection periods. DM digestibility and total digestible nutrients were not influenced by wheat variety or stage; crude fiber digestibility decreased ($P<.05$) as maturity increased. Lambs fed FS silage retained more nitrogen ($P<.05$) than those fed any of the seven wheat silages. Nitrogen retention tended to be higher in lambs fed BB silages than in those fed P silages. Forty-eight hr IVDMD was highest ($P<.05$) for FS silage followed, in decreasing order, by BB-boot, BB-dough, P-boot, BB-milk, P-milk and P-ripe silages. Parker milk and ripe silages had the lowest ($P<.05$) 48-hr IVDMD.

In the steer finishing trial, roughage treatments were: 10% corn silage; 20% corn silage; 10% wheat-head silage and 20% wheat-head silage. There were no significant differences in rate and efficiency of gain, DM intake or carcass characteristics among steers fed the four rations.

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# APPENDIX

TABLE 1. ANALYSIS OF VARIANCE FOR STEER PERFORMANCE DATA IN EXPERIMENT 1

| Source of variation | d.f. | Mean square | | |
|---|---|---|---|---|
| | | Average daily gain | Average daily feed | Feed/unit of gain |
| Total | 8 | | | |
| Treatment | 2 | .2121[a] | 1.9369[a] | 3.2867[b] |
| Replications | 2 | .0047 | .2001[b] | .2007 |
| Treat. x repl. | 4 | .0056 | .0260 | .1962 |

[a] $P<.01$

[b] $P<.05$

TABLE 2. ANALYSIS OF VARIANCE FOR LAMB PERFORMANCE DATA IN EXPERIMENT 3

| Source of variation | d.f. | Mean square | | |
|---|---|---|---|---|
| | | Average daily gain | Average daily feed | Feed/unit of gain |
| Total | 13 | | | |
| Treatment | 6 | .0122[a] | .1321[a] | 29.91[a] |
| Pen | 1 | .0015 | .0279[b] | 16.09 |
| Treat. x pen | 6 | .0006 | .0033 | 12.17 |

[a] $P<.01$

[b] $P<.05$

TABLE 3. ANALYSIS OF VARIANCE FOR LAMB DIGESTION DATA IN EXPERIMENT 4

| Source of variation | d.f. | Mean square | | | | | |
|---|---|---|---|---|---|---|---|
| | | Dry matter | Crude fiber | Crude protein | Nitrogen free extract | TDN | g N retained |
| Total | 47 | | | | | | |
| Treatment | 7 | 45.27[a] | 402.98[a] | 22.91[a] | 117.34[a] | 61.11[a] | 5.30[a] |
| Period | 1 | 1.20 | 9.99 | .90 | 5.10 | 10.70 | 2.48 |
| Treat. x period | 7 | 7.74 | 24.56[b] | 9.19 | 4.99 | 5.53 | 2.01[c] |
| Error | 32 | 4.70 | 8.51 | 6.02 | 7.24 | 4.43 | .97 |

[a] $P<.01$

[b] $P<.05$

[c] $P<.10$

TABLE 4. ANALYSIS OF VARIANCE FOR IN VITRO DRY MATTER DISAPPEARANCE DATA IN EXPERIMENT 5 (SILAGES FED IN EXPERIMENT 1)

| Source of variation | d.f. | Mean square | | |
|---|---|---|---|---|
| | | 3 hr | 6 hr | 48 hr |
| Total | 8 | | | |
| Treatment | 2 | 4.12 | 1.22 | 8.68 |
| Replications | 2 | 22.44[b] | 52.20[a] | 23.41 |
| Treat. x repl. | 4 | 2.58 | .615 | 9.43 |

[a] $P<.01$

[b] $P<.05$

TABLE 5. ANALYSIS OF VARIANCE FOR IN VITRO DRY MATTER DISAPPEARANCE DATA IN EXPERIMENT 5 (SILAGES FED IN EXPERIMENT 4)

| Source of variation | d.f. | Mean square | | |
|---|---|---|---|---|
| | | 3 hr | 6 hr | 48 hr |
| Total | 23 | | | |
| Treatment | 7 | 68.77[a] | 59.68[a] | 68.83[a] |
| Replications | 2 | 25.62[a] | 25.20[a] | 5.50 |
| Treat. x repl. | 14 | 3.23 | 3.81 | 3.79 |

[a] $P<.01$

# WHEAT SILAGE FOR STEERS AND LAMBS

by

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B.S., Kansas State University, 1972

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AN ABSTRACT OF A MASTER'S THESIS

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## ABSTRACT

Steer growth and digestion trials, lamb growth and digestion trials, an *in vitro* dry matter disappearance (IVDMD) study and a steer finishing trial were conducted to determine the effect of variety and stage of maturity on wheat silage quality and nutritive value.

In the steer growth trial, 63 steers were used to evaluate: whole-plant corn silage (CS); Blue Boy-head (BBH) or Parker-head (PH) wheat silages. Head silages contained the upper one-half of the plant in the mid to late dough stage. Percents dry matter (DM) and crude protein (CP), respectively, of the silages were; CS, 33.4, 8.74; BBH, 35.7, 13.61, and PH, 36.6, 13.20. Ration compostions (dry matter basis) were 86% silage and 14% supplement and all were formulated to contain 12.5% CP. Steers fed the CS ration gained faster ($P<.01$), consumed more ration DM ($P<.01$) and were more efficient ($P<.01$) than those fed the BBH or PH rations. Gain and DM consumption were greater ($P<.05$) for steers fed BBH silage than those fed PH silage. In the steer digestion trial, two steers received each of these three silage rations during a 10-day preliminary and 6-day collection period. Percent ration DM and CP digestibilities, respectively, were: CS, 70.1, 68.8; BBH, 66.9, 68.1 and PH, 66.7, 68.9. Nitrogen retention was highest in steers fed PH silage and lowest in those fed BBH silage. Forty-eight hr IVDMD (%) for the three silages was: CS, 63.5; BBH, 62.1 and PH, 59.8.

For the lamb growth and digestion trials, whole-plant wheat was harvested and ensiled at four stages: boot, milk, dough and ripe. Parker (P) was ensiled in all four stages; Blue Boy (BB), in the boot, milk and dough. Silage CP content decreased and soluble carbohydrate content increased as maturity increased. In the lamb growth trial,

the seven wheat silages and a forage sorghum silage (FS) were each fed to two pens of three lambs. Rations contained 86% silage and 14% supplement (DM basis). Lambs fed P-milk silage were removed from the trial for failure to consume their rations. Gain and intake were greatest ($P<.05$) for lambs fed the FS ration. Lambs fed BB-dough silage gained faster ($P<.05$) than those fed BB-milk, P-boot or P-ripe silage. Lambs receiving P-boot and BB-milk silages consumed less DM ($P<.05$) than those receiving any of the other four wheat silages. In the lamb digestion trial, three lambs received each of these eight rations during two 12-day preliminary and 6-day collection periods. DM digestibility and total digestible nutrients were not influenced by wheat variety or stage; crude fiber digestibility decreased ($P<.05$) as maturity increased. Lambs fed FS silage retained more nitrogen ($P<.05$) than those fed any of the seven wheat silages. Nitrogen retention tended to be higher in lambs fed BB silages than in those fed P silages. Forty-eight hr IVDMD was highest ($P<.05$) for FS silage followed, in decreasing order, by BB-boot, BB-dough, P-boot, BB-milk, P-milk and P-ripe silages. Parker milk and ripe silages had the lowest ($P<.05$) 48-hr IVDMD.

In the steer finishing trial, roughage treatments were: 10% corn silage; 20% corn silage; 10% wheat-head silage and 20% wheat-head silage. There were no significant differences in rate and efficiency of gain, DM intake or carcass characteristics among steers fed the four rations.