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NUTRITIVE VALUE OF TRITICALE
FOR RUMINANTS

by

Allen W. McCloy, B.S.

A THESIS

IN

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CHAPTER I

INTRODUCTION

Triticale is a polyploid that was developed by doubling the chromosome number of the sterile hybrid that results from crossing two genera of existing cereal grains and the name derived from the generic classification of these grains (wheat, Triticum and rye, Secale). Briggie (1969) reported that the first wheat x rye hybrid was obtained by Wilson in 1875 and the first wheat x rye amphiploid was developed in 1888 by W. Rimpau. Since that time, plant breeders have strived to develop hexaploid and tetraploid triticales that combine the desired characteristics of both wheat and rye. Extensive research has been conducted at the University of Manitoba in the past several years toward the development of higher-yielding, more vigorous triticales. (Briggie, 1969).

Recently, hexaploid (6n) triticales were developed at the Jenkins Foundation for Research, Salinas, California. This constituted a major contribution by plant geneticists in the development of new cereal grains. These new selections of 6n triticale represent considerable improvement in plant vigor, fertility, and yields over earlier triticales. Preliminary agronomic data from California indicated that yields of the 6n triticales were superior to either wheat or rye grown under similar production techniques. (Jenkins, 1970).

Research information is limited concerning the use of 6n triticale as a feed grain in high energy finishing rations for ruminants. The

protein and energy content of 6n triticale, however, rank this product among the more conventional feed grains in nutrient levels.(table 2).

The finishing trial, digestibility trials, and comparative acceptability studies reported herein were conducted to evaluate the nutritive value of triticale compared to sorghum grain for ruminant animals.

CHAPTER II

LITERATURE REVIEW

Most research conducted concerning the inclusion of triticale as a primary ingredient in ruminant finishing rations has been in Canada where various selections of triticale have been produced for several years. Different production variables such as soil types and nutrient levels, climatic conditions, managerial practices, and genetics all contribute varying degrees of influence on the characteristics and nutrient levels of the grain. Thus, it is expected that the 6n triticales will vary in nutrient content from the selections of triticale developed and tested in Canada. However, similar trends should be expected as to the value of triticale compared to conventional feed grains in ruminant finishing rations.

Feeding trials. During 1962, the first feeding experiments of record were conducted using triticale and its screenings from seed grain preparation (Stringam, 1968). These experimental feeding trials indicated a 10% improvement in efficiency of feed utilization for triticale over barley with equal daily gains. Later experiments with triticale screenings, recleaned screenings and the poorer ends of the whole grain were complicated by a high incidence of ergot in the grain. A comparison of triticale with corn and barley showed these grains to be superior for producing gains, but with triticale equal or slightly superior in efficiency of feed utilization. Stringam (1968) concluded that triticale rations might be expected

to produce 5 to 10% lower average daily gains than barley rations, but with equal efficiency.

~~Nicholson~~ (1970) found that rations containing triticale produced significantly less gain than barley, but that feed utilization between three treatments (barley, barley-triticale, and triticale) was not ~~sig-~~nificantly different. He suggested that the nutritive value of triticale possibly could have been affected by the presence of ergot in the grain. McElroy (1968) reported that steers finished on dry and steam rolled triticale rations gained 10% faster and were 6% more efficient in feed utilization than those fed dry rolled barley. Lofgreen (1969) observed that daily gains and efficiency of feed utilization were higher for steers fed the 6n variety of triticale than with sorghum grain when both grains were steam rolled. Stone (1970) indicated that triticale, when ergot-free, appeared to be equal to rye in ruminant feeding rations. He suggested, however, that only 25% of a finishing ration could be successfully composed of triticale without reducing performance.

Several researchers (~~Brethour and Duitsman, 1966; Richardson et al., 1967; Hale et al., 1970b~~) have reported equal or improved feed efficiency from cattle fed wheat as compared to sorghum grain in finishing rations. Equal or reduced average daily gains on wheat as opposed to sorghum grain finishing rations have also been reported by several investigators (Brethour and Duitsman, 1966; Richardson et al., 1967; Totusek et al., 1968; Hale et al., 1970b). ~~the conflicting report,~~ Hale et al. (1970a) indicated that steers fed 75:25 wheat:maize and 100% wheat rations consumed more feed, but showed reduced daily gains and feed efficiency when compared to a 50:50 wheat:maize ration. Thomas and

~~Geissler (1968)~~ found no difference in rate of gain and feed efficiency between barley and 20, 40 and 60% wheat replacing barley in cattle finishing rations. Results comparing wheat and corn mixtures in all-concentrate cattle rations (~~Oltjen et al., 1966~~) indicated that steers fed 60 and 90% corn rations made greater gains than steers fed 60 and 90% wheat rations. As the amount of wheat in the ration increased, efficiency of feed utilization decreased. ~~Baker and Baker (1960)~~ reported that wheat was inferior to corn when used as a total replacement in conventional finishing rations, but that wheat was satisfactory for finishing cattle when used to replace 50% of the corn. ~~Brethour (1966)~~ concluded that wheat should be limited to 50% of the ration concentrate portion and that when mixed with corn or sorghum grain, wheat was about 9% more efficient than when fed alone. It was also stated that wheat fed as the only grain in a finishing ration decreased intake to the extent that rate of gain was affected.

The increase in liver condemnations due to abscesses in cattle fed triticale (McElroy, 1968) and wheat (Baker and Baker, 1960; Gill, 1966; Oltjen et al., 1966) has been observed by several researchers when these grains were compared to conventional feed grains included in finishing rations for cattle.

Experimental feeding trials with swine have indicated that triticale was equivalent to barley as an energy source for growing and finishing pigs (Stothers and Shebeski, 1965; Bowland, 1968).

Comparative acceptability. Studies with nonruminants (~~Stothers and Shebeski, 1965; Bowland, 1968~~) indicated a possible palatability problem with triticale and a lowered acceptability when triticale was

substituted either partially or totally for barley or wheat in swine finishing rations. Other work with nonruminants (~~rats~~) showed that triticale was essentially equal in acceptability to wheat and rye. (~~Knipfel, 1969~~).

There have been conflicting reports as to the acceptability of triticale base rations by ruminants. Stringam-~~(1968)~~ found a lowered acceptability to triticale, but the experiment was complicated by ergot infestation. ~~Lofgreen (1969)~~ noted that feed intake was higher with triticale than with sorghum grain when both grains were steam rolled and fed in rations containing 68% grain and 7% molasses. In another feeding trial, McElroy ~~(1968)~~ reported little or no evidence of a palatability problem with either dry or steam rolled triticale. He indicated, however, that steers consumed 6% more steam rolled than dry rolled triticale. Nicholson ~~(1970)~~ reported no palatability or acceptability problems with experimental steer rations containing 73% grain composed of dry and steam rolled triticale. He did indicate a higher consumption of the steam rolled triticale ration.

Research has indicated somewhat divergent results as to the acceptability of wheat finishing rations for ruminants. Brethour and Dultsman (1966), Bris et al. (1966), Gill (1966), Totusek et al. (1968) and Waldern and Cedeno (1970) have reported lowered consumption of high concentrate rations based on wheat. Reports of equal or increased intake of high concentrate wheat rations by finishing cattle have been made by several investigators (Richardson et al., 1967; Thomas and Geissler, 1968; Hale et al., 1970a). Richardson et al. ~~(1967)~~ suggested that a mixture of wheat and sorghum grain seemed to be more acceptable

to the animals over a longer period than a ration containing wheat as the sole basal grain. Brethour-(1966) indicated that the addition of molasses to wheat rations did not affect intake of finishing cattle.

Protein utilization. The higher crude protein content of tritica compared to sorghum grain is another important consideration. This characteristic of tritica can be used to an economical advantage when formulating finishing rations containing tritica. Results with nonruminants have shown that the high protein content of tritica was utilized satisfactorily by pigs started at approximately 39 kg, but not by those started at lighter weights, i.e., ~~16~~-kg (Stothers and Shebeski, ~~1965~~). Knipfel (1969) reported that the protein efficiency ratio of tritica was equal to rye for rats, and both were more efficient than wheat.

Brethour (1966) indicated that wheat protein can be used as satisfactorily as protein from other sources in balancing beef cattle rations. He suggested that cottonseed meal or equivalent 41% supplement could be reduced by approximately 125 g for each kilogram of high-protein wheat added to the ration. Other researchers have recognized and reported the value of wheat protein in formulating and reducing the cost in cattle finishing rations. (Brethour and Duitsman, 1966; Ely and Duitsman, 1967; Totusek *et al.*, 1968).

CHAPTER III

EXPERIMENTAL PROCEDURE

The triticales used in these studies was a mixture of 6n selections produced under irrigation in the Imperial Valley of California and the Rio Grande Valley of Texas during the 1969 crop season. The sorghum grain was obtained at a commercial elevator from supplies grown within the local vicinity where production averages about 85% grown under irrigation and 15% under dryland conditions. Both grains were fed dry rolled in all trials.

Finishing trial. Forty uniform Hereford steers averaging 285 kg were randomly allotted into two main treatment groups with five replications of four steers in each main treatment for a 146 day feeding period. Composition of the isonitrogenous (15.1% crude protein, as fed) finishing rations is given in table 1. All steers were implanted with 30 mg diethylstilbestrol at the initiation of the study. The steers were self-fed and started on the respective experimental rations by initially including enough additional roughage to equal 25%, with roughage levels decreased approximately 9% at about 5 day intervals. The steers received the final rations (table 1) on the 12th day. Chlortetracycline levels were increased to 15.5 mg per kg of ration during the first 12 days of the experiment. Steers were weighed at 28 day intervals with initial and final live weights determined from individual unshrunk weights using a 3 and 4% arithmetical shrink, respectively. All steers were slaughtered upon completion of the feeding

TABLE 1. COMPOSITION OF FINISHING RATIONS

Ration	Triticale	Sorghum Grain
Ingredient composition ^a	%	%
Triticale	92.0	---
Sorghum grain	---	83.1
Ground sudan hay	7.0	7.0
Cottonseed meal	---	7.6
Urea	---	1.2
Calcium carbonate	0.5	0.5
Trace mineral salt	0.5	0.5
Elemental sulfur	---	0.1

^a The grains were dry rolled. Both rations contained 7.7 mg chlortetracycline and 4,400 I.U. vitamin A per kg.

period. Response criteria were average daily gain, feed consumption, efficiency of feed utilization, and standard carcass measurements. Performance data were expressed both on a live animal and a carcass basis. Statistical analyses were by analysis of variance.

Digestibility study. Twelve steers averaging 272 kg and 14 cross-bred wethers averaging 43 kg were placed in metabolism stalls and randomly allotted six and seven per treatment, respectively. The animals were fed rations containing triticale and sorghum grain for digestibility trials involving a 7-day adjustment period followed by a 7-day preliminary and collection periods. Ingredient and chemical composition of the rations are listed in table 2. Procedures were the same for the steers and wethers except that fecal collection bags were used and urine was not collected with the steers. All animals were initially fed the respective experimental rations on a limited intake basis (1% of body weight daily) in two feedings. Intake was gradually increased during the adjustment period with maximum consumption limited at 6.35 and 1.20 kg per head daily for the steers and wethers, respectively, fed in two approximately equal feedings. Feed intake was held constant at the level established for each animal during the remainder of the trial. Water was provided ad libitum. Rations were sampled at each feeding. Total wet feces were weighed and sampled (10% aliquot), and the samples were composited daily. Total daily urine of the wethers was diluted to a constant volume with a 100 ml aliquot composited for analysis. Fecal samples were frozen and the urine samples were refrigerated until analyzed. Proximate analysis of feed and feces and urinary nitrogen

TABLE 2. INGREDIENT AND CHEMICAL COMPOSITION OF DIGESTIBILITY TRIAL RATIONS

Ration	Triticale	Sorghum Grain
Ingredient composition ^a	%	%
Triticale ^b	79.0	---
Sorghum grain ^b	---	71.6
Cottonseed hulls	20.0	20.0
Cottonseed meal	---	6.3
Urea	---	1.0
Calcium carbonate	0.5	0.5
Trace mineral salt	0.5	0.5
Elemental sulfur	---	0.1
Chemical analyses, DM basis, %		
Organic matter	97.2	97.4
Ash	2.8	2.6
Crude protein	14.5	14.4
Calcium	0.28	0.30
Phosphorus	0.29	0.30
Gross energy, kcal/g DM	4.414	4.315

^a The grains were dry rolled. Both rations contained 10.5 mg chlortetracycline and 4,400 I.U. vitamin A per kg.

^b Crude protein levels (% of DM) and gross energy (kcal/g DM) were 17.8, 10.9 and 4.527, 4.474 in the triticale and sorghum grain, respectively. Mineral analyses for triticale and sorghum grain, respectively, were: as % of DM, Ca, <0.10, <0.10; P, 0.33, 0.28; Mg, 0.11, 0.12; K, 0.63, 0.48; and, as ppm, Mn, 27.0, 18.0; Fe, 27.0, 49.0; Cu, 11.0, 8.0; Zn, 51.0, 24.0; and Mo, 0.5, 0.6.

analysis were conducted according to A.O.A.C. (1965) methods. Gross energy determinations were made with an oxygen bomb, adiabatic calorimeter. Minerals were determined by atomic absorption spectrographic techniques (Warner, 1970). Nitrogen solubility of the rations was determined by the method of Lyman et al. (1953). True protein digestibility was calculated using the value of 0.45 g metabolic fecal nitrogen per 100 g dry matter intake (Blaxter, 1964). Digestibility of the grain portions was calculated by difference. Total digestible nutrients were calculated using the value of 4.41 kcal digestible energy per g TDN (N.R.C., 1969). Statistical analyses were by analysis of variance.

Acceptability trials. It was observed early in the finishing trial that consumption was lower with the triticale ration than with the sorghum grain ration. Intake levels were also somewhat more difficult to establish with the triticale ration in the digestibility study, particularly with sheep. Therefore, three 28 day comparative acceptability trials involving four treatments in each trial were conducted. Sixteen Hereford heifers initially averaging 227 kg and individually assigned four per treatment were used to evaluate the effects of various levels of dry rolled triticale upon voluntary feed intake. During allotment for the second and third trials, the restriction was imposed that no heifer would receive identical treatments (triticale levels) during any two successive trials. The heifers were kept in drylot and fed alfalfa hay ad libitum during a three week rest period between trials. In trial 1, the rations contained 0, 30, 60 and 90% triticale replacing equal parts of sorghum

grain and other concentrates by weight. The all triticale and all sorghum grain rations were comparable to those given in table 1 except that roughage levels were increased to 9%, replacing 2% of the grain. Rations with the intermediate triticale levels contained sorghum grain and other ingredients in respective proportions so that all rations were isonitrogenous. Rations were similar in trial 2 except that molasses replaced 5% of the grain by weight with grain reductions proportional to the respective grain fractions in rations containing both grains. Rations formulated for trial 3 compared acceptability of dry rolled triticale and sorghum grain at constant grain:roughage ratios, with and without molasses. The two rations without molasses each contained 89.0% grain, 10.0% ground sudan hay, 0.5% trace mineral salt, and 0.5% calcium carbonate, with 3.4 mg chlortetracycline and 4,400 I.U. vitamin A per kg ration. Molasses substituted for 5% of each grain in the other two rations.

The heifers were fed individually in all trials and initially offered 1.81 kg of feed during a two hour feeding period twice daily. Intake was increased by 0.45 kg after three consecutive feeding periods without weighback. Any unconsumed feed was weighed back and discarded after each feeding. Average daily consumption expressed as kilogram per mean metabolic size ($W_{kg}^{.75}$, determined from average of initial and final weights) was used to evaluate comparative acceptability of the rations in each trial. Statistical analyses were by analysis of variance with degree of orthogonal polynomials tested among treatment means for trials 1 and 2.

CHAPTER IV

RESULTS AND DISCUSSION

Finishing trial. Feedlot performance and carcass data are given in table 3. Average daily gains were higher ($P < .01$) with steers fed the sorghum grain ration than those fed the triticale ration. This lower gain was probably a function of the reduced ($P < .01$) consumption of the triticale ration. However, feed conversion was more ($P < .10$) efficient with the triticale ration. Similar results were obtained when performance was expressed on a carcass basis with feed per unit of carcass gain significantly ($P < .05$) lower with the triticale than with the sorghum grain ration. Lofgreen (1969) reported that feed intake and gains were higher with triticale than with sorghum grain when both grains were steam rolled and fed in rations containing 68% grain and 7% molasses. He also found that feed utilization was 7% more efficient with the triticale ration. Other investigators (Stringam, 1969; Nicholson, 1970) have observed reduced performance by cattle with triticale compared to barley and corn, but concluded that the presence of relatively high levels of ergot in the triticale may have influenced the results. They found that efficiency of feed utilization with triticale was comparable to that for barley. McElroy (1968) stated that steers fed triticale had 10% faster and 6% more efficient gains than steers fed barley rations. Stone (1970) indicated that ergot-free triticale appeared to be equal to rye in rations for ruminants.

TABLE 3. FEEDLOT PERFORMANCE AND CARCASS TRAITS OF STEERS
FED TRITICALE AND SORGHUM GRAIN RATIONS

Ration	Triticale	Sorghum Grain
No. Steers	20	20
Initial wt., kg	284.5	284.7
Final wt., kg	422.0	449.2
Total gain, kg	137.5	164.5
Daily gain, kg ^a	0.94	1.13
Daily feed intake, kg ^a	7.35	10.06
Feed/gain, kg ^b	7.82	8.90
Warm carcass wt., kg	267.2	285.4
Daily carcass gain, kg ^{c,d}	0.72	0.84
Feed/carcass gain, kg ^d	10.21	11.98
Dressing %	63.3	63.6
Marbling score ^e	4.6	4.6
Carcass grade ^f	11.1	11.3
Backfat thickness, cm	1.2	1.2
Abscessed livers, % ^a	65.0	15.0

^a Difference between means was significant ($P < .01$).

^b Difference between means approached significance ($P < .10$).

^c Calculated using 57% as the initial dressing percentage.

^d Difference between means was significant ($P < .05$).

^e Slight = 4; small = 5; moderate = 7.

^f Good plus = 11; choice minus = 12; choice = 13.

Performance data from the present study with triticale are consistent with research which shows that the replacement of sorghum grain with high levels of wheat in ruminant finishing rations tends to reduce average daily gains (Brethour and Duitsman, 1966; Richardson et al., 1967; Totusek et al., 1968; Hale et al., 1970b) and increase efficiency of feed utilization (Richardson et al., 1967; Hale et al., 1970b). However, research data consistently agree that feedlot performance from wheat rations is optimal when wheat is used to replace only 50% of conventional feed grains in ruminant finishing rations containing grain sorghum (Brethour, 1966; Ely and Duitsman, 1967; Hale et al., 1970a) and corn (Baker and Baker, 1960; Brethour, 1966). These results with wheat and the study reported herein with dry rolled triticale (as indicated by consumption data in tables 5 and 6) suggest that feedlot performance of finishing cattle receiving triticale rations could possibly be improved by a mixture of triticale and a conventional feed grain. However, Lofgreen (1969) reported that a finishing ration containing steam rolled triticale as the sole basal feed was equal or superior to a 50:50 triticale-barley or triticale-grain sorghum mixture in producing gains and efficient utilization of feed. The lower consumption and performance in the present experiment with dry rolled triticale might be partially explained by the different grain processing methods. Nicholson (1970) observed that consumption was 13% higher for steam rolled triticale rations than for those containing dry rolled triticale, although he indicated that the two processing methods produced similar rates of gain and efficiency of feed utilization. McElroy (1968) noted that steers consumed 6%

more of the steam rolled triticale rations than those containing dry rolled grain and that daily gains were approximately 2% higher for steam rolled grain with efficiency of feed utilization 3% greater for the dry rolled triticale rations. These results suggest the possibility of improving ruminant finishing rations containing high levels of triticale by steam processing the grain, which would tend to increase acceptability and consumption over dry rolled grain.

Standard carcass traits were comparable between the two grain treatments (table 3). Liver condemnations due to abscesses were significantly ($P < .01$) greater for steers fed the triticale ration. McElroy (1968) reported similar increases in liver abscesses when triticale made up more than 50% of the grain portion of finishing rations. He also noted considerable damage to ruminal epithelium in steers fed rations containing higher triticale levels. Baker and Baker (1960), Gill (1966) and Oltjen *et al.* (1966) observed higher incidences of abscessed livers when increased levels of wheat replaced corn in finishing rations. The present results along with those reported by other investigators suggest that incidence of abscessed livers may likely be higher in cattle fed cereal grains such as triticale and wheat than with most conventional feed grains.

Digestibility study. Digestibility data are presented in table 4. Digestibility of the energy components was higher with the triticale ration than with the sorghum grain ration, although the differences were not significant. Both crude and true protein digestibilities were higher ($P < .05$) for the triticale ration. Digestibility of the grain portions calculated by difference followed trends similar to the

TABLE 4. DIGESTIBILITY OF TRITICALE AND SORGHUM GRAIN RATIONS AND OF THE GRAIN PORTIONS BY CATTLE AND SHEEP

Ration	<u>Triticale</u>		<u>Sorghum grain</u>		
Species	Cattle	Sheep	Cattle	Sheep	S.E.
Daily DM intake, kg	5.247	1.078	5.223	1.070	----
Digestibility, total ration, DM basis, %					
Dry matter	72.8	72.9	69.6	72.4	1.5
Organic matter	73.5	74.0	70.3	73.3	1.5
Crude protein ^a	68.8	70.5	52.3	55.6	1.8
True protein ^a	88.5	89.9	72.8	75.1	1.4
Gross energy	70.8	72.3	66.6	70.2	1.6
Daily nitrogen balance, g					
Nitrogen intake	-----	24.98	-----	24.70	----
Nitrogen in feces	-----	7.36	-----	10.97	----
Nitrogen in urine	-----	14.33	-----	10.14	----
Nitrogen retention	-----	3.29	-----	3.59	0.32
N retained, % intake	-----	13.2	-----	14.5	----
Digestible energy, kcal/g DM	3.125	3.191	2.874	3.029	----
TDN, DM basis, %	70.9	72.4	65.2	68.7	----

Continued on next page.

TABLE 4. CONTINUED

Ration	<u>Triticale</u>		<u>Sorghum grain</u>		S.E.
Species	Cattle	Sheep	Cattle	Sheep	
Digestibility, grain portion, DM basis, %					
Dry matter	79.7	79.9	75.8	79.7	2.2
Organic matter	80.5	81.7	76.4	80.5	2.2
Crude protein ^b	75.3	76.7	35.8	38.1	3.0
True protein ^b	91.1	92.5	61.7	63.9	3.0
Gross energy	77.1	79.0	72.7	77.6	2.2
Digestible energy, kcal/g DM	3.490	3.576	3.252	3.472	----
TDN, DM basis, %	79.1	81.1	73.7	78.7	----

^a Significant difference ($P < .05$) between ration means.

^b Significant difference ($P < .01$) between grain means.

digestibility of the rations. The increased digestibility of the triticale reflected the improved efficiency of feed utilization obtained in the steer finishing trial (table 3). Digestibility data for triticale closely compare with those reported by Cornett et al. (1970) for a new feed-type wheat when fed dry rolled. Nitrogen retention by sheep was somewhat higher with the sorghum grain ration than with the triticale ration. This was probably a function of the lower nitrogen solubility of the sorghum grain ration (49.5 vs. 66.7% of total nitrogen). Danke et al. (1966) found that reduction of nitrogen solubility improved nitrogen retention as long as decreased urinary nitrogen losses compensated for increased fecal nitrogen losses. In the present study, fecal nitrogen losses from the sorghum grain ration were higher (table 4) than from the triticale ration. Lower urinary nitrogen losses, however, resulted in slightly higher nitrogen retention with this ration.

There were no significant ration x species interactions. Digestibility of the nutrient components was generally somewhat higher in sheep than in cattle for both grains with the largest differences noted in the sorghum grain. None of the observed differences, however, were statistically significant. These results are in agreement with those reported by Cornett et al. (1970) who found comparable digestibility of dry rolled wheat between sheep and cattle, and with Buchanan-Smith et al. (1968) who found higher digestibility of ground sorghum grain by sheep than cattle. The results reported herein lend further support to the hypothesis proposed by Cornett et al. (1970) that differences in digestibility of high concentrate rations between

sheep and cattle are inconsistent and may vary with different grains. The present results and the other reported data suggest that greater differences in digestibility of high concentrate rations between sheep and cattle may occur with rations containing sorghum grain than with the other grains studied.

Acceptability trials. Results of the acceptability trials are given in tables 5 and 6. In trial 1, consumption decreased with each higher level of triticales with a significant ($P < .01$) decrease between the 30 and 60% levels. This decreased consumption was expressed by a significant ($P < .01$) linear response. There was also a significant ($P < .05$) linear decrease in consumption in trial 2 when the rations contained 5% molasses. This was exhibited by almost constant consumption with the first triticales level, then decreased with each of the two higher levels. Consumption was significantly ($P < .01$) lower with the triticales rations in trial 3 with rations containing only grain, roughage and minerals. The addition of molasses did not apparently influence consumption within grain treatments in the third trial. Consumption differences between the all sorghum grain ration and those containing the first two levels of triticales were greater in trial 1 than in trial 2, when the rations contained molasses. However, consumption was not appreciably influenced by molasses in trial 3, possibly indicating that addition of molasses per se did not substantially improve acceptability of dry rolled triticales. Brethour (1966) reported that added molasses had no effect on consumption of wheat rations. Stone (1970) suggested that triticales could compose up to 25% of the ration without adversely affecting consumption.

TABLE 5. COMPARATIVE ACCEPTABILITY OF RATIONS CONTAINING DIFFERENT LEVELS OF TRITICALE (TRIALS 1 AND 2)

Triticale, %	0	30	60	90
Trial 1				
Mean wt., kg	280.4	249.5	255.4	254.0
Daily intake, kg/Wkg ^{.75}				
1st 7 days	1.09	0.95	0.79	0.76
2nd 7 days	1.75	1.55	0.91	0.87
3rd 7 days	1.99	1.62	1.17	1.28
4th 7 days	2.16	1.93	1.46	1.34
Total 28 days ^a	1.75 ^b	1.52 ^b	1.08 ^c	1.06 ^c
Trial 2 ^d				
Mean wt., kg	302.2	297.2	294.5	291.3
Daily intake, kg/Wkg ^{.75}				
1st 7 days	1.40	1.36	1.32	1.08
2nd 7 days	2.04	2.18	1.79	1.51
3rd 7 days	2.22	2.28	1.96	1.53
4th 7 days	2.25	2.15	1.89	1.55
Total 28 days ^e	1.98 ^f	1.99 ^f	1.74 ^{f,9}	1.42 ^g

^a Triticale levels were expressed by a significant ($P < .01$) linear response.

^{b,c} Means within the same category having different superscripts are significantly different ($P < .01$).

^d Molasses replaced 5% of the grain in all rations during trial 2 with grain reductions proportional to level of each grain in the rations containing both grains.

^e Triticale levels were expressed by a significant ($P < .05$) linear response.

^{f,9} Means within the same category having different superscripts are significantly different ($P < .05$).

TABLE 6. COMPARATIVE ACCEPTABILITY OF HAY-GRAIN RATIONS CONTAINING TRITICALE AND SORGHUM GRAIN BOTH WITH AND WITHOUT MOLASSES (TRIAL 3)

Grain Molasses, %	Triticale		Sorghum grain	
	0	5	0	5
Mean wt., kg	335.3	364.8	334.8	327.6
Daily intake, kg/Wkg ^{.75}				
1st 7 days	1.34	1.24	1.34	1.26
2nd 7 days	1.39	1.43	1.73	1.67
3rd 7 days	1.71	1.65	2.18	2.09
4th 7 days	1.76	1.79	2.22	2.20
Total 28 days ^a	1.55	1.53	1.87	1.81

^a Significant ($P < .01$) difference between grain means.

Results obtained in the finishing trial (table 3) indicated that the lower gains by steers fed triticale were primarily a function of the lower feed intake, suggesting that dry rolled triticale was less acceptable to the animals than dry rolled sorghum grain. This reduced acceptability was also reflected in the lower consumption observed in the acceptability trials (tables 5 and 6). Some difficulty was noted in establishing intake levels with the triticale ration in the digestibility study, particularly with sheep. Consumption was maintained, however, once the levels were established. It should be noted that intake was held constant in the digestibility study at levels lower than the ad libitum consumption used in the finishing and acceptability trials. Consumption data from the present study with triticale are consistent with research which has shown that higher levels of wheat may reduce acceptability and consumption of ruminant rations (Brethour, 1966; Brethour and Duitsman, 1966; Gill, 1966; Oltjen et al., 1966). Bris et al. (1966) found that steers consumed less dry rolled, pelleted, and steam rolled wheat than steam rolled barley when rations containing 70% grain were fed during a 29 day acceptability trial. Waldern and Cedeno (1970) reported that, unless pelleted, wheat was not as acceptable to lactating cows as conventional feed grain rations.

Lower consumption has been observed with rations containing the triticales developed earlier when compared with other feed grains. Stringam (1968) reported lower consumption of triticale than corn or barley rations, although he concluded that the presence of ergot in the triticale may have influenced acceptability of the grain. This was not an influencing factor in the present study since the triticales

used was free from any detectable ergot. Studies have shown that triticales in nonruminant rations reduced consumption by swine (Stothers and Shebeski, 1965; Bowland, 1968) and rats (Knipfel, 1969) as compared to barley and wheat.

Lofgreen (1969) found that feed intake and gains were higher and feed utilization more efficient with triticales from the same source as that used in the present study than with sorghum grain when both grains were steam rolled and fed in rations containing 68% grain and 7% molasses. Nicholson (1970) and McElroy (1968) observed that consumption of steam rolled triticales rations was 13 and 6%, respectively, higher than those containing dry rolled grain. The lower consumption with dry rolled triticales in the experiments reported herein might be partially explained by the different grain processing methods, since relatively low levels of the dry rolled triticales resulted in reduced feed intake. These results tend to indicate that consumption of triticales might be improved by steam processing, provided that a stable flake can be produced with minimum levels of fines. The latter, if present in excessive amounts, may reduce consumption.

Data from the present study suggest that triticales may potentially become an important feed grain. The high crude protein levels, improved digestibility, and more efficient feed utilization compared with sorghum grain are important factors for consideration in evaluating a feed grain for livestock rations. Further studies will be required to fully evaluate triticales and to establish feasible methods for improving and insuring a more consistent acceptability by the animals, including variables such as grain processing, optimum levels, and the addition of other ingredients in the ration.

CHAPTER V

SUMMARY

A finishing trial with steers, digestibility studies with steers and wethers, and three acceptability trials with individually fed heifers were conducted to evaluate and compare 6n triticale (wheat x rye) with sorghum grain as a feed grain in high concentrate rations. Crude protein levels (~~DM basis~~) were 17.8 and 10.9% in the triticale and sorghum grain, ~~respectively~~. The grains were dry rolled in all trials and fed in isonitrogenous rations containing 7 and 20% roughage in the finishing and digestibility trials, ~~respectively~~. Rations for the first acceptability trial contained 9% roughage with different levels of triticale (0, 30, 60 and 90%) replacing equal parts of sorghum grain and other ingredients in respective proportions so that all rations were isonitrogenous. Rations for the second acceptability trial were comparable to those in the first trial except that molasses replaced 5% of the grain with grain reductions proportional to the respective levels of each grain in the rations containing both grains. In the third trial, the grains were fed in 10% roughage rations containing only grain, roughage and mineral supplements, both with and without 5% molasses.

Average daily gains and feed intake were higher ($P < .01$) with steers fed the sorghum grain ration when expressed both on a live weight and carcass basis. Feed utilization was more efficient with triticale both on a live weight ($P < .10$) and a carcass ($P < .05$) basis. Carcass traits were comparable between the two treatments.

Incidence of abscessed livers, however, was higher ($P < .01$) in the steers fed triticales. Digestibility of the energy components was somewhat higher and protein digestibility was significantly higher for the ration ($P < .05$) and grain portion ($P < .01$) with triticales than for sorghum grain with species data combined. Digestibility of all nutrient components tended to be somewhat higher by sheep than cattle for both grains, although the largest differences occurred in the sorghum grain, none of the differences were statistically significant. Energy and crude protein digestibilities (%) of the grains by cattle and sheep were 77.1, 79.0; 75.3, 76.7; and 72.7, 77.6; 35.8, 38.1 for triticales and sorghum grain, respectively.

There was a linear decrease in consumption with higher triticales levels both in the first ($P < .01$) and second ($P < .05$) acceptability trials. In the second trial, consumption differences were less between the all sorghum grain ration and those containing the first two levels of triticales. Consumption was significantly ($P < .01$) lower with the triticales rations in trial 3 with no apparent influence on consumption by the addition of molasses with either grain.

These results suggest that 6n triticales may potentially become an important feed grain for ruminants. Further research will be required to fully evaluate triticales and develop methods to insure a more consistent acceptability by the animals.

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