CHEMICAL AND BIOLOGICAL EVALUATION OF FIFTEEN TRITICALE CULTIVARS

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SUMMARY

Fifteen triticale cultivars were chemically analyzed and tested in a feeding trial with weanling rats. Chemical and performance data were statistically analyzed by regressions methods. It was observed that 21 day performance of rats was not correlated to any of several chemical parameters such as dietary lysine, chemical score or essential amino acid index. However, dietary lysine was highly correlated to average daily lysine consumed (r = 0.81) and the latter was correlated to average daily gain (r= 0.63).

INTRODUCTION

Studies reported previously (1, 2) rendered information on the nutritive value of triticale for the nonruminant animal. The

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results showed that, in general, the grain is adequate for use as a component of animal feeds. Also, even with the limited triticale cultivars tested, it was possible to detect significant differences between them.

Breeding studies on triticale make possible the production of literally hundreds of different cultivars with promising agronomic characteristics, which need to be screened so that only those that also show chemical and nutritional advantages are further improved.

Conventional methods of chemical analysis are laborious and costly, so quick and less expensive methods of analysis for certain nutrients have been developed in recent years (3, 4). On the other hand, *in vivo* evaluation of the different cultivars is limited by the small amounts of grain available for feeding tests, and also by the facilities, expense and number of animals that would be needed if all cultivars were to be biologically tested. The use of small rodents as the meadow vole (5) and the white mouse (6) has been considered as a possible solution to the problem.

The purpose of the study reported herein was to determine some of the chemical characteristics of 15 ergotfree triticale cultivars and to correlate the data with growth parameters obtained with weanling rats.

MATERIAL AND METHODS

Chemical Analysis

Grain samples (Table 1) were ground in a Wiley mill, dried overnight at 70° C, allowed to reach constant weight, and subjected to proximate analysis, amino acid analysis, colorimetric lysine determination, gross energy determination, and *in vitro* metabolizable energy determination by the methods described in preceding papers (1, 2, 7).

Growth Study

Seventy-five male albino Sprague-Dawley weanling rats initially weighing 49.8 g were used in a 21-day feeding trial. Animals were individually placed in wire-bottom cages where feed and water were offered *ad libitum*. Groups of five rats were randomly assigned to each of the 15 dietary treatments. Experimental diets

TABLE 1

IDENTIFICATION OF FIFTEEN TRITICALE CULTIVARS

Sample	Identification
1	Badger E_2E8B-10B-ON-OB-ON-OM
2	Arm"s" $\overline{x}$-308-6y-3M-100y-8B-ON-OB-ON-OM
3	Badger"s" E_8-68B-23B-ON-OB-ON-OM
4	Beaver"s" E_1-68B-Z-ON-OM
5	(INIA-Rye) Arm"s" $\overline{x}$-2145-IN-OM-ON-OM
6	Badger"s" E_2-68-B-9-B-ON-100M-ON-OM
7	Arm"s" $\overline{x}$-308-6y-2m-0y-19B-ON-OB-ON-OM
8	Arm"s" $\overline{x}$-308-27y-2M-4y-5M-300B-0y-OB-ON-OM
9	TCL Bulk R. Balt
10	Cinnamon $\overline{x}$280Z-68N-16M-ON-OM
11	Camel
12	Arm"s" $\overline{x}$-308-17y-4M-3y-1M
13	6-4-298
14	G-12-131
15	304

Samples 1-12 were kindly provided by Drs. K. W. Finlay and F. J. Zillinsky of the International Maize and Wheat Improvement Center (CIMMYT); sample 13 was provided by J. Schwoeppe of Dubois, Indiana; sample 14 by International Commodities Corp. of Amarillo, Texas; sample 15 was purchased commercially; the latter three samples were obtained through the mediation of B. J. Hankins, Agronomy Department, Purdue University, Lafayette, Indiana.

were calculated to provide 10% protein, using triticale as the only source of dietary protein. Other components included glucose monohydrate, and a vitamin-mineral premix described elsewhere (1).

Average daily gain (ADG), feed/gain ratio (F/G), protein efficiency ratio (PER) and average daily consumption were statistically analyzed and means were tested by the Newman Keuls method. Linear regression analyses of growth parameters and chemical data were also performed (8).

RESULTS

Proximate composition data of the 15 triticale cultivars are summarized in Table 2. Also, gross energy and *in vitro* metabolizable energy values are included in the same Table. Essential amino acid composition of triticales is summarized in Table 3. The values for lysine were obtained by two methods, ion-exchange chromatography and the colorimetric method described by Villegas and Mertz (4). Tryptophan was not determined and methionine was not included because no recovery studies were made. The Table also includes the chemical score (9) and the essential amino acid index (10). Both parameters were calculated using published values for tryptophan (1) and sulphur amino acids (11).

Table 4 summarizes the performance data of rats fed the 15 triticale cultivars. Average daily gain was affected by the triticale cultivar fed; however, the difference was statistically significant ($P \leq 0.05$) in only three cases. Differences in F/G and PER were not statistically significant ($P \leq 0.05$).

DISCUSSION

Correlation coefficients of several chemical parameters and performance data are shown in Table 5. Except for a few cases, most of the regression analysis resulted in low correlation coefficients. The r value ($r = 0.40$) observed between the two methods for lysine determination, can only be explained by the fact that the colorimetric determination was originally developed for corn endosperm protein and the triticale samples used for analysis included the whole seed. Aside from this fact, the amino acid standard used in the colorimetric method is based on corn's protein, and the different composition of triticale's protein may therefore have influenced the results.

The negative correlation coefficient for lysine and protein ($r = 0.42$) seems to be an indication that high protein seeds are not necessarily high in their lysine content. This fact was earlier reported by other authors (13) who found a highly significant inverse relationship between lysine content and protein level ($r = -0.52$).

Unexpectedly, the amount of lysine provided by the diets was very poorly correlated to all three growth parameters used. The reason for this finding can not be satisfactorily explained at

TABLE 2

PROXIMATE COMPOSITION OF TRITICALE*

Triticale**	Crude protein	Ether extract	Crude fiber	Ash	N.F.E.	Gross energy	*In vitro* M. E.
	g/100 g	g/100 g	g/100 g	g/100 g	g/100 g	Kcal/kg	Kcal/kg
1	15.38	1.80	2.76	2.00	78.06	4263	3372
2	14.99	1.63	2.63	1.96	78.79	4217	3546
3	14.91	1.86	2.78	2.00	78.45	4275	3474
4	14.46	1.43	2.19	1.92	80.00	4306	3548
5	14.94	1.60	3.10	2.24	78.12	4261	3321
6	16.40	1.50	2.44	1.88	77.78	4252	3592
7	15.69	1.51	2.59	2.00	78.21	4256	3499
8	16.66	1.37	2.25	1.95	77.77	4240	3622
9	15.78	1.47	2.58	2.07	78.10	4319	3579
10	15.50	1.58	2.51	2.03	78.38	4348	3645
11	16.38	1.22	2.64	2.02	77.74	4270	3549
12	17.38	1.62	2.43	2.03	76.54	4271	3685
13	17.17	1.46	2.66	2.13	76.58	4229	3423
14	16.50	1.62	2.54	2.03	77.31	4222	3518
15	17.47	1.88	3.98	2.76	73.91	4326	3447
Average***	15.97 ±0.24	1.57 ±0.04	2.67 ±0.10	2.06 ±0.05	77.71 ±0.34	4270.33 ±10.06	3521.33 ±26.09

* All Values are expressed in dry matter basis.
** Complete identification of samples is shown in Table 1.
*** Mean ± SE.

TABLE 3

ESSENTIAL AMINO ACIDS OF TRITICALE
(g/16 gN)

Item	Triticale*															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Average**
Lys***	3.3	3.1	3.7	3.5	3.8	3.4	3.8	3.6	3.6	3.6	3.3	3.3	3.6	2.9	2.8	3.43 ± 0.07
Lys†	2.7	3.5	3.5	3.9	3.8	3.5	3.6	4.0	4.0	3.6	3.4	3.4	3.5	3.1	3.7	3.54 ± 0.08
Thr	3.0	2.7	3.5	4.6	3.1	3.2	3.7	2.9	3.0	2.9	5.1	2.7	2.9	2.9	3.7	3.32 ± 0.18
His	2.0	2.1	2.4	3.1	2.8	2.3	2.7	2.3	2.2	2.3	2.5	2.6	2.4	2.2	2.2	2.40 ± 0.07
Arg	5.1	4.2	6.3	6.4	6.2	6.2	7.7	5.7	6.0	7.1	5.7	7.3	5.1	5.0	5.2	5.94 ± 0.24
Val	4.4	4.0	4.4	5.3	5.0	4.2	4.7	4.1	2.7	4.6	4.5	4.6	4.7	4.7	4.5	4.42 ± 0.14
Ile	2.7	3.1	3.7	3.6	3.9	3.1	4.1	3.3	3.2	3.9	3.7	4.0	3.9	3.6	3.3	3.54 ± 0.10
Leu	8.1	11.3	7.4	11.8	9.2	6.8	13.1	7.0	6.4	8.0	7.2	8.8	6.7	6.4	5.9	8.27 ± 0.56
Phe	4.9	4.5	4.8	6.0	4.8	4.5	5.4	4.7	5.3	4.8	4.6	5.0	5.0	4.9	3.4	4.84 ± 0.14
CS●	34	39	46	45	49	39	51	41	37	49	46	46	47	49	39	43.80 ± 1.34
EAA††	61.3	59.6	66.2	73.1	69.7	62.9	66.7	56.2	57.6	63.5	61.6	66.2	66.0	61.8	58.9	63.38 ± 1.19

* Complete agronomical identification of samples is shown in Table 1.
** Mean ± SE.
*** Determined by ion-exchange chromatography.
† Determined by Dr. E. T. Mertz by the colorimetric method (4).
● Chemical score (9).
†† Essential amino acid index (10).

TABLE 4

PERFORMANCE OF RATS FED FIFTEEN TRITICALE CULTIVARS

Triticale*	ADG, g	Feed/gain	PER	Average daily lysine consumption, mg
1	2.56** ***	5.01**	2.01**	42.3** ***
2	2.59** ***	5.05**	2.05**	40.5** ***
3	1.84***	5.95**	1.72**	40.5** ***
4	2.42** ***	4.76**	2.11**	40.3** ***
5	2.05** ***	5.38**	1.87**	41.9** ***
6	2.23** ***	5.04**	1.99**	38.2** ***
7	2.84**	4.66**	2.15**	50.3**
8	2.05** ***	5.35**	1.88**	39.5** ***
9	2.20** ***	5.30**	1.91**	42.0** ***
10	2.32** ***	5.36**	1.87**	44.8** ***
11	2.19** ***	5.44**	1.86**	39.3** ***
12	2.13** ***	5.46**	1.87**	38.4** ***
13	2.06** ***	5.43**	1.85**	40.3** ***
14	2.17** ***	5.02**	2.00**	31.5***
15	1.85***	5.47**	1.84**	28.3***
Average●	2.23 ± 0.07	5.24 ± 0.08	1.93 ± 0.02	39.88 ± 1.30

* Complete identification of samples is shown in Table 1.

** *** Values in each column with same superscript do not differ significantly ($P \leq .05$).

● Mean ± SE.

this time, but the trend confirms the one observed earlier (1, 7).

Growth parameters were not highly correlated to either of the methods used to predict biological value.

The correlation coefficient of dietary lysine (x) and average daily lysine consumption (y) was high ($r = 0.811$) and the regression equation obtained was:

$$y = -5.98 + 13.4x$$

When average daily lysine consumption (x) and average daily

TABLE 5

CORRELATION COEFFICIENTS OF CHEMICAL AND GROWTH PARAMETERS OBTAINED WITH FIFTEEN TRITICALE CULTIVARS

x	y	r
Dietary lysine	Dietary lysine*	0.40
Dietary lysine	Protein	−0.42
Dietary lysine	ADG	0.12
Dietary lysine	F/G	0.06
Dietary lysine	PER	−0.07
ADG	Chemical score	−0.01
ADG	EAA index	0.12
F/G	Chemical score	0.03
F/G	EAA index	−0.16
PER	Chemical score	−0.04
PER	EAA index	0.18
Dietary lysine	Lysine consumed	0.81**
Ave. lysine consumed	ADG	0.63**
Ave. lysine consumed	F/G	−0.27
Ave. lysine consumed	PER	0.30

* Lysine as determined by colorimetric method.
All other lysine figures used were from ion-exchange chromatography data.

** Statistically significant ($P \leqslant 0.05$).

gain (y) were analyzed, the r value was 0.632 and the regression equation for predicting y values was:

$$y = 0.0344 + 0.8576x$$

Based on the latter observations, it was concluded that although the total lysine content of the grains is not directly correlated to animal performance, the values could be used to predict lysine consumption and thus, performance of the animals. The results of this study, however, should be considered preliminary, and further research needs to be conducted using a larger number of cultivars.

RESUMEN

EVALUACION QUIMICA Y BIOLOGICA DE QUINCE CULTIVARES DE TRITICALE

Quince cultivares de triticale se analizaron químicamente y fueron empleados en una prueba de alimentación con ratas. Los datos químicos y de comportamiento fueron analizados estadísticamente por métodos de regresión. Se observó que el crecimiento de las ratas no guardaba correlación con ninguno de varios parámetros como son la lisina en el alimento, el puntaje ("score") químico o índice de aminoácidos esenciales. Sin embargo, la lisina en el alimento tuvo una elevada correlación con el consumo promedio diario de lisina (r = 0.81), y este último parámetro estuvo correlacionado con la ganancia diaria promedio (r = 0.63).

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