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Quack Grass (*Agropyron repens* L.): As Ruminant Feed

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Abstract: The nutritive value of quackgrass (*Agropyron repens* L.) was evaluated at late maturity. Rumen mixed microbe inoculums were taken from two fistulated Gezel rams. Samples of quackgrass were incubated with rumen fluid to determine gas production. Gas production was measured at 2, 4, 6, 8, 12, 24, 48, 72 and 96 h. The results showed that the Crude Protein (CP), Neutral Detergent Fiber (NDF) and Acid Detergent Fiber (ADF) content of quackgrass hay were 8.9, 69.5 and 38.3%, respectively. Organic Matter Digestibility (OMD) and Metabolizable Energy (ME) content were 43.54% and 6.58 MJ kg^{-1} DM, respectively. In conclusion, it seems that quackgrass could be used as an efficient ruminant feed.

Key words: Quackgrass, gas production, fistulated ram, metabolizable energy, ruminant

INTRODUCTION

Weeds are troublesome in many ways. They reduce yield by robbing crops of water, light space and soil nutrient. Weeds can replace desirable grass species, filling in gaps or voids and reducing yield and overall quality of pasture and forages. Weeds can produce allelopathic substances that are toxic to crop plants (Bosworth *et al*., 1985). Quackgrass (*Agropyron repens* L.) is a perennial weed that competes aggressively with cereal and forage crops. Graminicides such as sethoxydim and fluazifop are used to control quackgrass in alfalfa stands but not in established forage grass stands due to lack of selectivity. Thus, producers renovate their fields because of quackgrass infestation (Christen *et al*., 1990). Although quackgrass has been used in ruminant feeding (Narasimalu *et al*., 1989; Christen *et al*., 1990) information on its nutritive value is limited. In goats, Dutt *et al*. (1979) estimated apparent digestibilities of DM and CP to be 57.1 and 67.7%, respectively, for alfalfa infested with 78 % quackgrass. These values increased to 61.4 and 75.5%, respectively, when the percentage of quackgrass infestation was decreased to 35% using pronamide as an herbicide. In beef cattle, Stoszek *et al*. (1979) reported that quackgrass resulted in higher average daily gain than did tall fescue. Narasimalu *et al*. (1989) found that quackgrass infestation of timothy did not affect silage composition, voluntary intake or apparent digestibility in sheep.

Since using chemical compounds resulted in air, water, soil and plant pollution, using biological methods for reducing weeds such as quackgrass was preferred. There are a few studies on quackgrass as a potential feedstuff for ruminants (Stoszek *et al*., 1979; Narasimalu *et al*., 1989; Christen *et al*., 1990), thus further studies would be useful.

The aim of this study was to determine the nutritive value of quackgrass (QCK) hay including chemical composition, *in vitro* gas production characteristics, organic matter digestibility and metabolizable energy.

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MATERIALS AND METHODS

Forages

The quackgrass (*Agropyron repens*) used for this study was collected near Karaj, Iran and evaluated at the laboratory of Animal Science Research Institute, Karaj, Iran in 2006. Forage, was harvested at late maturity. Samples were collected, air-dried and ground (1 mm screen) for chemical analysis and *in vitro* gas production (Kamalak *et al*., 2005a).

Chemical Analysis

Dry Matter (DM) was determined by drying the samples at 105°C overnight and ash by igniting the samples in muffle furnace at 525°C for 8 h and Nitrogen (N) content was measured by the Kjeldahl method (AOAC, 1990). Crude Protein (CP) was calculated as N × 6.25. Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF), Acid-Detergent Lignin (ADL) and Acid Insoluble Ash (AIA) were determined by procedures outlined by Goering and Van Soest (1970) with modifications described by Van Soest *et al*. (1991); sulfite was omitted from NDF analysis. Hemicellulose and cellulose were calculated as (NDF-ADF) and (ADF-ADL-AIA), respectively (Andrighetto *et al*., 1993). Gross Energy (GE) was measured in an adiabatic bomb calorimeter.

In vitro Gas Production

Fermentation of QCK hay samples were carried using rumen fluid obtained from two fistulated Gezel rams (1.5 years old, avg initial BW 55 kg) fed twice daily with a diet containing alfalfa hay (60%) and concentrate (40%) following the method described by Menke and Steingass (1988). Approximately 200 mg hay sample was weighed into the glass syringes of 100 mL. The fluid-buffer mixture (30 mL) was transferred into the glass syringes of 100 mL. The glass syringes containing hay samples and rumen fluid-buffer mixture were incubated at 39°C. The syringes were gently shaken 30 min after the start of incubation. The gas production was determined after 2, 4, 6, 8, 12, 24, 48, 72 and 96 h of incubation. All samples were incubated in triplicate with three syringes containing only rumen fluid-buffer mixture (blank). The net gas productions for hay samples were determined by subtracting the volume of gas produced in the blanks. Gas production data were fitted to the model of Ørskov and McDonald (1979).

$$Y = a + b\,(1 - e^{-ct})$$

Where:

a = The gas production from the immediately soluble fraction (mL),
b = The gas production from the immediately insoluble fraction (mL),
c = The gas production rate constant for the insoluble fraction (%/h),
a + b = Potential gas production (mL),
t = Incubation time (h),
Y = Gas production at time t.

The ME (MJ kg^{-1} DM) content of QCK hay samples were calculated using equation of Menke *et al*. (1979) as follows:

$$\text{ME (MJ kg}^{-1}\text{ DM)} = 2.20 + 0.136\ \text{GP} + 0.057\ \text{CP}$$

Where:

GP = Twenty four hour net gas production (mL/200 mg),
CP = Crude protein (%).

Organic Matter Digestibility (OMD) (%) of QCK hays samples were calculated using equation of Menke *et al*. (1979) as follows:

$$\text{OMD (\%)} = 14.88 + 0.889\ \text{GP} + 0.45\ \text{CP} + 0.0651\ \text{XA}$$

Where:
GP = Twenty four hour net gas production (mL/200 mg),
CP = Crude protein (%),
XA = Ash content (%).

In vitro gas production measurements were carried out in the laboratory of Animal Science Research Institute in Karaj.

RESULTS AND DISCUSSION

The chemical composition of QCK hay is presented in Table 1. The CF content of QCK hay was 34.3%, while the ADF, NDF and ADL contents were 38.3, 69.5 and 5.7%, respectively. NDF value for QCK hay was similar to the value 66.4 found by Marten *et al*. (1987). Stoszek *et al*. (1979) estimated that ADF content for immature QCK was 34.1% and this value for QCK was lower than the value at 38.3% obtained in this experiment. NDF content was correlated positively with ADL and the ADL/ADF ratio, suggesting that as the plant matured lignification of cell walls increased ($R = 0.93$, $p<0.06$; $R = 0.95$, $p<0.05$, respectively). It was well established that the cell wall content of forages increase with increasing maturity (Gulsen *et al*., 2004; Kamalak *et al*., 2005b, c). Crude protein for QCK was 8.9%, a value lower than 14.5% reported by Stoszek *et al*. (1979) for immature QCK and of 17.2% reported by Marten *et al*. (1987) for common QCK harvested at joint.

The NFC and NFE values were 8.96 and 66%, respectively. The ash content, which is an index of mineral contents, was 11.2% in QCK hay. Cellulose (CE) and Hemicellulose contents were 32.6 and 31.1% in QCK hay, respectively. The lignification index (Table 1), on either NDF or ADF basis (Van Soest, 1982), in QCK hay was 8.1 and 14.6 %, respectively. The GE content for QCK hay was 4285.1 kcal kg^{-1}.

Table 1: Chemical composition, fiber component and gross energy content of Quackgrass (QCK) hay

Components	QCK	SD
DM (%)	95.00	0.58
OM (%)	88.70	0.21
CP (%)	8.90	0.25
Crude fiber (%)	34.30	0.37
Ether extract (%)	1.44	0.02
Ash (%)	11.20	0.21
NFC (%)	8.96	0.81
NFE (%)	66.00	1.89
Cell contents (%)	30.50	0.36
NDF (%)	69.50	0.36
ADF (%)	38.30	0.30
Hemicellulose (%)	31.10	0.92
Cellulose (%)	32.60	4.20
ADL (%)	5.70	0.31
AIA (%)	1.15	0.06
ADL/NDF (index)	8.10	0.49
ADL/ADF (index)	14.70	1.50
GE (kcal kg^{-1})	4285.10	84.80

QCK = Quackgrass; the data are mean value of three replicate; Non-fibrous carbohydrate (NFC) is calculated using the equation of NRC (2001), NFC% = 100 – (%NDF + %CP + % FAT + % Ash); NFE = Nitrogen-free extract; ADL = Acid-detergent lignin; AIA = Acid insoluble ash; ADL/NDF = Lignification index based on NDF; ADL/ADF = Lignification index based on ADF. GE = Gross Energy; SD = Standard Deviation

Table 2: Organic matter digestibility, gas production (mL) and estimated parameters of QCK hay at different incubation times

Time (h)	2	4	6	8	12	24	48	72	96
QCK	4.35	6.4	7.7	9.75	15.1	32.2	44.7	49.5	52.4
Estimated parameters	a	b	(a + b)		c	OMD		ME	
QCK	−0.95	56.3	55.35		0.035	43.54		6.58	

a = The gas production from the immediately soluble fraction (mL); b = The gas production from the immediately insoluble fraction (mL); c = The gas production rate constant for the insoluble fraction (%/h); (a + b) = Potential gas production (mL); OMD = Organic matter digestibility (% of DM); ME = Metabolizable energy (MJ kg^{-1} DM), SD for OMD = 0.28 and for ME = 0.06 RSD of total incubation times = 1.865

Gas production data during the fermentation period are shown in Table 2. The cumulative volume of gas production increased with increasing time of incubation. Gas production at 96 h incubation was 52.4 mL per 200 mg of dry matter for QCK. Therefore the estimated parameters a, b, c and (a + b) of QCK hay were -0.95, 56.3, 0.035 and 55.35 mL, respectively.

In vitro gas production was measured at 2, 4, 6, 8, 12, 24, 48, 72 and 96 h following the describe kinetics of fermentation using the modified exponential model $y = a + b[(1 - \text{Exp}(-ct)]$ (Ørskov and McDonald, 1979). Although there are other models available to describe the kinetics of gas production, the Ørskov and McDonald (1979) was chosen because the relationship of its parameters with intake, digestibility and degradation characteristic of forages and concentrate feedstuffs had been documented (Blummel and Ørskov, 1993; Khazaal *et al*., 1993).

The value for a, intercept, in QCK hay was negative in this study. These data suggested that a lag phase due to delay in microbial colonization of the substrate occurred in the early stage of incubation. Several authors (Menke *et al*., 1979; Blummel and Ørskov., 1993) have also reported negative values with various substrates when using mathematical models to fit gas production kinetics. The soluble fraction makes it easily attachable by ruminal microorganisms and this leads to much gas production (Khazaal *et al*., 1993; Blummel and Becker, 1997).

The gas volumes at asymptote (b) described the fermentation of the insoluble fraction and this was 56.3 mL in QCK hay. The gas volumes at asymptote have the advantage for predicting feed intake. Blummel and Ørskov (1993) found that gas volume at asymptote could account for 88% of variance in intake.

Rate of gas production (c) expressed in %/h, was 0.035. High rate of gas production possibly influenced by carbohydrate fractions that readily available to the microbial population. Deavill and Givens (2001) reported that carbohydrate fraction could affect kinetics of gas production.

Potential extent of gas production (a+b) expressed in mL, was 55.35% in QCK hay. It is well known that gas production is basically the result of fermentation of carbohydrates to acetate, propionate and butyrate (Getachew *et al*., 1998), whereas, protein fermentation do not lead to much gas production (Khazaal *et al*., 1995). However, the potential extent of gas production in QCK hay was low, possibly due to the carbohydrate fraction of QCK hay which has a large proportion of cell walls (Table 1) with low fermentation and leading to low gas production.

The OMD and ME contents of QCK were 43.54% of DM and 6.58 MJ kg^{-1} DM, respectively. The current finding agrees with studies on the nutritive value of pure QCK and timothy (Christen *et al*., 1990). The decrease in digestibility was due to increase in concentration of cell wall contents (Wilson *et al*., 1991), lignin content in mature plant (Morrison, 1980) and decrease in leaf/stem ratio (Hides *et al*., 1983). Menke *et al*. (1979) suggested that gas volume at 24 h after incubation has relationship with metabolisable energy in feedstuffs. Sommart *et al*. (2000) reported that gas volume is a good parameter from which to predict digestibility, fermentation end product and microbial protein synthesis of the substrate by rumen microbes in the *in vitro* system. Additionally, *in vitro* DM and OM digestibility were shown to have high correlation with gas volume (Sommart *et al*., 2000). Gas volumes also have shown a close relationship with feed intake (Blummel and Becker, 1997) and growth rate in cattle (Blummel and Ørskov, 1993).

CONCLUSION

The results of the current study based on chemical composition, digestibility of organic matter and metabolizable energy indicated that quackgrass could be a fair to good forage in ruminant nutrition. In addition, using weeds such as quackgrass in ruminant nutrition could reduce the use of chemical and toxic compounds (graminicides)which are usually used for controlling weeds in farms and therefore decreasing air, water, soil and plants pollution.

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