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In vitro fermentation of ten cultivars of barley silage

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ABSTRACT - The fermentation characteristics of whole-crop barley silages from ten different cultivars were evaluated by the in vitro gas production technique. The organic matter degradability of barley silage (62.9% in average) was comparable to those reported in our previous trials for oat (59.7%) and sorghum silages (65.5%); while the maximum gas production rate (5.38 ml/h in average) was slightly lower respect to oat (6.71 ml/h) and sorghum silage (6.74 ml/h). The mean nutritive value (4.00 MJ/kg DM) calculated on the basis of both chemical composition and in vitro fermentation data was comparable to that (4.16 MJ/kg DM) obtained in our previous research performed on corn silage, from crop sowed in the same area.

Key words: Barley, In vitro gas production technique, Ensilage.

Introduction – Harvesting whole-crop cereal silage arouses increasingly interest because it enables crop rotation and manure utilization in the fields and reduces feed production costs (Manninen et al., 2005). In south of Italy, whole-crop barley (Hordeum vulgare L.) harvested at milky-waxy maturation of grain (32-34 %DM) yields 10.5-12.5t of dry matter/hectare (Gianinetti and Stanca, 2006) and it has also been thought as possible and convenient substitute of corn silage which shows some weak aspects like high contamination with aflatoxins and fumonisins, parasites and high cost of irrigation. However, nutritive value of whole-crop barley silage is strongly influenced by several factors like cultivar, soil characteristics, water availability, weather conditions and stage of maturity. Aim of present work is to evaluate the chemical composition and the fermentation characteristics of whole-crop silages from 10 different cultivars of barley by means of the in vitro gas production technique (Theodorou et al., 1994).

Material and methods – The trial was performed in a farm sited in Cassino (FR, Italy) using ten cultivars of barley, chosen for productive and morphologic characteristics and disease resistance, which were sowed (November 2007) in plots of 10 m² each and harvested (May 2008) at milky-waxy maturation of grain. The forage was chopped to 2 cm length using a cutter, and was well pressed in the microsilos. After ensiling (2 months), 3 representative samples of each cultivar were taken from each microsilos. The samples, pooled, dried at 60°C for 48 h and milled (1.1 mm screen) were analyzed for the chemical composition (AOAC, 2000), the fibrous carbohydrates were fractioned (Van Soest et al., 1991) and pH was measured. The in vitro fermentation characteristics were studied (Calabrò et al., 2005) incubating at 39°C about 1 g sample in three replications in serum bottles buffered rumen fluid. The rumen fluid was sampled at slaughter-house from 2 dry buffalo (Bubalus bubalis) cows fed a
standard diet. The gas production was recorded at 2 and 24h intervals using a manual system (Theodorou et al., 1994). At 120 h the fermentation was stopped, pH was measured and the fermentation residue was filtered through pre-weighted crucibles (porosity #2), dried at 105°C, and then burned at 550°C to determine the OM degradability (OMD). The data describing the cumulative gas production were fitted to a sigmoid model (Groot et al., 1996). The maximum gas production rate (Rmax) and the time at which it occurs (tmax), were calculated according to Bauer et al. (2001). The nutritive value (net energy for lactation) was predicted as follows (Menke and Steingass, 1988): \[ \text{NEL (MJ/kg DM)} = 0.54 + 0.0959 \times \text{P} + 0.0038 \times \text{CP} + 0.0001733 \times \text{CP}^2 \] where P is the 24h gas production (ml/200 mg DM) and CP is the protein content of feed (g/kg DM). The influence of cultivar on the in vitro characteristics was statistically assessed using the proc \text{LM} (SAS, 2000).

Results and discussion – DM ranged between 24.3% and 28.4% (table 1) and was slightly lower than that reported by Manninen et al. (2005). These authors found on whole-crop barley silage also higher percentage of crude proteins (11.0% DM) and lower NDF (46.5% DM) than our results (CP% DM between 8.2 and 9.8; NDF% DM between 62.1 and 69.1) probably due to the early stage of harvesting (dough stage). The nutritive value calculated on the basis of both chemical composition and in vitro fermentation, ranged between 3.58 and 4.25 MJ/kg DM. It has to be underlined that the mean value is comparable to those (4.16 MJ/kg DM) obtained in our previous research (Calabrò et al., 2007) performed on corn silage, from crop sowed in the same area.

As regards the fermentation characteristics (table 2), the values of pH was in each case higher than 6.4, useful to guarantee the activity of cellulolytic microorganisms (Doane et al., 1997). All the cultivars show values of OMD (62.9% in average) comparable to those obtained in vitro with whole crop oat (59.7%, Calabrò et al., 2005) and sorghum silages (65.5%, Calabrò et al., 2007). The mean values of tmax

| Table 1. Chemical composition (% DM), pH and nutritive value (MJ/kg DM) of barley silages. |
|-----------------------------------------------|---------------|--------|--------|--------|--------|----------------|--------|
| Cultivar | DM | CP | NDF | ADF | ADL | pH | NEl |
|----------|----|----|-----|-----|-----|-----|-----|
| Alce     | 26.5 | 9.6 | 65.7 | 40.2 | 6.0 | 5.13 | 3.91 |
| Aldebaran| 27.3 | 9.8 | 65.1 | 45.7 | 5.6 | 5.36 | 4.06 |
| Amilis   | 25.5 | 8.2 | 69.1 | 43.7 | 6.7 | 5.42 | 3.67 |
| Boreale  | 25.6 | 9.0 | 66.1 | 41.2 | 4.1 | 5.26 | 4.33 |
| Estival  | 28.4 | 8.5 | 67.5 | 45.3 | 5.3 | 4.58 | 3.58 |
| Ketos    | 27.0 | 8.2 | 69.4 | 46.8 | 5.8 | 5.19 | 3.89 |
| Lutece   | 27.7 | 9.0 | 65.2 | 44.5 | 6.0 | 5.33 | 4.14 |
| Ninfa    | 24.3 | 9.5 | 68.5 | 42.5 | 5.7 | 5.07 | 4.03 |
| Nute     | 24.6 | 9.7 | 62.1 | 43.0 | 5.2 | 4.77 | 4.18 |
| Sixtine  | 24.9 | 9.5 | 67.6 | 44.6 | 4.7 | 5.08 | 4.25 |

| Table 2. In vitro fermentation characteristics of barley silages. |
|-------------------------------|-----------------|-------|-------|-------|-------|-------|
| Cultivar | pH | OMD | OMCV | A | B | tmax | Rmax |
|----------|----|-----|------|---|---|------|------|
| Alce     | 6.64 | 63.7B | 228CD | 271B | 32.6B | 15.2 | 5.15B |
| Aldebaran| 6.65 | 61.3C | 236BC | 273B | 33.1A | 17.9 | 5.25C |
| Amilis   | 6.68 | 60.7C | 223D | 261B | 32.2B | 16.5 | 5.10B |
| Boreale  | 6.65 | 67.1A | 250A | 285A | 28.6C | 15.3 | 6.35A |
| Estival  | 6.69 | 63.6B | 236BC | 286A | 35.3A | 16.0 | 5.01C |
| Ketos    | 6.67 | 63.5C | 245AB | 289A | 32.2B | 15.3 | 5.56B |
| Lutece   | 6.69 | 61.5C | 242BC | 284A | 32.6B | 16.4 | 5.44B |
| Ninfa    | 6.65 | 63.8B | 231CD | 276A | 34.0A | 16.6 | 5.07C |
| Nute     | 6.65 | 61.3C | 234C | 281A | 32.6B | 14.3 | 5.30B |
| Sixtine  | 6.73 | 63.0BC | 237BC | 271B | 30.9B | 16.3 | 5.56B |
| MSE      | 0.0035 | 0.785 | 16.34 | 33.02 | 0.909 | 1.47 | 0.0376 |

OMD: organic matter degradability; OMCV: cumulative gas production of incubated OM; Rmax: maximum gas production rate; tmax: time at which Rmax occurs; A (ml/g): asymptotic gas production; B (h): time after incubation at which A/2 was formed. In the same column, A,B,C,D: P<0.01; MSE: mean square error.
for barley silage (16.0h) were similar to those obtained with sorghum silage (15.1h) but higher compared to oat silage (8.3h). Besides the mean values of Rmax (5.38 ml/h) were slightly lower that those obtained with oat (6.71 ml/h) and sorghum silage (6.74 ml/h). In present trial, the behaviour of the different cultivars for all the fermentation parameters (figure 1) was similar excepted for the “Boreale” which showed significantly (P<0.01) higher OMD and OMCV and faster fermentation kinetics. These last results are probably due to the lower lignin content (table 1). In conclusion, all the tested whole-crop barley silages showed a good fermentative behaviour and a nutritive value comparable to other cereal silages. However, a complete judgement on the tested barley silages will be possible from the elaboration in progress of their other qualitative characteristics.

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REFERENCES – AOAC, 2000. Official Methods of Analysis, 17th edn. Association of Official Analytical Chemists, Arlington, VA. Bauer, E., Williams B.A., Voigt, C., Mosenthin, R., Verstegen, M.W.A., 2001. Microbial activities of faeces from unweaned and adult pigs, in relation to selected fermentable carbohydrates. Anim. Sci. 73:313-322. Calabrò S., Cutrignelli MI., Bovera F., Piccolo G., Infascelli F., 2005. In vitro fermentation kinetics of carbohydrate fractions of fresh forage, silage and hay of Avena sativa. J. Sci. Food Agric. 85:1838-1844. Calabrò S., Tudisco R., Grossi M., Bovera F., Cutrignelli M.I., Guglielmelli A., Piccolo V., Infascelli F., 2007. In vitro fermentation characteristics of corn and sorghum silages. Ital. J. Anim. Sci. 6 (Suppl. 2):559-562. Doane, P.H., Schofield, P., Pell, A.N., 1997. Neutral detergent fiber disappearance and gas and volatile fatty acid production during the in vitro fermentation of six forages. J. Anim. Sci. 75:3342-3352. Gianinetti A., Stanca M., 2006. Orzo da zootecnia: quali varietà scegliere. Risultati 2005-2006 delle prove nazionali. L’Informatore Agrario 32:32-39. Groot J.C.J., Cone J.W., Williams B.A., Debersaques F.M.A., 1996. Multiphasic analysis of gas production kinetics for in vitro fermentation of ruminant feedstuffs. Anim. Feed Sci. Tech. 64:77-89. Manninen M., Virkajärvi P., Jauhiainen L., 2005. Effect of whole-crop barley and oat silages on the performance of mature suckler cows and their progeny in outdoor winter feeding. Anim. Feed. Sci. Tech. 121:227-242. Menke, K.H., Steingass H. 1988. Estimation the energetic feed value obtained from chemical analysis and in vitro gas production using rumen fluid. Anim. Res. Develop. 28:7-55. SAS/STAT, 2000. User’s Guide, Version 6.03. SAS Institute Inc., Cary, NC, USA. Theodorou M.K., Williams B.A., Dhanoa M.S., McAllan A.B., France J.,1994. A simple gas production method using a pressure transducer to determine the fermentation kinetics of ruminant feeds. Anim. Feed Sci. Tech. 48:185-197. Van Soest, P.J., Robertson, J.B., Lewis, B.A. 1991. Methods for dietary fiber, neutral detergent fiber, and nonstarch polysaccharides in relation to animal nutrition. J. Dairy Sci. 74:473-481.