**Whole-crop legume/barley silages ensiled with different additives**

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**Introduction** Whole-crop barley has a relatively high feed value, which results in satisfactory ruminant performance (Nadeau, 2007; Rustas et al., 2008; Wallsten and Martinsson, 2009). To increase its crude protein (CP) content it can be grown in mixture with a legume. Use of various legumes and silage additives may affect fermentation characteristics and nutritive value of legume/barley mixtures. The aim of this study was to evaluate the effects of legume species and additive on feed value and fermentation characteristics of whole-crop legume/barley silages.

**Materials and Methods** Spring-sown vetch (V), field bean (F) or pea (P) was grown in mixture with spring barley (B) containing legume proportions of 47, 28 and 29% of dry matter (DM), respectively. Mixtures were harvested on July 17, 2007 at the early podding stage of the legumes and at medium to late milk stage of the barley. The herbage was chopped, wilted for ca 4 hours and treated with Lactisil 200®NB (*Lactobacillus plantarum, Enterococcus faecium, Pediococcus acidilactici, Lactococcus lactis,* cellulase and sodium benzoate; Medipharm Inc., Kågeröd, Sweden) at 200 000 cfu of lactic acid producing bacteria/g fresh herbage, with Proens™ (2/3 formic acid, 1/3 propionic acid; Perstorp Inc., Perstorp, Sweden) at 5 litres/tonne fresh herbage or with no additive. The treated herbage was ensiled in mini silos for 100 days. The design was a randomized block with three field replicates. Data were analyzed in PROC GLM of SAS (Cary, NC, USA) with mixture and additive as fixed factors (. When the *F*-value was significant for the main effects of mixture and additive and their interaction ($P < 0.05$), pair-wise comparisons among treatment means were performed with Tukey´s t-test and declared significant at $P < 0.05$.

**Results and Discussion** Yields of DM were 6.7 tonnes for VB and FB and 6.9 tonnes for PB.

**Table 1** Fermentation characteristics of silages as affected by crop mixture (n = 9).

| | Mixture with barley | | | | |
|---|---|---|---|---|---|
| Chemical composition | 47% vetch | 28% field bean | 29% pea | SEM | *P* - value |
| Dry matter, % | 26.3[b] | 32.7[a] | 32.1[a] | 0.5 | <0.0001 |
| Starch, % of DM | 2.7 | 2.4 | 2.8 | 0.16 | NS |
| Sugar, % of DM | 6.0[b] | 15.6[a] | 15.5[a] | 0.62 | <0.0001 |
| pH | 3.94 | 3.93 | 3.96 | 0.015 | NS |
| Lactic acid, % of DM | 8.9[a] | 5.3[b] | 5.8[b] | 0.46 | 0.0001 |
| Acetic acid, % of DM | 1.6 | 1.2 | 1.3 | 0.11 | 0.072 |
| Propionic acid, % of DM | 0.25[a] | 0.18[b] | 0.18[b] | 0.017 | 0.010 |
| Butyric acid, % of DM | 0.04[a] | 0.03[b] | 0.03[b] | 0.0006 | <0.0001 |
| Ethanol, % of DM | 0.35 | 1.07 | 0.82 | 0.34 | NS |
| 2,3-buthandiol, % of DM | 0.13 | 0.19 | 0.15 | 0.017 | 0.080 |
| $NH_4$-N[1], % of total N | 4.6 | 4.2 | 5.7 | 0.51 | NS |
| DM losses, % | 0.24[a] | 0.28[a] | 0.17[b] | 0.019 | 0.007 |

[a,b]Means in the same row with different superscripts differ ($P < 0.05$).
[1]$NH_4$-N = ammonia-nitrogen; SEM = standard error of the mean; NS = non-significant.

Wilted VB, FB and PB contained 27.7, 34.0 and 33.7% DM, 13.2, 8.5 and 9.0% CP, 4.3, 4.4 and 4.8% starch and 11.9, 19.1 and 19.5% sugar of DM, respectively. *In vitro* rumen organic-matter disappearance was 74.0, 71.7 and 75.3% for VB, FB and PB, respectively. The neutral detergent fibre content was 47.8, 50.7 and 53.0% of DM for VB, FB and PB silage, respectively ($P < 0.001$). The lower DM content of VB silage resulted in a more extensive fermentation of sugar to lactic and volatile fatty acids compared to FB and PB silages (Table 1). On average, starch was hydrolized from 4.5 to 2.6% of DM ($P < 0.0001$) during ensiling. Addition of the acid decreased starch content of the control silage while restricting fermentation of sugar to fatty acids, resulting in more sugar in the acid-treated silage than in the wilted herbage (19.2 vs. 16.9% of DM, $P < 0.01$; Table 2). Contents of alcohols and ammonia-N were lower in acid-treated than in untreated silage. Silage treated with the inoculant had the lowest pH and a lower content of 2,3-buthandiol than the control silage (Table 2). No interactions between crop mixture and herbage treatment were found for any of the variables studied, except for the sugar content. Acid-treated VB silage had similar sugar content to the wilted herbage of VB whereas acid-treated silages of FB and PB contained more sugar than their wilted herbages ($P < 0.05$).

**Table 2** Fermentation characteristics of silages as affected by additive (n = 9).

| | Silage treatment | | | | |
|---|---|---|---|---|---|
| Chemical composition | Control | Inoculant | Acid | SEM | *P* - value |
| Dry matter, % | 30.0 | 29.9 | 31.2 | 0.50 | NS |
| Starch, % of DM | 3.0[a] | 2.7[a] | 2.1[b] | 0.16 | 0.005 |
| Sugar, % of DM | 8.2[b] | 9.7[b] | 19.2[a] | 0.62 | <0.0001 |
| pH | 3.93[b] | 3.86[c] | 4.04[a] | 0.152 | <0.0001 |
| Lactic acid, % of DM | 7.7[a] | 8.8[a] | 3.5[b] | 0.46 | <0.0001 |
| Acetic acid, % of DM | 1.9[a] | 1.6[a] | 0.5[b] | 0.11 | <0.0001 |
| Propionic acid, % of DM | 0.07[a] | 0.07[a] | 0.05[b] | 0.017 | <0.0001 |
| Butyric acid, % of DM | 0.034 | 0.034 | 0.032 | 0.0006 | NS |
| Ethanol, % of DM | 1.41[a] | 0.77[a,b] | 0.06[b] | 0.340 | 0.040 |
| 2,3-buthandiol, % of DM | 0.24[a] | 0.18[b] | 0.06[c] | 0.017 | <0.0001 |
| $NH_4$-N[1], % of total N | 5.7[a] | 5.1[a,b] | 3.7[b] | 0.51 | 0.041 |
| DM losses, % | 0.24 | 0.24 | 0.21 | 0.019 | NS |

[a,b,c]Means in the same row with different superscripts differ ($P < 0.05$).

[1]$NH_4$-N = ammonia-nitrogen; SEM = standard error of the mean; NS = non-significant.

**Conclusions** Silages of VB, FB and PB had good feed values and fermentation characteristics, which were further improved by use of additives, especially of the acid.

**References**


Nadeau, E. 2007. Effects of plant species, stage of maturity and additive on the feeding value of whole-crop cereal silage. J. Sci. Food Agric. 87:789-801.

Rustas, B-O., E. Nadeau and S. Johnsson. 2008. Performance of dairy steers fed whole-crop barley silages harvested at different stages of maturity. Grassl. Sci. Europe 13:852-854.

Wallsten, J. and K. Martinsson. 2009. Effects of maturity stage and feeding strategy of whole crop barley silage on intake, digestibility and milk production in dairy cows. Livest. Sci. 121:155-161.