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SILAGE FROM INTERCROPPING OF MAIZE WITH COMMON BEANS (PHASEOLUS VULGARIS) AS ROUGHAGE FOR FATTENING PIGS

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Abstract: Maize silage is a high-energy roughage that can be fed to fattening pigs to provide both employment and additional nutrients. Intercropping of maize with common beans was tested to produce a roughage higher in protein, but was still found to contain considerably less protein than grass-clover silage, which is frequently fed to pigs. In a fattening trial with 144 pigs, maize-bean silage was compared to grass-clover as roughage. Although silage consumption in early fattening was lower when maize-bean silage was fed, neither fattening nor slaughter performance differed. So maize-bean silage as roughage was equally efficient as grass-clover silage, but did not show nutritional benefits.

Introduction: Maize silage has been found to be a suitable roughage for heavy pigs at inclusion rates of up to 30 % in the diet (Zanfi et al. 2014). However, maize silage is poor in protein, therefore we tested intercropping maize with common beans (Phaseolus vulgaris) to improve protein supply from home-grown sources. As part of a project cultivating different bean varieties intercropped with maize over several years, we tested a silage with bean cultivar Tarbais as roughage for fattening pigs. Tarbais had been found to perform well under organic cultivation, and as a white-blooming variety was expected to contain less of the anti-nutritional factors present in common beans (Fischer et al. 2020, Van der Poel 1990). The focus of the feeding trial was the acceptance of maize-bean silage for the pigs and their performance.

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Material and methods: The feeding trial was conducted between June 2015 and August 2019 at the experimental farm of Thuenen Institute of Organic Farming (Schleswig-Holstein). Maize-bean silage was standardised to contain 15 % beans (dry matter basis) and was prepared in plastic barrels of 120 l capacity. Animal husbandry followed the rules of EU Directive EC 834/2007. In total, 144 pigs born of crossbred sows (Large White*Landrace) inseminated with 14 different Piétrain sires participated in the trial. Each of the eight replicates included one control and one experimental group of 9 animals (sows and barrows) each. The fattening period started with an average body weight of 28.8 ± 3.5 kg, and the target weight for slaughter was 122 kg. The pens were equipped with a straw-bedded shed (1.5 m^2 pig^{-1}), a concrete outdoor run (1.1 m^2 pig^{-1}), a roofed trough, drinkers and a silage rack. The outdoor run was littered with straw and cleaned

twice a week. Until the average body weight per pen had reached 50 kg, an early fattening feed (183 g crude protein, 14.7 MJ ME, 10.8 g lysine kg^{-1} dry matter) was fed in amounts adjusted to the pigs´ appetite (*semi ad-libitum*). The finishing feed (168 g crude protein, 14.3 MJ ME, 9.6 g lysine kg^{-1} dry matter) was fed restricted, in amounts depending on the pigs´ body weight (2.2-2.9 kg feed at 50-117 kg body weight). Throughout the fattening period, the pigs had access to either grass-clover silage (154 g crude protein, 6.1 MJ ME) or maize-bean silage (75 g crude protein, 9.5 MJ ME). The silages were provided in separate racks and given fresh daily, in amounts of 0.5 kg during early fattening and 1.0 kg during late fattening (fresh matter basis).

Data collection included feed consumption, body weight, slaughter performance and meat quality. Feed refusals were documented daily, and pigs were weighed individually once a week. Immediately after slaughter, warm carcass weight was documented to calculate dressing percentage. 24 h after slaughter, muscle and fat measurements were taken on the left half of the carcass, as well as samples for the assessment of meat quality according to the federal standard of German pig testing stations (ZDS 2007). Lean meat content was calculated using the “Bonner Formula”. During late fattening, scratches and injuries were scored every 14 days (score 0 = no injury, 1 = at least one scratch >= 2 cm).

Statistical analysis was done using SAS 9.4 proc mixed, with a model including the fixed effects of diet and replicate, and the random effect of litter. For average daily gain, the covariate body weight at the start was included, and for meat quality, the covariate warm carcass weight. Analysis of scratches and injuries was based on a binomial distribution and the model included only the effect of diet. Probability values <0.05 were interpreted as representing statistically significant differences. Table 1 shows lsmeans and P values for the effect of diet, as well as standard errors of the means.

Results: The only effect of diet on feed consumption was a significantly lower silage consumption in early fattening, when maize-bean silage was fed (Table 1). This difference did not translate into total feed consumption over the whole fattening period, which did not differ. Fattening and slaughter performance and meat quality were not affected by diet.

Very little scratches and injuries on hind quarter and legs (grass-clover silage: 1.7 and 3.5 % injuries; maize-bean silage: 4.4 and 4.7 %) were observed, with no effect of diet on their frequency (P = 0.092 and 0.534). Higher frequencies were found for the areas “shoulder to hind quarter” and “head and shoulders”, where 7.7 and 19.0 % of all observations on pigs fed grass-clover silage and 15.6 and 33.2 % of all observations on pigs fed maize-bean silage were scored with “1”. For both areas, the frequency was significantly higher when maize-bean silage was fed (P = 0.004 and P < 0.001). The highest frequency of injuries was found for the tails, of which 52.6 and 56.3 % were scored as injured in the grass-clover and maize-bean group, respectively, with no effect of diet (P = 0.405).

Table 1. Fattening and slaughter performance as well as meat quality of pigs fed either grass-clover silage or maize-bean silage in addition to concentrates throughout the fattening period

	Grass-clover silage	Maize-bean silage	SEM	P value
Concentrate consumption*, kg day^{-1}				
Early fattening	1.48	1.45	0.060	0.747
Late fattening	2.34	2.38	0.029	0.324
Silage consumption*, kg day^{-1}				
Early fattening	0.13	0.07	0.009	<0.001
Late fattening	0.23	0.21	0.019	0.499
Total feed consumption	2.30	2.27	0.034	0.669
Body weight, kg				
Start early fattening	29.3	29.2	0.43	0.737
Start late fattening	51.1	51.8	0.80-0.81	0.437
At slaughter	121.1	120.9	0.62-0.63	0.836
Average daily gain, g				

Early fattening	711	708	14.5-14.7	0.850
Late fattening	881	863	12.1-12.2	0.243
Total	832	820	12.8-13.0	0.465
Concentrate conversion ratio, kg feed kg^{-1} gain				
Early fattening	2.08	2.04	0.065	0.740
Late fattening	2.67	2.75	0.058	0.351
Total feed conversion ratio	2.77	2.77	0.042	0.983
Slaughter performance				
Age at slaughter, days	190	191	1.6	0.427
Dressing percentage, %	79.9	80.1	0.24	0.329
Back fat depth, cm*	2.00	3.97	0.070	0.710
Side fat depth, cm	2.73	2.81	0.063	0.344
Lean meat content, %	56.9	56.4	0.43	0.262
Meat quality				
Electrical conductivity	3.46	3.34	0.144	0.543
pH value	5.55	5.54	0.008	0.235
L*	51.5	51.1	0.31	0.381
a*	10.4	10.7	0.17	0.204
b*	3.16	3.18	0.130	0.909
Drip loss	3.93	3.87	0.263-0.271	0.879
*feed is given on dry matter basis; back fat depth was measured at the thickest location at withers; L = luminosity, a = redness, b = yellowness, all measured with a Minolta® CR-300 device				

Discussion: Despite the presence of protein-rich beans in the maize-bean silage, its crude protein content was still considerably lower than in grass-clover silage. During early fattening, the pigs fed maize-bean silage consumed less silage than the pigs fed grass-clover silage, which could be interpreted as maize-bean silage being less palatable. However, during late fattening no difference in silage consumption was observed, leading to the conclusion that the pigs simply needed more time to adjust to the new feed. It might be beneficial to start offering maize-bean silage already during the rearing period. Neither total feed consumption nor total feed conversion ratio differed, so maize-bean silage as roughage was equally efficient as grass-clover silage. The general level of fattening and slaughter performance is in accordance with previous reports on organic pig fattening (Brandt et al. 2010). Total feed conversion ratio was better than the value of 3.1 reported by Brandt et al. (2010) for organic fattening, but not as good as their report for conventional fattening (2.5). Based on electrical conductivity values considerably lower than 6 and pH values lower than 5.8, neither PSE nor DFD meat occurred. Scratches and injuries from head to hind quarter were more frequentl on pigs fed maize-bean silage, which could indicate less satisfactory employment compared with grass-clover silage. Possible effects of the anti-nutritional factors present in common beans cannot be ruled out, but seem unlikely in light of the satisfactory performance level. To summarize, maize-bean silage with 15 % of the white-blooming cultivar Tarbais was found to be a suitable roughage for fattening pigs, but did not show nutritional benefits compared to grass-clover silage. Further research using a higher proportion of beans and other bean varieties might offer additional insights.

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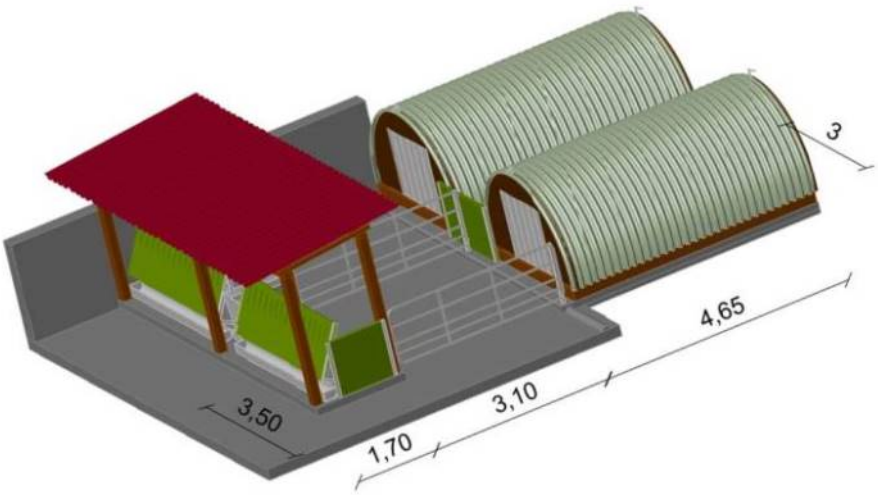
Image:



Disclosure of Interest: None Declared

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