

Feeding Control for Fattening Pigs

Measurable Parameters in Liquid Manure as Potential Control Variables

An efficient supply of nutrients increasingly plays a major role in the economic efficiency and ecology in pig fattening. For this reason measurable parameters, which quickly supply data on growth and nutrient conversion are necessary. As a product of decomposition from utilised protein, the nitrogen fractions in the manure are of vital importance. Tests were made to determine whether easily measurable parameters in liquid manure can be used as indicators, in order to purposefully enter this data into an automated feeding control loop.

In four trial-groups (VG) of a practical pig fattening experiment different protein conversion (PCR) in the animals were induced by increasing the lysine supply. By the employment of standardised laboratory analyses and the NIRS-measurement the content of nitrogen, $\text{NH}_4^+\text{-N}$, ash, dry-matter and pH in manure were recorded and the gain of the pigs via individual weighing determined in intervals of three weeks. Overall three fattening periods were conducted in the time from February 2004 till May 2005. The aim of the experiments was to verify if there are interrelationships between simple measurable parameters in manure and the progression of pig growth, which can be introduced in the process control for feeding.

Materials and methods

The experiments have been carried out under practical livestock conditions in a stable of a co-operation partner Hölischer&Leuschner, Germany.

In each feeding period 624 animals have been divided in four lysine level groups (V1 – V4). Differentiated by gender, the trial groups were randomly distributed in 24 double pens à 26 animals over the stable. All animals got a basic ration of cereals and soy-bean meal which was supplemented with lysine with a micro-injector according to the specifications for each trial group. The lysine concentration in the diet V1 rose from the natural content in the basic ration. For each 3-week fattening observation period (MA), the lysine concentration in V2 was adjusted to the level as in the recommendations by DLG (2002). The lysine concentrations for V3 and V4 were graded above these recommendations.

The animals were supplied with feed by a sensor controlled liquid-feeder (Bio-Feeder, Hölischer&Leuschner, Germany) four times a day. This system feeds the pigs according to their feed intake behaviour. According to the emptying speed of the trough at the earlier meal, the feed amount could be adjusted

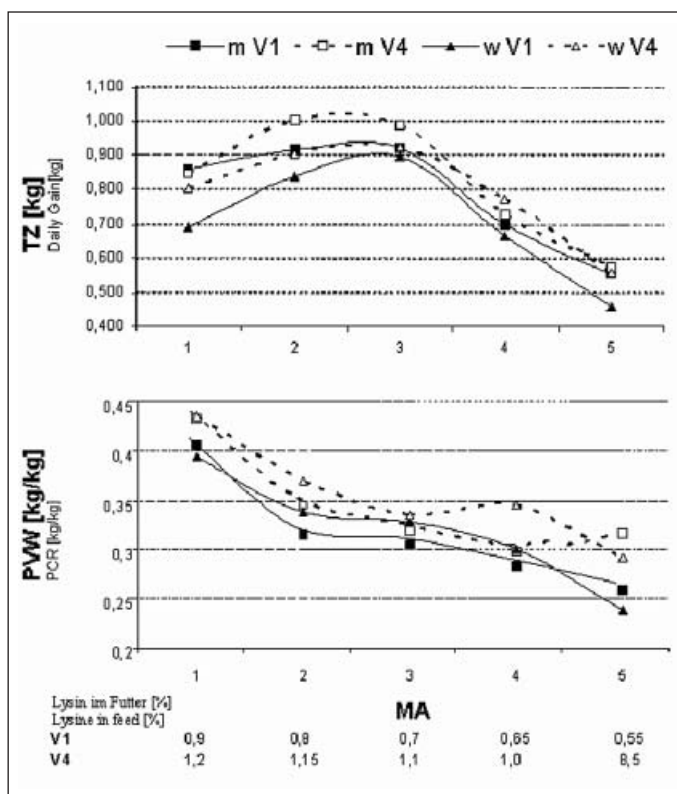
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Keywords

NIRS flow rate sensor, protein conversion, pig, lysine supply

Fig. 1: Average daily gain [kg], protein conversion rate (PCR [kg/kg]) and lysine concentration (%) in the different fattening periods (1-5) for graded lysine levels V1 and V4, differentiated for female (w) and castrated males (m)



for $\pm 6\%$ along the feeding curve for every feeding time. Among to the regularly individual weight recording appropriate sensors registered the climate, amount of feed intake and feed intake behaviour continuously.

The manure was quantitatively collected in each MA. Therefore each pen was equipped with a manure collecting funnel (1.5 m³). At the end of each MA the manure was analysed for dry matter-, ash-, total-N-, NH₄⁺-N- content and pH-value by laboratory and NIRS flow rate sensor [2]. In this way the growth process and the changes in excretion related to MA and VG could be determined.

Results

The different lysine levels in the VGs caused significant varying intensity of growth in the pigs. Over all groups the average daily gain for the male was 0.816 kg, for the female 0.772 kg. Within each MA the gain in V4 was increased, both for female and male (Fig. 1, top). Within the MA the daily gain was significantly dependent on the lysine level.

As expected the amount of feed (FA) for one kg gain during the fattening period increased in the average from 2,06 : 1 up to 3,45 : 1. In tendency within the MA a lower FA was regarded for the higher lysine level groups.

In response to the VG within the MA and between the gender the differences were highly significant (<0.0001).

In contrast to the PCR the interrelation between manure parameters and FA was not significant (p= 0.01). The PCR represents the rate of protein deposition in response to the crude protein intake. Due to the physiological mechanism the PCR decreases during fattening, whereupon within the MA, V4 showed always an improved PCR for males and females (Fig. 1, bottom).

Averaging all the fattening periods the total-N-concentration in manure was 0.74 % in fresh matter for male and 0,69 % for female. The differences were significant between gender (p=0.001).

The total-N-concentration for males decreased continuously from 0.78 % in V1 to 0.71 % in V4. For females the V4 showed the lowest total-N-content, too, but without the continuous gradation. Over the entire fattening and all gender the NH₄⁺-N- content in manure decreased with the increasing lysine supply level from 0.51% (V1) upon 0.47 % (V4). The average concentrations for males were 0.51 % and for females 0.48 %. Within

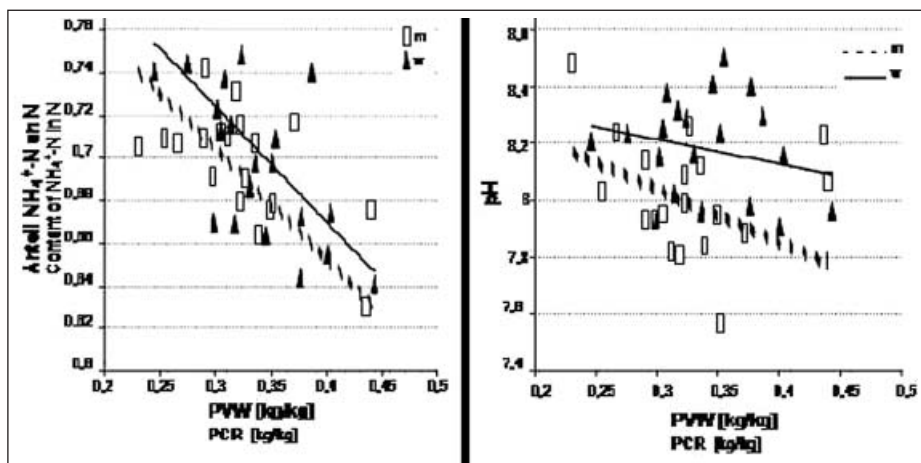


Fig. 2: Share of NH₄⁺-N in total N and pH-value in relation of protein conversion rate (PCR); differentiated for female (v) and castrated males (m)

each MA for males and females the NH₄⁺-N-contents were decreasing with increasing lysine supply level (p = 0.004). In response to the daily gain, the NH₄⁺-N- content differed significant between the gender and between the MA.

Independently of MA and VG, the NH₄⁺-N-content in total-N decreased with increasing protein conversion (Fig. 2, left).

In the course of fattening the PCR declined while the mean pH-value increased from 7.8 to 8.2. Independently of time and VG, a relationship between high PCR and low pH-values (Fig. 2, right) can be assumed. This was more distinctive for the males than for the females, but on a lower level than the NH₄⁺-N-content within total-N. The pH-value differed significantly between MA and the gender. The average pH-value was 7.8 for the female and 8.0 for the male. With increasing lysine supply level the mean pH-value of the females continuously decreased from 8.0 (V1) to 7.7 (V4), for the males it rose from 7.7 (V1) to 7.9 (V4).

Conclusions

By the different lysine levels in the feed for each VG, a significantly varying intensity of growth of the pigs in the specific MA was induced. An increasing of the lysine supply above the proposed actual German recommendations had a positive effect on the fattening performance parameters. This provides a data basis to discover possible indicators in manure under practical livestock conditions, which are correlated with the different weight gains of the animals.

The pH-value and as well as the NH₄⁺-N-content in total-N of the manure have shown as a potential parameter for some relation-

ships between the performance of the pigs and the manure in this experiment. These values have to be regarded separately for the fattening periods and the genders.

The gain performance of the pigs depend on multiple factors as housing conditions, climate, nutrient, age, constitution and genetic. The introduced trial shows that several measurable manure parameters can give a reference about the actual performance level of the animals. But they couldn't offer an explicit conclusion for the growth development and/or nutrient utilisation.

Therefore more research is necessary to detect a representative point of time for measurement respectively observation periods that can present relationships and provide supporting (feeding) measures.

In order to develop an automated feeding control loop by regarding ingredients of manure as a definite control variable for a performance-related feeding is it necessary to regard the recordable manure parameter in respect of further growth parameters as e.g. climate, feed intake and behaviour etc.

Literature

- [1] DLG : Leistungs- und qualitätsgerechte Schweinefütterung. Deutsche Landwirtschafts-Gesellschaft, DLG-Verlag, Frankfurt am Main, 2002
- [2] Dolud, M., H. Andree and Th. Hügler. Rapid analysis of liquid hog manure using near-infrared spectroscopy in flowing condition. Precision-livestock-farming'05. 2005, pp. 115-122
- [3] Naatjes, M., C. Suhr, H. Andree, Th. Hügler and A. Susenbeth : Effect of lysine concentration in the diet of fattening pigs and practical livestock farming-conditions. In 5th European Conference on Precision Agriculture (5ECPA) and 2nd European Conference on Precision Livestock Farming (2ECPFLF), Uppsala, Sweden, 2005