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Influence of protein supply on odour emission by fattening pigs

The majority of odour-active substances from fattening pig slurry result from protein metabolism. Hence, changes in protein supply are likely to influence odour emission. However, the olfactometric examination of fattening pigs differently supplied with protein does not yet provide a clear result. While odorant concentration exhibits virtually no reaction to protein supply, the composition and quality of the odour seem to change.

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Keywords

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Literature

Literature references can be called up under LT 03119 via internet http://www.landwirtschaftsverlag.com/landtech/local/literatur.htm.

In litterless housing, odorants are almost exclusively emitted by slurry, whose quantity and composition are dependent upon feeding. As fattening progresses, the pig's demands with regard to feed composition change. In comparison with the energy requirements, the demand for protein in the ration exhibits disproportionately small growth. Multiple-phase feeding also results in the fattening pigs being oversupplied with protein for the longest time.

In addition to ammonia, slurry contains other volatile components, which rather cause environmental nuisance than harm to the environment. Most of these substances are organic degradation products with functional osmophoric groups. Among these odour-active substances, which are often a product of protein metabolism [1, 2, 3], particularly those containing sulphur, whose perception threshold is extraordinarily low, are noted. Sulphides resulting from amino-acid metabolism also seem to be the lead components responsible for the nausea-causing effect of slurry odour [4].

The further classification of the characteristic odorants in pig slurry also indicates that feed protein is one of the main substrates for the microbial and enzymatic intermediate and final products in the digestive tract and in the faeces after excretion. In addition to the sulphides, in particular volatile fatty acids (VFA), phenolic compounds, indoles, NH_3 and amines seem to contribute to the typical slurry odour [1]. Except for the VFA, all substance classes listed above are products of amino-acid metabolism, whereas the formation of VFA is also the result of carbohydrate metabolism. All in all, these results indicate that feed protein is a central element in the production and the properties of slurry odours. This would enable the hypothesis to be deduced that a reduction in excess protein in fattening pig rations would cause a decrease in the concentration of the odorants resulting from protein metabolism, which would lead to lower odour emission and less nuisance.

On the other hand, feeding also influences the biological, chemical and physical processes in the slurry so that altered emission processes must be expected [5, 6, 7]. In addition, one must take into account that the odorants from animal housing are odorant complexes [8]. If altered feeding strategies, for example, lead to a change in the concentration of an individual substance or the chemical-physical environmental conditions and thus influence the quality and quantity of the emitted odorant complex, compensatory, additive, synergistic and overlaying effects on the odour impression may occur. Here, a technical analysis of gas composition as an examination method reaches its limits because it does not allow for a semantic interpretation of the odour impression which results from the interaction of the single components [9, 10]. However, olfactometry enables the effect of different feeding strategies to be determined directly using the human nose as a sensor.

Fattening period	Compartment	Pens	Groups	Feeding strategy
1	1	1-4	A	30-120 kg LM* K
		5-8	B	30-65 Kg LM K / >65 kg LM V1
	2	1-4	C	30-120 kg LM K
		5-8	D	30-65 Kg LM K / >65 kg LM V2
2	1	1-4	E	30-65 Kg LM K / >65 kg LM V1
		5-8	F	30-120 kg LM K
	2	1-4	G	30-65 kg LM K / >65 kg LM V2
		5-8	H	30-120 kg LM K

Table 1: Trial groups and pen allotment *LM = live mass

Table 2: Mean odour concentration c_o (OU/m³)

Group U	V1	V2	Total GE/m³	s		Pre-fattening before feed change GE/m³	s		Main fattening after feed change GE/m³	s	
A			4486	0,705	n.s.	3067	0,820	n.s.	5550	0,564	n.s.
	B		6700	0,968		4100	0,854		8650	0,542	
C			3400	0,982	n.s.	3367	0,778	n.s.	3425	1,105	n.s.
		D	3514	1,063		3067	0,713		3850	1,236	
	E		6379	0,992	n.s.	4700	0,622	n.s.	7638	0,284	n.s.
F			6464	0,619		5200	0,798		7413	0,212	
		G	3700	0,378	n.s.	3433	0,239	n.s.	3900	0,332	n.s.
H			4136	0,424		2733	0,531		5188	0,244	

Pair difference comparison (t-test) n.s. = P>0.05

Experimental Set-Up

In the experimental stall of the Training- and Counselling Service Futterkamp of the Chamber of Agriculture Schleswig-Holstein, the influence of protein-reduced rations on the odour-emission behaviour of slurry was studied in two fattening periods with regard to odorant concentration, intensity and hedonics. Per fattening period, at least two compartments divided into eight individual pens for 12 animals each were available. The pens were separated by a central aisle. Four pens each were connected by the slurry cellar and combined into a trial group. The individual stall compartments were demanured using the retention-washing technique. Each of the four trial groups was demanured individually. The slurry was retained in the channels for 14 days. Subsequently, it was homogenized, collected, and sampled immediately for the olfactometric analyses (odorant concentration, intensity, hedonics). The samples were stored at -18°C until they were used.

The olfactometric analyses were carried out with a MANNEBECK TO7 olfactometer. Odorant concentration cG (OU/m³) was determined in a standardized manner by diluting it dynamically with neutral air until the odour threshold was reached. Intensity and hedonic odour impression were evaluated by presenting a dilution series in the range above the threshold. The intensity scale included seven steps from „imperceptible“ (0) to „extremely strong“ (6). The hedonics scale comprised nine steps from „extremely pleasant“ (4) to „neither-nor“ (0) and „extremely unpleasant“ (-4). Gas samples were taken immediately before the measurement from the air space above the slurry sample container after controlled thawing in a 20°C water bath.

The comparison comprised one universal fattening period (U: 13.4 MJ ME; 19.5% XP) versus two groups (V1: 13.4 MJ ME; 15.5% XP; V2: 13.4 MJ ME; 13.5% XP) with differently strict protein reduction during main fattening. The feed was mainly based on the components wheat, rye, triticale, barley and extracted soy bean meal, whose percentage varied. Depending upon the requirements, the protein-reduced experimental feeds (V1, V2) were supplemented with amino acids. The animals of one fattening period were stalled up at the same time. One control group and one trial group each were housed in one compartment. Group allotment and pen occupation are shown in *table 1*. During initial fattening, all animals got the universal fattening feed containing 19.5% XP, which was dispensed continuously to the control groups until the end of the fattening period. As of a live mass of approximately 65 kg, this feed was replaced with the experimental feed V1 or V2 in the trial groups. The goal of the experiments was the comparative analysis of the groups under identical conditions. For statistical evaluation, the t-test as a pair difference comparison between the groups of each compartment was employed (A vs. B, C vs. D, E vs. F and G vs. H).

Results

Fattening performance, feed intake, feed requirements and water intake in the individual fattening groups, as well as the dry mass contents of the examined slurry samples were similar in all compared groups and did not show any statistically significant differences. This also applies to the measured odorant concentrations c_G (*table 2*). Both in total as well as during pre- and main fattening, the difference between the compartments and the fattening periods was larger than between the feeding variants.

With regard to the odour characteristics (intensity and hedonics), the following results were found: after they have been sorted according to growing concentration, the ten odour samples presented in the above-threshold range can be divided into a latent phase in which an increase in c_G does not yet result in higher perception intensity even though the odour is perceived. This stage is followed by a phase where odour perception becomes more intense with growing c_G until the maximum of perception intensity/hedonics of the individual sample is reached.

Even though the differences cannot be statistically secured, several trends are worth noting. In principle, the groups which were fed protein-reduced rations (B, D, E and G) seem to exhibit slightly prolonged latent phases, during which the odour threshold is exceeded even though perception is weak/neutral. A particularly striking result is that the length of the latent phase in pre-fattening (i.e. before the feed change) is identical in all groups. In the subsequent main fattening phase, the control groups (A, C, F and H) show a tendency towards longer latent phases than the trial groups (B, D, E and G). The maximum intensity of perception, however, is slightly lower than in the control groups (A, C, F and H).

Discussion

The olfactometrically measured c_G does not exhibt any effect caused by the protein content of the ration. At first glance, this seems to contradict studies by [11]. Using gas chromatography, the authors of this study measured lower concentrations of individual typical slurry odorants in slurry produced by animals which were fed protein-reduced rations. However, only a selection of substances was measured and not the slurry odour which causes a subjective odour impression in the human nose. If this is applied to our own results, one can draw the conclusion that individual effects are likely to result in opposing effects. These include altered individual substance composition as well as influences on the chemical-physical emission conditions in the slurry. In addition, there are certainly also overlaying effects of individual components. The sulphide-containing volatile substances, for example, exert an extraordinarily strong influence on the typical slurry odour even at very low concentrations. Especially the tendential differences in intensity and hedonics indicate that the animals which were fed protein-adapted feed cause slightly milder slurry odour and that hence one can also assume a qualitative change in the odour components.