Reducing ammonia emissions in the poultry house

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The term 'intensive livestock farming' is the topic of the day amongst the general public. Next to the discussion about housing conditions and stocking densities, the public is becoming more conscious about the unavoidable emissions from intensive livestock farming. The legislators have tackled this problem in relevant regulations on the European and national levels. Measures to reduce emissions are therefore of vital interest to all livestock farmers.

Legal basis

Livestock farms with 40,000 broilers, 2,000 units of fattening pigs over 30kg live weight or 750 sows have been subject since 6th January 2011 to the EU Directive 2010/75/EU 'Industrial Emissions' (Integrated Prevention and reduction of environmental Pollution).

Animal welfare has no role to play in these regulations rather they primarily cover the visualisation of the house and surrounding environment. The housing conditions have been regulated under the Protection and Welfare of Farm Animals Act since 9th October 2009. Section 4.18 of the Protection and Welfare of Farm Animals Act specifies the requirements that livestock farmers should ensure that the air flow is at head level of the animals and heating or cooling systems have the maximum ammonia concentration of $20cm^3/m^3$ (ppm), respectively.

Likewise, the aim of the regulation is to positively influence the indoor air on animal density of broilers, so that the broiler stocking density at no time exceeds $39kg/m^2$ (long or heavy fattening).

For short term fattening (maximum of 1600g) the stocking density of up to $35kg/m^2$ of house area is specified. The broiler stocking density should not exceed on an average the limit of $35kg/m^2$ in three consecutive fattening cycles, if the average weight of broilers is less than 1600g. Farmers must notify the competent authority an increase of over $33kg/m^2$ stocking density.

Environmental pollution

1 Physiological and feeding related aspects.

From the statistical point of view, the proportion of ammonia emission attributed to poultry farming is lowest in the overall proportion of NH3 emission in the agricultural farming, estimated to be around 6% in Germany.

Nevertheless, in the last 15-20 years the pollution caused by poultry farming has increased by more than 3%, whilst the NH3 release in animal production had been reduced by a quarter overall.

In this context, we must not lose sight of the fact that a reduction in cattle and pig herds has contributed significantly to this development.

If we consider poultry farming in this context, some fundamental correlations must be seen. Poultry gives up consumed water both in excreta and through respiration – 80% of consumed water is given up in this manner. In the first week of life, for example, 1,000 chicks require 300 litres of water and in the second week approximately 530 litres.

Water balance in healthy animals can be unbalanced both by disease and feed effects. For example, an increase of 1% crude protein in diet results in a 3% increase in water intake and 10% increase in nitrogen excretion. In contrast, a reduction of protein in the diet leads to a reduction in nitrogen excretion.

Ferguson et. al. have already observed in broiler feeding experiments that with lower crude protein (215g/kg and 11.5g/kg lysine reduced to 196g/kg and 11.3g/kg lysine), the crude protein content fed positively correlated with the moisture content of the litter.

By reducing crude protein, the ammonia concentration in the air significantly decreased by 31%, while nitrogen content of the litter decreased by 16.5% with regard to dry matter.

Since poultry excrete redundant nitrogen from protein synthesis and nitrogen from undigested protein as uric acid, the microbial mobilisable content of nitrogen in poultry excreta is therefore relatively high.

When the water content of the faeces exceeds 25%, the litter is perceived as 'wet'. Ammonia is formed in turn by the microbial degradation of uric acid in the wet bedding. From one molecule of uric acid four molecules of ammonia are formed.

The higher the relative humidity and temperature of the litter, the more intensive is the conversion of uric acid to ammonia. The humidity increased ammonia concentration causes an increasingly poor housing atmosphere. By increased ammonia concentration respiratory diseases are heightened along with the occurrence and extent of inflammation of the feet balls due to the moisture content of the litter.

Inflammation of the ball of the feet causes pain and leads to limited mobility, which results in reduced feed intake in poultry.

Since wet litter is an indicator of digestive disorder as well as energy losses due to deficient feed conversion, this parameter is particularly important for floor rearing systems.

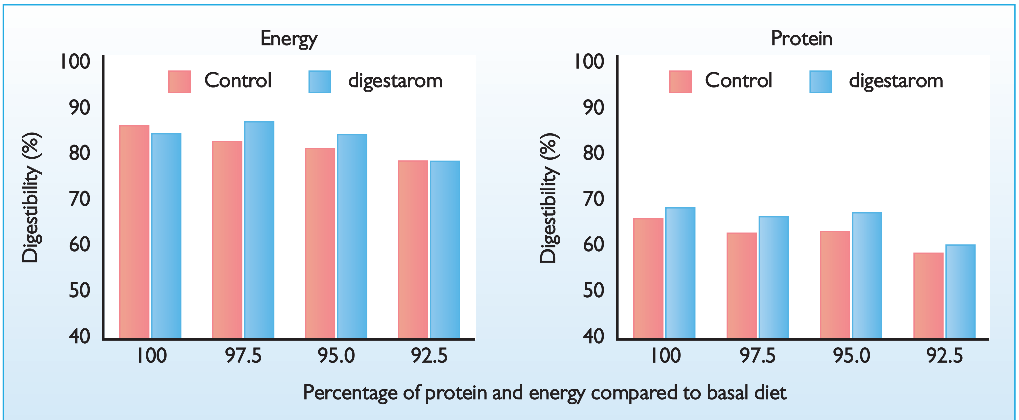
At the same time, the removal of poultry excrement with high nitro-

Continued on page 13

Parameter	Control	digestarom
Crude protein (%)	89.9	91.7
Lysine (%)	83.9	85.8
Methionine (%)	81.7	83.2
Crude fat (%)	77.2	78.4
Calcium (%)	34.5	35.7
Phosphorus (%)	32.2	33.4

Table 1. Nutrient digestibility in laying hens.

Fig. 1. Digestibility of diets with reduced energy and protein contents.



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gen concentration contributes to air and water pollution.

On the other hand, the poultry slurry loses nitrogen in the form of ammonia during its land-spreading causing atmospheric pollution.

These N-losses in the house can amount to 30% and up to 60% for laying hens reared on a flooring system.

Reduction measures.
The proportion of minerals in the diet, the anion-cation ratio, and various feed additives affect the water intake and retention time in the intestines and thus alter the moisture content of urine and faeces.

A step towards clean house air, regardless of the number of animals per square metre, type of the litter and condition of the drinkers, contributes to nutrient intake in the digestive process. When the nutrients fed are absorbed by the animal at a higher percentage, the amount of uric acid excreted also decreases simultaneously. As a reminder, an increase of 1% protein in the diet corresponds to a 10% rise in the nitrogen load. A reduction in the nutrient density in poultry feed is therefore interesting from an ecological point of view. In multiphase feeding, more phases instead of the conventional 3-4 phases for broilers and 6-7 phases for turkeys could better match the feed ration with the theoretical requirements.

This method, however, requires high logistical costs associated with fatteners and feed manufacturers. Additional technical facilities would be required at the farm for storage and transport of feed and the compound feed plants would have to shrink the batches produced correspondingly, which would clearly make it more expensive.

In contrast, if one increases the feed quality through the use of highly digestible raw materials, those that particularly lead to a reduction in nitrogen excretion, the price of feed will certainly rise. In the current economic situation both solutions are equally unpractical for poultry farmers and feed manufacturers.

Phytogenic feed additives

Supplementation with the phytogenic digestibility enhancer, digestarom, has proven to be cost effective and has a demonstrable record of success.

With the use of this feed additive nitrogen content in the faeces is diminished with a higher animal performance by enhancing daily weight gain and feed conversion.

Digestarom is a precise combination of selected essential oils, herbs, aromatic extracts and spices, which is species and age specific.

Digestarom 1317 Poultry Premium consists of approximately 200 phytogenic components that have various effects on the animal organism.

Parameter	Control	digestarom	Difference
Liveweight at start (g)	1552.0±19.8	1539.7±20.2	-12.3
Liveweight at end (g)	1767.5±27.2	1770,1±31.3	+2.6
Laying intensity (%)	84.2	91.3	+7.1
Feed expenditure (feed/10 eggs in kg)	1.33	1.25	-0.08

Table 2. Zootechnical parameters of laying hens.

Standardised active ingredients of tailor-made combinations of herbs and spices that are used in human nutrition for seasoning, while succulence enhancement of food are enriched by etheric oils. As a natural digestibility enhancer the phytogenic flavour stimulates the internal secretion of enzymes and bile acid and enhances the nutrient absorption.

The most striking effect is increased feed intake, accelerated growth performance, significant increase in carcase yield and quality, and a reduction in mortality.

The latter is also based on a significant influence on so-called transcription factors, controlling the inflammatory processes.

Amongst other things this feed additive has a suppressive effect in the gut and disencumbers the immune system. It is noteworthy that this plant based product is proven to enhance the succulence and tenderness of the meat through better digestion, as demonstrated by studies from Germany and Great Britain.

Studies and results

Improvement in nutrient digestibility equals higher animal performance.
Studies on protein digestibility at the research station of the Council for Research, Hyderabad, India, showed that by using digestarom, the available quantity of crude nutrients from the ration to the animal, especially crude protein and essential amino acids, are better exploited for animal performance.

In four rations, broilers (Cobb 400) were fed with a 2.5% lower content of protein and energy up to the fifth week of life each based on the requirements according to the feeding recommendations.

In addition to the control diet, the experimental groups received digestarom at a dosage of 150g per ton (manufacturer's recommendation).

The excrements from each group were collected for 24 hours on three consecutive days in the last week of the experiment and the apparent digestibility of energy and protein determined.

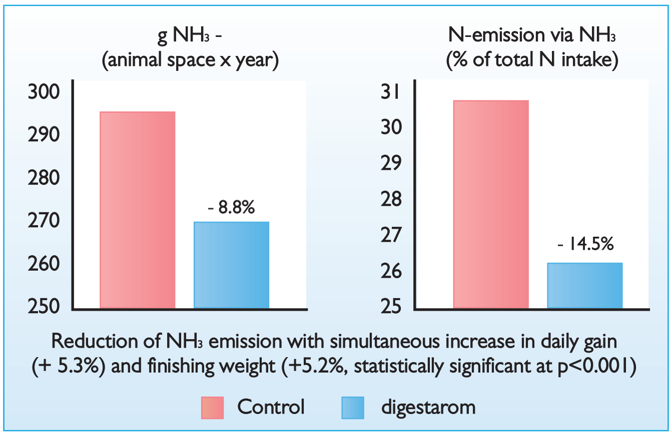
Both energy and protein digestibility were improved in the groups fed with digestarom. The values thereby were highest in the 97.5% and 95% reduced diet groups particularly in protein as compared to the 100% diet (see Fig. 1).

In a study conducted with hybrid 'Radonezh' laying hens at the vivarium of the All-Russian Scientific Research and Technology Institute for the Poultry Industry in the region of Moskovskaja Oblast, the previous results in terms of digestibility performance and zootechnical parameters were confirmed.

Protein digestibility in the experimental group was 91.7%, around 1.9% higher than in the control group with 89.8%.

The digestibility of essential amino acids lysine and methionine in the experimental group were 85.8 and 83.2% improved respectively, as compared to the control at 83.9 and 81.7%. Feed conversion decreased by 6.0% for 10 eggs in the experimental group supplemented with digestarom at a dosage of 150g per ton of feed compared to the control group. Similarly, the laying performance of the experimental group rose by 7.7% (see Table 2).

Fig. 2. Ammonia formation in broilers (35 days).



Since the birds digest crude protein better with digestarom, it is also possible to reduce the dietary crude nutrients and in this way reduce the nitrogen excretion and the associated ammonia emissions.

Reduced ammonia – increased performance.
In commercial applications in broiler houses in the Netherlands, it was ascertained that the phytogenic digestibility enhancer reduced the quantity of excreta from 0.11 to 0.29kg/animal. This measurable decrease corresponds with the subjective observations of the manager that, as a whole, the litter was dry and led to better air in the stall.

Furthermore, by the application of digestarom the finishing weights were achieved earlier than in the reference period in a total of 1.1 million broiler chickens.

Farmers in the Netherlands are satisfied in every aspect with the changeover in feeding and continue to use this phytogenic product.

This practical experience was scientifically examined at the International Poultry Station (Medizinarodni Testovani Dr bež) in Ustrasice, Czech Republic, and the ammonia levels in the stall air were measured: 180 day old chicks of the genotype Ross 308 were randomly divided, independent of gender into two equal groups (control and experimental) and were fed in three phases as per the recommendations of the breeder.

With reference to the quantity of nitrogen in the feed, the nitrogen loss in faeces decreased by more than 14% in the animals in the experimental group (see Fig. 2).

Summary

It is possible with the use of the aforementioned phytogenic digestibility enhancer to reduce the ammonia content in the stall air, firstly due to the reduction in the diet specification and secondly due to the improved nutrient utilisation through better animal performance.

Diets with lower crude protein contents are an energetic advantage for poultry because they no longer have to make the energy consuming conversion of the excess protein into uric acid and this energy remains available for profitable growth.

Moreover, protein optimised diets decrease the demand for ingested water because for each per cent crude protein in feed the animals need to take around 3% more water, of which 80% is again excreted. This serves the best interests of the animal and also represents tangible economic benefits for the producers. ■

References are available from the authors on request.