Minimising hunger stress in broiler breeders with insoluble fibre

Broiler meat production worldwide has been growing tremendously from 83 million tons in 2012 to 100 million metric tons in 2020. This is an average growth rate of more than 2% per year. The predicted broiler meat consumption (equivalent to carcase weight) in 2029 will be 145 million metric tons. This would be another average growth of 4% per year.

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This massive growth has put some pressure on the industry to optimise production from a breeding and reproduction point of view to make sure there are enough broilers available for the increasing demand.

Breeding (selection) is an ongoing process for years and broilers became the most efficient meat producing animals due to their capability of a very high voluntary feed intake and their intense selection for fast growth.

As the growth is negatively correlated with the effectiveness of reproduction, many problems in the management of broiler breeder hens occur.

The required management tools like restricted feeding or skip-a-day feeding programmes have a negative influence on breeder physiology and welfare. As the regulations are getting stricter for animal welfare, these topics have been discussed intensively, especially in Europe but more and more in other continents too.

The breeder industry is trying to find a way to overcome these problems related to the so-called breeder paradox and many trials are ongoing or in preparation.

The main goal in this research is to minimise the voracity and hunger stress by using feed components that could have a positive impact on this scenario. Some groups even try to establish ad libitum feeding for broiler breeders. Several trials show the positive impact of fibre, especially insoluble fibre on the hunger stress scenario.

Fibre classification

In the past nutritionists were just talking about crude fibre. This classification is very unclear, as the substances that remain after the classical crude fibre analysis are not defined in a functional way. The chemical and physical properties need to be further differentiated, as there is evidence that there is a strong impact of the gastrointestinal environment on the whole digestive process.

One main factor to differentiate is the solubility of fibre. Hetland et al looked at the influence of fibre and its positive effects on digestion. It was concluded that the digestibility of starch is higher and the digesta passage rate is faster when a moderate level of insoluble fibre is present in the diet.

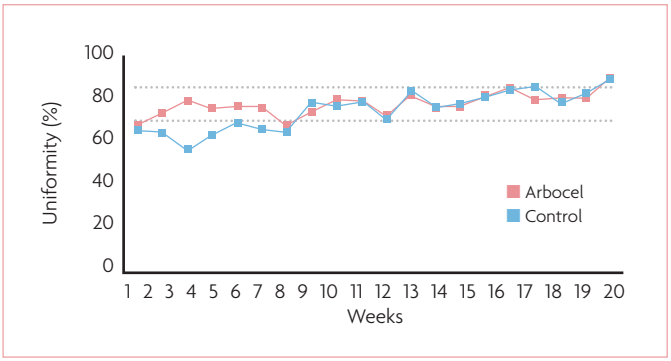
Due to a faster passage rate in the intestine there is less accumulation of toxic substances in the intestinal tract.

This effect is connected to the ability of the insoluble fibre to accumulate in the gizzard, which regulates the digesta passage rate.

As soluble fibre reacts differently in the digestive tract, it is important to differentiate between the fibre fractions, with a special focus on the solubility.

Vegetable roots and fruits like apple, orange and sugar beet deliver mainly soluble fibre (pectin), while all kinds of cereal brans and wood-based fibres deliver a high percentage of insoluble (cellulosic) fibre.

Fig. 1. Flock uniformity in the trial group including 0.8% Arbocel crude fibre concentrate compared with the control group.



Consumption time	Control	Crude fibre concentrate*	Differences (%)
XL Lot	23:06	28:15	22.07
L Lot	23:55	29:00	23.14
M Lot	24:59	30:00	22.0
MS Lot	26:47	33:00	24.66
S Lot	31:33	35:00	11.71

*crude fibre concentrate: Arbocel, JRS Germany

Table 1. Feed consumption time in week 15 as influenced by the insoluble Arbocel crude fibre concentrate.

The role of insoluble fibre in restricted feeding systems

● **Satiation – feed clean up time, weight control and flock uniformity:**

The commercial restricted feeding programme of broiler breeders has a major negative effect on welfare and the physiological precondition for production. Issues connected to hunger stress in breeders contributes to the development of feather pecking/cannibalism, wet litter, as well as problems with flock uniformity.

A good indicator for the level of hunger stress is the feed clean up time. In situations with reduced hunger stress the feed clean up time will be increased, in other words the birds eat slower. The impact of insoluble fibre on feed clean up time and flock uniformity was evaluated in a field trial in Brazil.

A total of 80,000 Cobb 500 breeders were involved in this trial. They put 40,000 birds on a commercial breeder formulation and 40,000 on exactly the same formulation with the difference that 0.8% wheat bran was replaced by 0.8% of an insoluble crude fibre concentrate (Arbocel, JRS Germany). They evaluated feed clean up time as well as flock uniformity during the trial period from week five to week 20.

The feed consumption time was prolonged up to 24% due to the use of the insoluble crude fibre concentrate (Table 1).

This confirms the observations of J. Michard. As a consequence of the prolonged feed clean up time the flock uniformity was significantly improved (Fig. 1).

These trials confirm the results from the SGGW University of Warsaw. They had a similar trial set up in breeders from week 10-18. Here the flock uniformity was improved due to the use of the insoluble crude fibre concentrate Arbocel (JRS, Germany) by 2.3%.

Weight control is an important issue in roosters as well. If they exceed the standard weight as defined by the genetic companies there is a negative impact on semen quality and the birds can also become aggressive.

As there are even more negative aspects of overweight roosters the weight control of roosters should be

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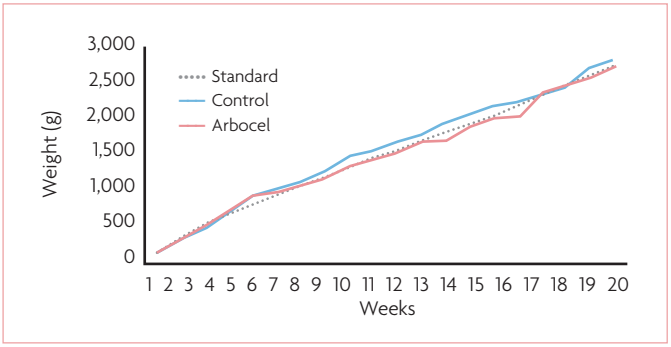

Fig. 2. Weight development in roosters until week 20 in the trial group with 0.8% insoluble Arbocel crude fibre concentrate, compared with the control group.

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a major concern in the poultry house. The impact of insoluble fibre on the weight of roosters has been evaluated as well in the above mentioned Brazilian field trial. The results are shown in Fig. 2.

The weight development of the roosters in the control group is clearly above the target weight, while the birds in the trial group (0.8% Arbocel) match the target weight as given by the genetics company.

It can be concluded from this trial that insoluble crude fibre concentrates are a good tool to control the weight of roosters.

To summarise this interesting field trial from Brazil, insoluble fibre caused an increase in feed clean up time which is an indication of satiation.

Additionally, better flock uniformity and better weight control of roosters could be seen. Flock uniformity and weight control are a consequence of better satiation.

Similar observations have been made by J. Michard, running many trials in his leading position in the genetics company Hubbard.

Impact of insoluble fibre on the gizzard size and performance in restricted feeding systems

In 2019 Gonzalo Mateos from Spain and his group evaluated the impact of insoluble fibre sources on the gizzard size in broilers with ad libitum feeding. They found that insoluble fibre sources like oat hulls and rice hulls increased the weight of the gizzard.

Trials at the La Trobe University in Australia confirm the same effect of insoluble fibre on the gizzard of layers. Here the use of a bark-free lignocellulose caused a 30% heavier gizzard. Both trials have been done in ad libitum feeding conditions. In broilers, and also in layers, a bigger gizzard is the intention as we want to increase the feed intake capacity and therefore the performance.

What about broiler breeders? The main topic in these usually restricted fed animals is to minimise hunger stress. A bigger gizzard would therefore be counterproductive.

A quite interesting trial was done at the University of Sao Paulo, Brazil in 2019. The researchers used 160 broiler breeders (strain AP 95) to evaluate in a 40 week trial period (week 22-62) the impact of a lignocellulose (Arbocel, JRS Germany) on health, performance and gastrointestinal parameters.

The feed composition is shown in Table 2 and the results are shown in Table 3.

No impact of insoluble fibre on the gizzard size could be detected. There is limited information available on the impact of insoluble fibre on the gizzard size in restricted feeding systems, especially in broiler breeders.

An interesting trial was done at the University of New England, Australia in 2012. The researchers fed broilers intermittently without additional fibre and with 15% addition of a fibre mix. As fibre sources they used a mixture of oat hulls and barley. The fibre mix was either supplied as coarse or as a fine milled mix.

Both fibre groups had a significant bigger gizzard as a percentage of the body weight compared to the control formulation. There is further research required to clarify this important point.

Table 3 reveals that insoluble fibre based on debarked lignocellulose showed a significant positive effect on red hocks and dehydration.

In this trial they also detected an influence on chick quality. They could see a significant positive effect of the lignocellulose on mortality.

Mortality was reduced from 10% in the control group to 2.5% in the trial group.

These results confirm the observations of Professor Farran who ran a trial at the American University of Beirut. Here, 0.8% lignocellulose reduced hen mortality significantly from 11.4% down to 9.4%.

A trial from the University of Bydgoszcz in Poland helps to explain why lignocellulose has a positive impact on mortality. The researchers fed different level of lignocellulose (Arbocel, JRS Germany) to broilers. The lignocellulose reduced the number of harmful bacteria in the caecum and ileum (E. coli and Clostridium spp.) and increased the number of beneficial bacteria at the same time (Bifidobacterium spp.; Lactobacillus spp).

The explanation mode of action is based on three theories. Firstly, it is well known that insoluble fibre reduces the viscosity of the digesta and speeds up the intestinal transit. For this reason pathogenic bacteria cannot colonise that easily. Moreover, it is well established that insoluble fibres have an abrasive action on the intestinal mucosal surface.

According to the literature this abrasive action of insoluble dietary fibre favours the elimination of pathogenic bacteria capable of adhering to the mucus layer, such as Clostridium perfringens.

This effect can support the growth of beneficial microbiota, as all the bacteria are competing for nutrients. Moreover, polyphenolic compounds of lignin can cause bacterial cell membrane disintegration and in this way inhibit the growth of micro-organisms in the digestive tract.

Summary

Reduced flock uniformity, wet litter, feather pecking and high mortality are major issues in broiler breeders and strongly connected to the management of feed restriction.

This article shows that insoluble fibre, especially lignocellulose, has a positive impact on the feed clean up time and, related to this, also on the hunger stress. In consequence, the use of lignocellulose improves flock uniformity, reduces mortality, allows better weight control in roosters and reduces dehydration in broiler chickens. Based on the above effects a certain level of insoluble fibre from lignocellulose should be indispensable in broiler breeder formulations. ■

Table 2. Feed composition in the trial and control groups.

	Trial	Control
Corn	62.57	68.48
Soybean meal	17.05	19.86
Wheat bran	10.71	0
Limestone	6.76	6.69
Dicalcium phosphate	1.28	1.39
Soybean oil	0.79	0.76
Salt	0.37	0.37
Premix	0.3	0.3
Methionine	0.16	0.15
Threonine	0.01	0
Arbocel	0	1.5
Inert	2	0.5
Total	**100**	**100**

Table 3. The impact of Arbocel insoluble fibre on the performance of breeders, chicken quality and gizzard size.

Parameter	Arbocel (%)		SEM	P (%)
	0	1.5		
Egg production (%) (25-62 weeks)	77	75.78	1.01	0.311
Mortality (%)	10.00[b]	2.50[a]	2.4	0.033
Chick quality				
Weight bird day 1 (g)	49.43	49.98	2.24	0.224
Red hocks (%)	16.96[b]	5.82[a]	3.65	0.006
Dehydration (%)	21.90[b]	5.38[a]	2.09	0.027
Intestine characteristics				
Gizzard (%)	1.15	1.14	0.084	0.963