A new approach to litter quality and performance in poultry nutrition

by Liu Jin, Julia Trautwein and Georg Dusel, University of Applied Science, Bingen, Germany and Manfred Pietsch, J. Rettenmaier & Sohns GmbH and Co. KG, Holzmühle, Germany.

The so called wet litter syndrome in poultry can cause significant commercial damage. According to Butchers & Miles (2009) litter quality is one of the key factors in poultry production.

If litter is not kept at an acceptable level, very high bacterial loads and unsanitary growing conditions may result in odours (including ammonia), insect problems (particularly flies), soiled feathers, footpad lesions and breast blisters.

In a well managed broiler house litter moisture normally averages between 25-35%. In winter it is difficult to have sufficient ventilation due to the high energy cost.

Until now litter quality in Europe was just an issue in the broiler house, but very soon cages will be banned in Europe and then litter quality will be an issue for layers as well.

Beside disease, feed quality, animal bedding and the temperature, including ventilation in the house, the feed has a major impact on litter quality. The use of feed additives, for example NSP-enzymes, has been established already to address the wet litter syndrome. Another approach could be the use of raw fibre concentrates as a feed additive.

There is already evidence that raw fibre concentrates have a positive effect on litter quality and on the performance of the animals as well.

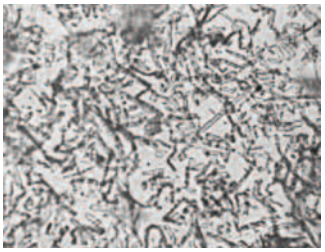
A potential solution?

Raw fibre concentrates describes raw fibres with at least 60% raw fibre content. This is mostly achieved by concentration processes, which can be of physical or thermo-mechanical nature.

Raw fibre concentrates are usually based on a lignocellulosic or a cellulosic fibre. The main differences of raw fibre concentrates to common fibre sources are:

- Raw fibre content >60%.
- Free of mycotoxins.
- Free of soluble fibres.
- Not binding nutrients.
- Stimulating the intestinal villi.
- Increasing enzyme activity.
- High swelling and water binding capacity (4-8g H20/g raw fibre concentrate).

Not only its chemical composition



Raw fibre concentrate Vitacel (50x magnification).

and the purity but also the physical appearance of the raw fibre concentrate particles are significant different to the standard raw fibres.

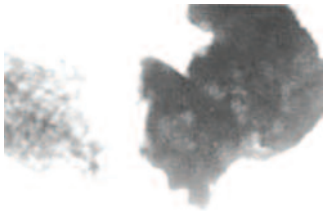
The particle size of raw fibre concentrates and the standard fibres is significantly different as shown in the photographs.

Growth promoter

There is evidence that the raw fibre concentrate Arbocel, from J. Rettenmaier and Sons, can improve the digestibility of fat and protein in sows, piglets and other species.

Additionally the use of insoluble cellulosic fibre is recommended from ISA (2007). They argue in their paper that 'the presence of insoluble fibre appears indispensable, causing an increase in gizzard size, improving starch digestibility and limiting feather pecking by reducing the need to ingest fibres'. The positive effect of raw fibre concentrates on digestion of fat and protein as well as the effect on performance has not been evaluated in broilers until now.

The raw fibre concentrate Arbocel is a natural, pure and fibrillated lignocellulose which is free of mycotoxins and bark. It is produced with a special milling technology called HPC-fibrillation. The difference to the



Wheat bran (50x magnification).

above mentioned raw fibre concentrate Vitacel is the lignin content. Vitacel is free of lignin and Arbocel delivers about 25% lignin. Both products are based on cellulosic fibre. The aim of the trial described below was to evaluate the effect of a HPC-fibrillated lignocellulose on broiler performance.

Table 1. Composition of the feed (main components of starter and grower feed). Groups: A = commercial broiler feed without additives, B = commercial broiler feed + 0.3% Arbocel, C = commercial broiler feed + 0.6% Arbocel, D = commercial broiler feed + 0.9% Arbocel, E = commercial broiler feed + 1.2% Arbocel.

Component (%)	Starter (day 1-14)					Grower (day 15-35)				
	A	B	C	D	E	A	B	C	D	E
Maize	16.00	16.00	16.00	16.00	16.00	15.40	15.40	15.40	15.40	15.40
Wheat	48.83	48.83	48.83	48.83	48.83	49.04	49.04	49.04	49.04	49.04
Extracted soya 46	22.60	22.60	22.60	22.60	22.60	18.95	18.95	18.95	18.95	18.95
Fat (vegetable)	3.800	3.800	3.800	3.800	3.800	4.000	4.000	4.000	4.000	4.000
Oil (vegetable)	---	---	---	---	---	1.600	1.600	1.600	1.600	1.600
Extracted rapeseed	2.000	2.000	2.000	2.000	2.000	5.000	5.000	5.000	5.000	5.000
Amino acid premix	2.010	2.010	2.010	2.010	2.010	1.720	1.720	1.720	1.720	1.720
Di-Calcium-Phosphate	1.250	1.250	1.250	1.250	1.250	0.950	0.950	0.950	0.950	0.950
CaCO3	1.060	1.060	1.060	1.060	1.060	1.140	1.140	1.140	1.140	1.140
Na-Carbonate	0.160	0.160	0.160	0.160	0.160	0.160	0.160	0.160	0.160	0.160
NaCl	0.120	0.120	0.120	0.120	0.120	0.120	0.120	0.120	0.120	0.120
Premix	0.970	0.970	0.970	0.970	0.970	0.720	0.720	0.720	0.720	0.720
Wheat bran	1.200	0.900	0.600	0.300	---	1.200	0.900	0.600	0.300	---
Arbocel	---	0.300	0.600	0.900	1.200	---	0.300	0.600	0.900	1.200

Material and methods

The experiment was carried out in the trial station at the University of Applied Science in Bingen, Germany. Some 200 three day old poults with an average weight of 85g were kept in 100 cages (two birds per cage).

The broilers were weighed and distributed to five treatments (40 animals per treatment). Commercial formulations have been used as experimental diets. All animals received the same diet apart from the Arbocel, which was used with up to 1.2% instead of wheat bran (details in Table 1). The trial period was 35 days until an average of 2.2-2.3kg live weight. The analysis of the components was done according to the Weenders method in the laboratory of the University of Applied

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Component (g/kg 88%)	Starter (day 1-14) A	B	C	D	E	Grower (day 15-35) A	B	C	D	E
Crude protein	217	213	215	211	215	196	194	200	200	197
Crude fat	40,8	41,0	39,9	39.9	39.4	42.9	42.4	42.7	43.0	43.4
Crude fibre	26,2	25,0	28,7	26.0	36.1	32.7	34.0	32.6	34.8	36.4
Crude ash	57,1	61,2	65,1	71.3	75.7	49.9	50.1	51.4	50.5	49.9
Starch	421	419	415	411	409	415	425	429	432	424
Sugar	58,6	54,3	55,5	52.3	53.9	48.2	50.5	50.5	51.5	50.2
ME-G (in MJ)	11.9	11.7	11.6	11.5	11.5	11.8	12.0	12.1	12.2	12.1

Table 2. Analysed components (g/kg at 88% dry matter) in the different trial formulations.

Group Arbocel	A Control	B 0.3%	C 0.6%	D 0.9%	E 1.2%	Statistics SEM	p-value
Live weight	2295±357	2347±225	2406±299	2377±230	2366±304	29.14	0.824

Table 3. Final weight of the broilers (g) at day 35 in relation to the Arbocel level in feed.

Weight gain (g/day) Week	A Control	B 0.3%	C 0.6%	D 0.9%	E 1.2%	Statistics SEM	p-value
1-3	44.5 a±8.3	49.4 b±6.7	49.1 b±5.9	49.4 b±5.8	47.8 ab±7.4	0.51	0.010
4-5	90.0±18.9	84.1±13.7	91.8±12.7	88.0±11.0	87.0±18.2	1.68	0.590
1-5	61.4±10.0	62.8±6.2	64.5±8.2	63.6±6.4	63.3±8.4	0.81	0.822

Table 4. Daily weight gain in g (40 birds/group).

Table 5. Feed conversion ratio (FCR) for the trial groups in g of feed consumed per g of live weight gain (20 cages per group).

FCR (g/g) Week	A Control	B 0.3%	C 0.6%	D 0.9%	E 1.2%	Statistics SEM	p-value
FCR 1-3	1.79±0.13	1.70±0.09	1.74±0.08	1.70±0.09	1.76±0.13	0.011	0.056
FCR 4-5	2.01±0.32	1.95±0.22	1.91±0.18	1.90±0.16	1.98±0.20	0.023	0.591
FCR 1-5	1.83±0.13	1.77±0.08	1.79±0.09	1.74±0.07	1.80±0.09	0.011	0.129

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Science in Bingen. The metabolisable energy was calculated based on the analysed crude components. The results are shown in Table 2.

The feed intake was measured per cage once a week. Water was available ad libitum. The animals were weighed individually at the beginning of the trial and then once a week. The feed conversion rate was calculated per week per cage basis.

Results

The poults were assigned to the different trial groups with an average weight of 85g. After 35 days on trial the control group achieved an average weight of 2.295g (Table 3).

Arbocel caused a dose dependent increase in weight. The peak seems to be at an inclusion level of 0.6% Arbocel.

Table 4 shows the consolidated daily weight gain for week one to three, four to five and for the whole trial period for the different trial groups.

In the weeks one to three Arbocel induced with an inclusion rate of 0.3, 0.6 and 0.9% a statistically significant ($p<0.05$) increase in daily weight gain compared to the control group.

The control group consumed an average over the whole trial period 115g/head/day. The trial groups B, C, D and E consumed 114g, 120g, 116g and 119g. The feed conversion ratio (FCR) for the control group was calculated to be 1.83g feed for 1g weight gain during the whole five weeks trial period.

Similar to the live weight numbers the FCR improved dose dependent with increasing Arbocel levels in the formulation. A peak was reached at 0.9% Arbocel weight a FCR value of 1.74 (Table 5).

Summary and conclusion

The inclusion of lignocellulose in the feed in this trial caused an improvement in weight gain and FCR. Feed intake as well as the fibre network is potentially the reason for the positive impact of Arbocel on these performance parameters.

Further studies are required to understand the mode of action. The insoluble fibre could improve the intestinal peristalsis and therefore reduce the transit period.

Due to the faster transit period there would be consequently less colonisation of pathogenic bacteria. Therefore lignocelluloses could contribute to the intestinal health.

Improved litter quality

The impact of crude fibre on the litter quality has been discussed in detail in other studies.

To have an impact on the faeces consistency a product with a high reversible water binding capacity is required. In addition, the product should be not fermented in the intestinal tract.

Rezzaie et al. (2008) investigated the effect of different fibre sources on the litter quality in broilers.

In this trial they compared the effect of the cellulosic raw fibre concentrate Vitacel (Rettenmaier and Sons) with corn hulls and a negative control on the litter humidity.

Some 560 broilers (Ross 308, one day of age) have been involved in the trial. The trial design is shown in Table 6 and the results are shown in Table 7. After a trial duration of four weeks they determined a significant increase of the litter humidity in the barn where the animals were kept that were fed the corn hulls compared to the control group ($p<0.05$; LSD test).

Vitacel reduced the humidity in the litter compared to the control group as well as compared to the corn hull group.

The same results could be observed in the trial week 5, 6 and 7. The researchers conclude from their results that the use of the raw fibre concentrate Vitacel via the feed is a good tool to improve the litter quality in poultry.

They explain the missing significant impact of the fibre sources in the first three weeks of the trial with the comparable little water and feed intake in this stage. They did not evaluate any other performance data in this trial.

Conclusion and perspective

It has been demonstrated in two separate and independent trials that crude fibre concentrates have a positive impact on performance and on litter quality as well.

The wet litter problem in poultry is a serious problem that causes real damage in terms of economical output.

Having realised this, raw fibre concentrates could offer a solution, especially as the raw fibre concentrates have a positive impact on the performance as well.

Further studies are required to understand the mode of action better. ■

Treatment	Corn hulls (%)	Vitacel (%)	Sand (%)
Control	-	-	0.5
Corn hulls 1	0.3	-	0.2
Corn hulls 2	0.4	-	0.1
Corn hulls 3	0.5	-	-
Vitacel 1	-	0.3	0.2
Vitacel 2	-	0.4	0.1
Vitacel 3	-	0.5	-

Table 6. Vitacel, corn hull and sand level in the different groups.

Table 7. Impact of different fibre sources on the litter humidity (%).

Treatment	Week 1	2	3	4	5	6	7
Control	29.2	26.9	25.5	19.9^{c}	24.4^{b}	22.8^{b}	24.3^{b}
Corn hulls 1	26.4	25.0	23.1	25.0^{cb}	26.0^{b}	29.2^{b}	30.2^{b}
Corn hulls 2	24.6	23.1	19.1	41.4^{a}	27.7^{b}	44.1^{a}	45.0^{a}
Corn hulls 3	23.0	23.3	21.8	35.3^{ab}	46.5^{a}	42.3^{a}	43.2^{a}
Vitacel 1	30.7	35.5	24.0	22.5^{c}	23.4^{b}	22.7^{b}	23.1^{b}
Vitacel 2	30.0	25.2	26.1	19.4^{c}	20.0^{b}	17.8^{b}	18.2^{b}
Vitacel 3	27.0	23.8	20.0	15.9^{c}	16.7^{b}	17.1^{b}	17.5^{b}
Statistics	ns	ns	ns	*	*	*	*

(ns) not significant; (*) $p<0,05$ - LSD-Test