Enzymes in layer diets: an opportunity

Benefits linked to NSP-enzyme supplementation of layer feeds have been shown in several trials, from energy digestibility determinations to laying performance and egg quality measurements. Enzyme addition does not appear to affect egg quality in terms of yolk colour, egg composition or eggshell characteristics.

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Non-starch polysaccharidases, or NSP-enzymes, such as xylanase and β-glucanase have long been used in wheat or barley-fed broilers due to the adverse effect of such cereals particularly when newly harvested. It has often been assumed that adult birds are less sensitive to viscosity problems and thus to soluble NSP's. However, laying hens may lay dirty eggs due when barley or wheat is used, relative to soluble NSP's. Furthermore, work done in recent years with enzyme-supplemented feeds for laying hens have demonstrated some advantage on performance, particularly on feed efficiency. With the development of NSP-enzymes' use in maize-fed broilers, investigation of their effect in maize-fed layers is also of interest.

A range of experimental studies have been done on digestibility measurements, laying performance and egg parameters in wheat-, barley- or maize-fed laying hens supplemented with a natural multi-enzyme combination secreted by *Penicillium funiculosum*,which includes xylanase, β-glucanase and cellulase activities, as well as all relevant side enzyme activities (*Table 1*) required for NSP hydrolysis.

Improve feed digestibility

The improvement of digestibility with NSP-enzymes has been clearly demonstrated, using the European reference method for apparent metabolisable energy (AME) evaluation adapted to laying hens (Lessire *et al.*, 1995). The method is based on *ad libitum* feeding and total excreta collection for 1 week (*Table 2*). Hens were fed on different wheat-, barley- or maize-based diets. The improvement ranged from a low, but significant 45 kcal, due to very low variability, up to 168 kcal. The results do not strengthen the linear relationship between wheat incorporation level and AME or nutrient digestibility increase. Indeed, the enhancement of nutrient digestibility depends on wheat characteristics and type of protein and lipid dietary sources. Similar digestibility improvements were also reported by Barrier-Guillot *et al.* (1995) and Francesch and Perez-Vendrell (1996).

Improve performance

Improved energy, protein and lipid digestibilities result in enhanced performance. Laying rate is more significantly improved for barley-based diets than for wheat- and maize-based diets. The impact on feed conversion is more consistent for all types of diets, increasing by 2.7 % in wheat up to 4.2 % in barley, between 22 and 42 weeks of age (*Figure 1*). Using poor quality raw materials such as wheat bran or rye, it has even been demonstrated the possibility to add up to 35 % rye or 45 % bran without adverse effects using the enzyme supplementation (internal data). Such incorporations will also reduce feed costs. In a maize-soybean meal based diet, up to 66 kcal reduction in energy level was fully compensated by enzyme addition without affecting either feed conversion or egg mass output.

Table 1. Enzyme activities*

Group	*Enzyme*	*Group*	*Enzyme*
Xylanases	Endo-1,4 -β-xylanase α-arabinofuranosidase β-xylosidase Feruloyl esterase Endo-1,5 α-arabinanase	Pectinases	Pectinases Polygalacturonase Pectin esterase
β-glucanases	Endo-1,3(4) -β-glucanase Laminarinase	Proteases	Aspartic protease Metallo protease
Cellulases	Endo-1,4 -β-glucanase Cellobiohydrolase β-glucosidase	Others	Endo-1,4 β-mannanase β-mannosidase

*Rovabio Excel, Adisseo, France

Table 2. Summary of digestibility trials* (AME, protein and lipid digestibility) in laying hens

Main cereal level	*AME (kcal/kg DM)*		*Increase in apparent digestibility*	
	Control	*Increase*	*Protein*	*Lipid*
Wheat (%)				
65	3025	+ 116	+ 0.6	+ 0.5
50	3048	+ 69	+ 0.6	+ 1.2
48.5	3084	+ 79	+ 1.8	+ 1.6
30	2990	+ 32		
Barley (%)				
46	3043	+ 168		
40	3038	+ 88		
Maize (%)				
42	3075	+ 45	+ 0.9	+ 1.1

*Trials performed with Rovabio™ Excel, Adisseo, France

Figure 1. Effect of exogenous enzyme* addition on overall laying performance of maize-fed hens between 18 and 36 weeks of age, barley- or wheat-fed hens between 22 and 42 weeks of age: expressed in absolute change over control (FCR : x 10). The energy value of the maize-reformulated based-diet has been decreased by 66 kcal/kg

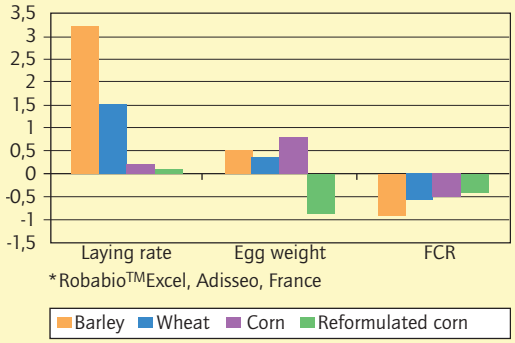

Table 3. Effect of exogenous enzyme* addition on overall laying performance with sorghum- and maize-reformulated diets

Sorghum diets (23-33 wks)	*Control 2900 kcal/kg*	*+ Enzyme* 2875 cal/kg*	*2850 kcal/kg*	*2825 kcal/kg*
Egg percentage (%)	79.9	82.8	82.0	85.5
Egg weight (g)	55.0	54.8	55.3	55.3
Egg mass (g/day)	44.4	45.8	45.7	46.0
Feed intake (g/hen/day)	91.9[b]	92.1[b]	94.5[ab]	95.7[a]
Feed conversion	2.43	2.16	2.22	2.26
Maize diets (35-45 wks)	*Control 2950 kcal/kg*	*+ Enzyme* 2925 cal/kg*	*2900 kcal/kg*	*2875 kcal/kg*
Egg percentage (%)	88.4	88.5	90.0	88.7
Egg weight (g)	60.9	60.7	61.1	61.5
Egg mass (g/day)	53.9	53.7	55.0	54.5
Feed intake (g/hen/day)	95.7	95.7	97.9	98.2
Feed conversion	1.78	1.78	1.78	1.80

*Rovabio™ Excel, Adisseo, France

Table 4. Effect of exogenous enzyme* addition on overall laying performance of with maize-rice bran-fed laying hens between 23 and 45 weeks of age (2 x 2500 birds per treatment)

Treatment	*Control Mean + std*	*+ Enzyme* Mean + std*	*P*
Feed intake (g/hen/day)	104.2 + 13.5	103.9 + 14.4	NS
Egg percentage (%)	81.0 + 9.0	82.0 + 9.0	NS
Average egg weight (g)	59.3 + 2.8	59.5 + 2.9	NS
Feed conversion	2.18 + 0.25	2.14 + 0.24	0.023

*Rovabio™ Excel, Adisseo, France

Table 5. Effect of exogenous enzyme* addition on egg quality of laying hens fed a wheat (60 %)- based diet (mean of 60 eggs per treatment)

Parameter	*Control*	*Enzyme**	*Effect*
Mean egg weight (g)	62.6	63.11	NS
Yolk (%)	27.7	27.2	NS
Albumen (%)	60.8	61.3	NS
Shell weight (g DM)	5.9	6.1	NS
Shell index (g/100 cm2)	8.1	8.2	NS
Shell thickness (mm)	0.34	0.35	NS

*Rovabio™ Excel, Adisseo, France

On average, the feed conversion ratio was reduced by 4.2 % in barley-diets, 2.7 % in wheat-fed diets and 2.5 and 2 % in corn (maize) diets whether standard or reformulated.

To benefit from the use of exogenous enzymes, reformulation of diets is often recommended. In trials performed in Mexico, the energy value of a sorghum or maize-soybean meal based diets was decreased by 25, 50 or 75 kcal/kg (*Table 3*). Results demonstrated that a 75 kcal per kg down-specification could be totally compensated by enzyme addition with even a further improvement of the feed conversion and egg mass on the sorghum-base diet.

An alternative to a reformulation is to simply add the enzymes "on-top" of the feed. This is frequently done in field conditions and the global improvement in performance can only be observed when all the parameters are precisely recorded. In these conditions, it is possible to obtain a significant reduction of feed conversion (-2%), as demonstrated in recent field experiment in Asia (*Table 4*).

Unlike what is normally observed in broilers, in layers the improvement in energy digestibility is not always accompanied by a reduced feed intake and depends on the feed form. Indeed, mash-fed layers exhibited an increased egg mass while crumble-fed layers reduced their feed intake in response to a commercial enzyme preparation (Rovabio™ Excel, Adisseo, France) addition to a wheat-based diet between 25 and 36 weeks of age (Frapin *et al.*, 1997). Moreover, layers often exhibit limited eating capacities mainly due to their genetic potential and a reduced feed consumption would impose a drastic rebalance of the diets. Moreover, the specific appetites for some nutrients like calcium carbonate in relation to oviposition would limit the interest of decreasing feed intake.

Improved egg quality

An improvement in yolk colour has also often been reported (Le Ny, 1996) due to improved lipid digestibility by enzyme supplementation. Such an improvement will also save on carotenoid incorporation.

Conversely, no significant effect of enzyme supplementation was observed on egg characteristics (*Table 4*), irrespective of the parameter measured. Similar observations were done by Francesch *et al.* (1995) on a barley-sunflower meal based diet.

Conclusion

The addition of enzymes in layer feeds containing either wheat, barley or even sorghum and maize improved the nutritive value of the feeds and thus their efficacy. Enzyme supplementation appears worthwhile to consider in laying production. Indeed, laying hens often demonstrated a limitation in their capacity to ingest feed and thus to perform according to their potential genetic. By improving nutrient availability, use of enzymes can overcome this feed intake limitation. □

References available on request.