

## **The effect of conditioning temperature and exogenous xylanase addition on the viscosity of wheat-based diets and the performance of broiler chickens.**

*A. J. Cowieson<sup>1\*</sup>, M. Hruby<sup>1</sup> & M. Faurschou Isaksen<sup>2</sup>, <sup>1</sup>Danisco Animal Nutrition, PO Box 777, Marlborough, SN8 1XN, UK. E-mail: [aaron.cowieson@danisco.com](mailto:aaron.cowieson@danisco.com). <sup>2</sup>Danisco Innovation, Brabrand, Aarhus, Denmark*

### **Abstract**

A total of 1920 Ross broiler chicks were used in a 6 treatment and 8 replicate growth study to investigate the effect of conditioning temperature and exogenous xylanase addition on diet characteristics and bird performance. Increasing conditioning temperature from 80°C to 90°C increased the viscosity of the diets by approximately 6 centipoise and reduced ( $P < 0.05$ ) the body weight gain of the broiler chickens by 7%. Furthermore, there was a significant interaction between temperature and the addition of exogenous xylanase, with a proportionately greater positive response to added xylanase in the diets that were pelleted at higher temperatures. Addition of exogenous xylanase also increased the proportion of soluble arabinoxylan in the feed, but reduced dietary viscosity, which is likely to be related to the degree of polymerisation of the soluble carbohydrate. These results suggest that conditioning temperature should be considered as a factor when attempting to predict the response of broilers to added xylanase. It can be concluded that pelleting wheat-based diets above 80°C can compromise bird performance and that if higher temperatures are to be employed, the use of exogenous xylanase is critical to maintain productivity.

### **Introduction**

The use of exogenous xylanases in wheat-based diets for poultry is not a novel concept and has been intensively studied and reviewed over at least the last two decades (Bedford, 2002). However, although many mechanisms have been proposed to explain the beneficial effects of xylanases in poultry diets, a reduction in the viscosity of the contents of the gastrointestinal tract (GIT) is perhaps the most commonly cited (Bedford, 2002). Although the effects of both viscosity and xylanase on broiler performance have been documented previously, there is scant evidence in the literature on the effects of high-temperature conditioning of poultry diets on dietary viscosity and the interaction with exogenous xylanase. It was the purpose of this study to examine the effects of conditioning temperature and xylanase addition on the physical characteristics of poultry feed and on the performance of growing broiler chickens.

### **Materials and Methods**

A total of 1920 Ross broiler chicks were used in a 6 treatment and 8 replicate growth study. The birds were assigned to the experimental diets on day 1 and were offered both feed and water ad libitum for a further 41 days. The diets were wheat/soybean meal-based and were formulated to contain a sub-optimal concentration of metabolisable energy (ME; 12.1 MJ/kg starter and 12.8 MJ/kg finisher) but to be adequate in all other nutrients. Once the starter (1-21d) and finisher (22-42d) diets had been mixed they were divided into 2 batches and to one batch intrinsically thermostable arabinoxylanase from *Trichoderma reesei* (Danisco Animal Nutrition) was added in sufficient quantity to result in 2000 U/kg finished feed. These two batches of feed were subsequently divided into 3 further batches, which were conditioned at 80, 85 and 90°C respectively, resulting in a total of 6 experimental diets. Xylanase activity in feed was measured using a modified method based on the Megazyme xylanase assay kit. The relative viscosity of the feed samples was measured at 20°C using a Brookfield viscometer in a model digestion system according to Bedford & Classen (1993) and the results are expressed relative to the viscosity of water. The amount of soluble pentosan in the filtered extracts was then determined by the phloroglucinol/FIA method described by Rouau & Surget

(1994). Data were analyzed using 2-way ANOVA to give overall significance of enzyme, conditioning temperature and the interactions between diet and enzyme addition.

## Results

The recovery of xylanase activity in the feed samples was good, with mean recoveries (pooled starter and finisher) at 80, 85 and 90°C of 108, 93, and 78 % respectively compared with the mash feed. The viscosity of mash feed samples was approximately 13.7 cP after *in vitro* digestion irrespective of the addition of xylanase (Fig. 1 & 2). The viscosity of the pelleted feed was significantly higher than that of the mash feed when no xylanase was added whereas the addition of xylanase essentially returned dietary viscosity to that of the mash feed. The concentration of soluble xylan in the feed increased with the addition of xylanase, suggesting that xylanase is able to degrade insoluble xylan, rendering it more soluble. However, this was not reflected in an increase in the viscosity of those feed samples, a result that is likely to be related to the degree of polymerisation of the arabinoxylan. Increasing conditioning temperature from 80°C to 90°C resulted in a decrease ( $P<0.05$ ) in body weight gain of approximately 7% and poorer ( $P<0.05$ ) FCR. Supplementation of the diet that was conditioned at 80°C with exogenous xylanase had no effect ( $P>0.05$ ) on performance parameters. However, supplementation of the diets that were pelleted at 85°C or 90°C with exogenous xylanase improved ( $P<0.01$ ) body weight gain and FCR compared with the birds fed on the respective control diets.

## Discussion

The effect of conditioning on the nutritional value of poultry feed has received considerable attention in the scientific literature (for an excellent review the reader is referred to McCracken, 2002) and although conclusions are sometimes conflicting, it appears that thermal treatment of poultry diets, to a point, improves bird performance. The fact that moderate thermal treatment of poultry diets appears to improve their nutritional value may be explained by gelatinisation of starches, degradation of heat labile anti-nutrients and destruction of cell walls, improving the availability of nutrients (Pickford, 1992). However, although moderate conditioning of poultry feed can be beneficial, more extreme heating inactivates endogenous enzymes and vitamins and reduces the availability of protein and starch (Pickford, 1992). Furthermore, based on evidence from the current trial, increasing conditioning temperature above 80°C can also increase the viscosity of the diet, suggesting an increased release of previously encapsulated non-starch polysaccharides (NSP). However, in the present study, although increasing conditioning temperature increased diet viscosity, this was actually associated with a small reduction in the concentration of soluble xylan, which is contrary to the findings described above. This can be explained because viscosity is a function not only of the concentration of soluble carbohydrate but more importantly the degree of polymerisation of the carbohydrate (Izydorczyk & Biliaderis, 1992). The beneficial effects of xylanase on viscosity translated into beneficial effects on the performance of the birds, with improved FCR and gain associated with xylanase addition, particularly in the diets with the highest viscosity (Table 1). Previous work has shown that small changes in intestinal viscosity (<5 cPs) can have a substantial impact on the diffusion of nutrients (Bedford, 2002) and that *in vitro* viscosity is well correlated with *in vivo* performance (Bedford & Classen, 1993). The data from the current study suggest that it is the negative impact of conditioning temperature on viscosity that is primarily responsible for the poorer performance of the birds fed on those diets. It can be concluded that conditioning temperature can have a substantial impact on the subsequent performance of broilers fed on those diets. In instances where highly viscous ingredients are used, the negative effects of viscosity may be exacerbated by high conditioning temperature, making the use of exogenous xylanase even more important.

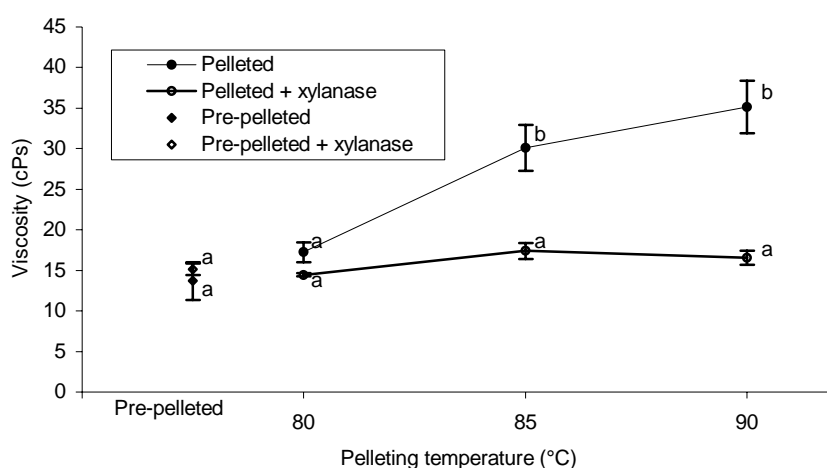
Therefore, it is particularly important when formulating diets using viscous cereals such as wheat and rye that exogenous xylanase is used strategically to minimise the negative impact of viscosity on bird performance.

Table 1. Effect of conditioning temperature and xylanase addition on the feed intake (FI), body weight gain (BWG) and FCR of birds fed on wheat-based diets\*.

Diet	FI (g/b) 1-21d	FI (g/b) 1-42d	BWG (g/b) 1-21d	BWG (g/b) 1-42d	FCR 1-21d	FCR 1-42d
Control 80°C	1087.6	4176.4	719.3b	2153.2b	1.51ab	1.94b
Control 80°C + xylanase	1046.6	4056.0	711.1bc	2151.9bc	1.47b	1.89b
Control 85°C	1013.7	4046.9	636.5d	1979.6d	1.60a	2.05a
Control 85°C + xylanase	1102.5	4247.6	760.4a	2210.0a	1.45b	1.92b
Control 90°C	1065.3	4056.6	667.8cd	1999.4cd	1.60a	2.03a
Control 90°C + xylanase	1068.8	4145.4	731.9ab	2126.2ab	1.46b	1.95b
SED	38.34	93.56	22.92	39.02	0.039	0.028
P	NS	NS	***	***	*	**
Temperature	NS	NS	NS	*	NS	*
Xylanase	NS	NS	**	***	**	**
Temp*Xylanase	NS	NS	*	*	NS	NS

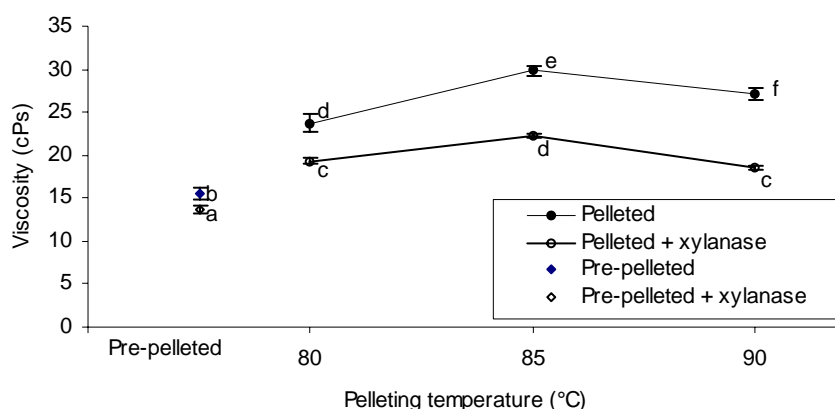
\*Body weight gain and feed intake are expressed as grams per bird; values in columns with no common superscript differ significantly ( $P < 0.05$ ); \*\*\*  $P < 0.001$ ; \*\*  $P < 0.01$ ; \*  $P < 0.05$ ; NS  $P > 0.05$

Fig. 1. Viscosity of diets (cPs) in starter diets after an in vitro digestion



Different letters indicate significant differences ( $P < 0.05$ ).

**Fig. 2.** Viscosity of diets (cPs) in finisher diets after an in vitro digestion.



Different letters indicate significant differences ( $P < 0.05$ ).

## References

- BEDFORD, M.R. (2002) The role of carbohydrases in feedstuff digestion. In: *Poultry Feedstuffs: Supply, Composition and Nutritive Value*, (Eds. McNab, J. & Boorman, N.), CAB International. 319-336.
- BEDFORD, M.R., & CLASSEN, H.L. (1993) An in vitro assay for prediction of broiler intestinal viscosity and growth when fed rye-based diets in the presence of exogenous enzymes. *Poultry Science*, 72: 137-143.
- IZYDORCZYK M. & BILIADERIS C.G. (1992) Effect of molecular size on physical properties of wheat arabinoxylan. *Journal of Agriculture and Food Chemistry*, 40, 561-568.
- KRAVTCHEKNO T.P. & PILNIK W. (1990) A simplified method for the determination of the intrinsic viscosity of pectin solutions by classical viscosimetry. In *Gums and stabilizers for the food industry*. Eds G.O.Phillips, P.A.Williams & D.J.Wedlock. IRL Press. pp. 281-285.
- MCCRACKEN, K.J. (2002) Effects of physical processing on the nutritive value of poultry diets. In *Poultry Feedstuffs: Supply, Composition and Nutritive Value*. Eds J.M. McNab & K.N. Boorman. CAB International. pp. 301-316.
- PICKFORD, J.R. (1992) Effects of processing on the stability of heat labile nutrients in animal feeds. In: *Recent advances in animal nutrition*. Garnsworthy, P.C., Haresign, W. & Cole, D.J.A. (Eds.), Butterworth-Heinemann, Oxford, UK, p177-192.
- ROUAU X. & SURGET A. (1994) A rapid semi-automated method for the determination of total and water-extractable pentosans in wheat flours. *Carbohydrate Polymers* 24, 123-132.
- SILVERSIDES, F.G. & BEDFORD, M.R. (1999) Effect of pelleting temperature on the recovery and efficacy of a xylanase enzyme in wheat-based diets. *Poultry Science*, 78: 1184-1190.