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Review

Interactions between wheat characteristics and feed enzyme supplementation in broiler diets

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ABSTRACT

Wheat is a very variable grain in terms of its physical and chemical characteristics. Of its physical characteristics, hardness appears to be the most important quality, having the greatest influence on broiler performance and nutrient digestibility. The effect of wheat hardness on broiler performance is also likely to be influenced by feed form (e.g. mash versus pelleted feed). For the chemical characteristics, the level and structure of the non starch polysaccharides (NSP) are important criteria in determining the feeding quality of the wheat. With regard to enzyme response, most research has focused on the chemical structure, in particular NSP level of the wheat with little attention on the importance of the physical quality. Further studies are required to better understand the effect of physical qualities of wheat and how they influence the response to feed enzymes. This review sheds light on some of the chemical and physical wheat quality that may affect enzyme response in broilers.

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1. Introduction

Wheat is a major energy source in broiler feeds in many parts of the world, including Europe, Canada, Australia and New Zealand. However, the physical and chemical composition of wheat is highly variable, making it one of the most variable cereal grains (Choct et al., 1999). Commercially, wheat can account for up to 70% of the metabolisable energy and 35% of the protein requirements of broilers. Therefore, variation in the quality of the wheat is expected to have a major impact on the performance of chickens (Gutierrez del Alamo et al., 2008). The variation in broiler performance when feeding different

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Table 1
Chemical composition of wheat (g/kg)[a].

	Average	Range
Protein	120	80–201
Starch	585	402–712
Amylose: amylopectin	0.466	–
Fat	20	9–34
Ash	16	15–18
Water-insoluble cell walls	102	94–118
Non-starch polysaccharide		
Total	115	66–146
Soluble	28	8–41
Insoluble	87	
Pentosans		45–61
Arabinoxylans		
Soluble	18	
Insoluble	63	
Total P	3.6	2.3–8.3
Phytate P	2.8	0.9–3.2
Endogenous enzymes		
Xylanase XU[c]	0.48	0.27–0.64
Phytase (FTU/kg)	508	206–775
α-Amylase activity (AU)[d]	0.12	
Lipase[b]	7.93	2.0–27.3
Xylanase inhibitors[e]		
TAXI	94	17–137
XIP	299	234–355
Xylanase inhibition activity (InhU)[d]	183	

[a] From Barrier-Guillot et al. (1996b), Rose et al. (2001), Carre et al. (2002) Svihus and Gullord (2002), Gys et al. (2004), Choct (2006) and Ravindran and Amerah (2009).
[b] Degradation percentage of 1.9 g rapeseed oil mixed with 15 g of wheat ground on 3 mm screen after 4 weeks at ambient temperature (Carre et al., 2002).
[c] One enzyme unit is the amount of enzyme needed to increase the extinction at 590 nm (E590) by 1 per hour of incubation under the conditions of the assay (Dornez et al., 2006).
[d] Gys et al. (2004).
[e] Dornez et al. (2006); TAXI (*Triticum aestivum* xylanase inhibitor); XIP (xylanase inhibitor protein).

wheats was attributed, in most studies, to the high variability in chemical composition, in particular the level of non starch polysaccharide (NSP; Wiseman, 2000). Physical characteristics of the wheat are also important criteria which may influence broiler performance (Rose et al., 2001; Peron et al., 2006; Carre et al., 2007) but have attracted less attention in the literature. For example, in terms of feed processing and feeding value, whether a grain is hard or soft is of great importance (Amerah et al., 2007).

Xylanase supplementation to broiler diets is a common practice to alleviate the adverse effects of NSP and to minimise the variation in apparent metabolisable energy (AME) and performance of poultry fed wheat-based diets (Bedford, 1996; Hughes and Choct, 1999). However, there is a variable response to enzyme supplementation when added to wheat based diets (Gutierrez del Alamo et al., 2008), which may be explained, in part, by the diverse and complicated nature of the carbohydrate fraction and linkage between nutrients and the cell wall structure (Kim et al., 2005). Physical structure of the wheat may also explain partly the variable responses to enzyme supplementation (Carre et al., 2007; Amerah et al., 2009). Other factors that may cause variation in response include, feed processing, xylanase molecule properties, breed and age of birds (Bedford, 1997; Amerah et al., 2011). The aim of the present paper is to review available data on the effects of physical and chemical composition of wheat on the efficacy of exogenous enzymes.

2. Wheat chemical composition

The chemical composition of wheat of a given type and variety varies from year to year depending upon area, growing location, use of fertilizer, moisture conditions and other agronomic factors (Ravindran and Amerah, 2009). However, the intrinsic factors in wheat that cause this variation are not yet completely established (Svihus and Gullord, 2002). A summary of the chemical variation of wheat from selected publications is presented in Table 1. For example, Svihus and Gullord (2002) compared 16 samples of Norwegian wheats, reported variation in starch content between 614 g/kg and 712 g/kg, protein between 109 g/kg and 154 g/kg, fat between 22 g/kg and 34 g/kg, crude fibre between 20 g/kg and 26 g/kg and, sugar between 16 g/kg and 55 g/kg.

The AME value of the wheat depends on the content and digestibility of starch, protein and lipids (McCracken and Quintin, 2000; Svihus and Gullord, 2002; Wiseman, 2006; Carre et al., 2007). Starch is the most abundant carbohydrate in wheat and the main energy-yielding component. The starch content varies from 60 to 75% and is inversely related to the protein content of the wheat (Pirgozliev et al., 2003; Ravindran and Amerah, 2009). However, the digestibility of starch in the wheat may vary according to starch structure, amylose to amylopectin ratio and interactions with other components of the endosperm