Is there a correlation between the nutritional value of wheat-based diets and efficacy of NSP-enzymes for broiler chickens as measured by a zootechnical and a balance trial ?

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Abstract
Wheat is highly variable in chemical composition and nutritional value being partly due to antinutritional components. There are literature indications that the nutritional value might be affected by the bioassay procedure. The objective of this study was to determine the nutritional value of wheat-based diets and efficacy of NSP-enzymes for broiler chickens as measured by both a zootechnical and a balance trial.
For the entire growing period, there were significant factorial effects for weight gain (wheat and enzyme factor), feed intake (wheat factor) and feed conversion (wheat and enzyme factor). For MEn and fat digestibility, there were significant factorial effects for MEn (wheat and enzyme factor). The relative differences in response to wheat cv and NSP-enzymes depended on the kind of response parameter (e.g. growth rate, feed conversion or dietary MEn content).

Introduction
Wheat is highly variable in chemical composition and nutritional value being partly due to antinutritional components (e.g. NSP). NSP show antinutritional properties by encapsulating nutrients and/or depressing the digestibility of nutrients through gastro-intestinal modifications. The nutritional improvement with exogenous enzymes depends mainly on the target substrate and the enzyme preparation (with its major and minor activities) (Huyghebaert, 1995). However, the estimation of both the nutritional value of wheat and the efficacy of NSP-enzymes remains uncertain because of e.g. possible interactions. Moreover, in-vivo evaluations of wheat and NSP-enzymes often depends on the bio-assay procedure (Dusel et al., 1998).
The objective of this study was to determine the nutritional value of wheat-based diets and efficacy of NSP-enzymes for broiler chickens as measured by both a zootechnical and a balance trial.

Materials and Methods
This “double” trial was designed as a Complete Block Design (3 wheat cv * 2 enzymes (-/+) * 6 replicates = 36 pens). Selection of the 3 resp. wheat cv was mainly based on differences in chemical composition, physico-parameters and in-vitro “extract” and “suspension” viscosity patterns, incl. in combination with Belfeed (vs the unsupplemented control).
The starter (1-14d; MEn=12.3 MJ/kg) and grower (15-39 d; MEn=12.7 MJ/kg) diets were formulated with 53% wheat; thereby meeting the nutrient requirements, however, without any correction for differences in chemical composition between the wheat cv (table 1). The 3 resp. diets were supplemented with Belfeed at 100 mg/kg or not. Furthermore, all these 6 diets were supplemented with avilamycine at 10 mg/kg and anti-coccidials (robenidine at 30 mg/kg “1-14d” and salinomycine at 50 mg/kg “15-36d”).
For the zootechnical trial the broilers were kept in floor pens with ad libitum access to feed and water. Responses were measured in terms of weight gain, feed intake (DFI) and feed conversion. The balance trial was carried out according to the EU-reference method (Bourdillon et al., 1990); consisting of a 7-day period of adaptation (to the respective experimental diets : 14-21 days) and a 4-day main balance period (21-25 days of age) with restricted feeding and total excreta collection. The total number of broilers was 1224 for the zootechnical trial and

144 for the balance trial (Ross 308 / males and females in 50/50 ratio).
The MEn-contents of the experimental diets were corrected for N-retention to zero (34.4 kJ/g N). MEn and digestibility of dietary fat were, however, not corrected for endogenous secretions or metabolic losses.
All parameters were subjected to a 3-factorial analysis of variance ("3*2*6" incl. "wheat*enzyme"-interaction) and the corresponding LSD-multiple range test.

Results and Discussion
Table 1 shows that the differences between the 3 resp. wheat cv depend on the parameter, being more pronounced for CP & HLW than for e.g. the extract viscosity. On the other hand, there were clear differences in suspension viscosity (SP) and its pattern related to exogenous enzyme supplementation (Figure 1). The starting SP was higher for Vivant, intermediate for Elephant and lower for Equinox. SP-control increased much more pronouced for Elephant and Vivant than for Equinox (differences in solubilisation & "endogenous" xylanase inhibition?). The impact of Belfeed in terms of SP-reduction was significant for Vivant only (relative differences in exogenous enzyme inhibition ?).
For the zootechnical trial, it is worthwile noting that the differences in the effect of both wheat cv and enzyme depend on age with e.g. divergent enzyme effects of resp. feed intake and feed conversion on growth rate. The enzyme effect on growth rate was lower for the starter period than for the subsequent period "15-39d". The effect of wheat cv on growth rate was only slightly age-related but with higher values for Vivant and Elephant than for Equinox and moreover with a higher impact of feed intake than of feed conversion. For the entire growing period (1-39 d), there were significant factorial effects for weight gain (wheat and enzyme factor) feed intake (wheat factor) and feed conversion (wheat and enzyme fator)(table 2).
For MEn and fat digestibility, there were significant factorial effects for MEn (wheat and enzyme factor). The diet with Elephant had the higher MEn but the lower enzyme impact, while the diet with Vivant had the lower MEn but the higher enzyme impact. The respective responses were indermediate for Vivant-diets.
The dietary MEn is only slightly related to the zootechnical responses in terms of growth rate and feed conversion. This inconsistency might be related to the interaction with (1) the wheat characteristics (e.g. the endogenous xylanase activity & degree of "endo/exo-genous" xylanase inhibition), (2) the dietary protein level (proportional to dietary MEn / with the lower CP for Equinox), (3) "voluntary" feed intake (intestinal hydratation and digesta passage rate) and (4) the "age-related" bacterial load of the gastro-intestinal tract (floor pens vs cages or growth trial vs balance trial). The starting "suspension" viscosity is more related to the dietary MEn than to the zootechnical responses. On the other hand, the starting "suspension" viscosity and its pattern was not related to the in-vivo enzyme efficacy. Further research might be needed in order to develop other in-vitro tools for the prediction of the nutritional value of wheat and the efficacy of NSP-enzymes.

References

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Table 1. The composition of the 3 respective wheat varieties

Wheat cv	H_2O	CP	Starch	Sugar	Cfat	Cfiber	GE	HLW	Visc
Elephant	126	112	628	38	14	16	16.17	82.2	6.4
Equinox	124	94	616	37	18	23	16.11	76.0	6.3
Vivant	140	106	617	45	19	21	15.85	78.0	7.6
Wheat cv	P	Met+Cys	Lys	Thr	Try	Arg	Leu	Ileu	Val
Elephant	2.4	4.5	3.3	3.5	1.4	5.6	7.9	4.1	5.0
Equinox	2.4	3.9	2.5	2.9	1.3	4.8	6.9	3.5	4.3
Vivant	2.4	4.3	3.2	3.4	1.4	5.5	7.7	3.9	4.8

CP = crude protein (N*6.25), starch (Ewers-polarimetry), GE = gross energy (MJ/kg), HLW = hectoliter weight (kg/hl), Visc = extract viscosity (on supernatant after a digestion simulation with pepsine and pancreatine)

Table 2. **The impact of wheat cv and enzyme suppl. on zootechnical responses and nutritional value (*in terms of MEn & fat dig.*) of the experimental diets**

	BW 39 d, g	DFI 1-39d, g	FC 1-39 d	MEn, Kcal/kg	Fat dig., %
Wheat cultivar					
1 : Elephant	2162 a	91.0 b	1.679 a	2655 ab	80.3 a
2 : Equinox	2106 b	89.7 b	1.700 b	2689 a	81.0 a
3 : Vivant	2180 a	92.9 a	1.699 ab	2625 b	79.7 a
LSD (P:0.05)	54	1.9	0.021	38	2.3
Enzyme suppl.					
- enz.	2123 b	90.9 a	1.708 b	2628 b	79.3 b
+ enz.	2176 a	91.6 a	1.678 a	2685 a	81.4 a
LSD (P:0.05)	44	1.5	0.017	31	1.9
wheat cv * enzyme					
Elephant – B	2131	91.4	1.710	2592	78.4
Elephant + B	2192	90.6	1.647	2719	82.3
Equinox – B	2077	88.7	1.705	2683	80.1
Equinox + B	2136	90.8	1.695	2695	81.9
Vivant – B	2160	92.5	1.707	2610	79.3
Vivant + B	2200	93.3	1.691	2641	80.2

Figure 1: The "suspension *(wheat/water-ratio=1/1.5)*" viscosity pattern during incubation for the 3 respective wheat varieties, as control and supplemented with Belfeed (B).