Validation of the nutritional matrix of a multienzyme complex through performance and digestibility improvement

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Introduction

It is well known that feed represents the most important cost in poultry production. Together with variable costs, it can reach up to 80% of the total cost in a poultry operation. Therefore, it is reasonable that improving feed efficiency should be the very first target of every poultry producer. There are multiple tools to optimize feed cost, with feed enzymes one of the most cost effective and most widely accepted solutions by nutritionists. These products should provide a well proven and reliable nutritional matrix for the most cost-effective feed reformulation.

When evaluating nutritional matrices for feed enzymes we should not only pay attention to the absolute figures but more importantly how they were obtained. Feed enzymes need to offer poultry nutritionists a reliable and well researched matrix value for different nutrients. Ideally this is obtained from a safely corrected average improvements of nutrient digestibility recorded in different poultry trials. This creates a trustful and reliable nutritional matrix to optimize feed cost without impairing poultry performance. The aim of the following study is to validate the proposed matrix value of a commercial multi-enzyme complex (MEC).

Material and methods

320 one-day-old male Ross 308 chickens (average initial weight 41.2 g) obtained from a commercial hatchery were randomly assigned to 4 treatments with 8 replicates (pens) of 10 birds each:

- T0: positive control (PC) without enzymes.
- T1: negative control (NC), PC reformulated to reduce apparent metabolizable energy, digestible amino acids and crude protein by 65 kcal/kg and 2% respectively (reduced the feed cost by 12 €/tonne compared to the PC)
- T2: NC + MEC (xylanase + beta-glucanase + cellulase + amylase + protease) at 250 g/ton.
- T3: NC + a commercial xylanase + beta-glucanase complex (XBC) at 50 g/ton.

The experiment lasted for 35 days and was divided into 3 feeding periods: (starter 1-11d), grower (12-24d) and finisher (25-35d). The composition of experimental diets and calculated values are presented in Table 1. Average pen weight and feed intake were recorded at the end of every feeding phase. Feed conversion, daily growth rate, bird-days and daily feed intake per bird was calculated per feeding phase and for the overall trial. Digestibility was determined during the grower period from day 18 to 21, using titanium oxide as indigestible marker. Collection trays were installed in allfloor pens on day 18 to 21, for collecting eight excreta samples per treatment, one excreta sample per pen.

Table 1. Composition of experimental basal diets and calculated nutritional value

	Starter (1-11d)		Grower (12-24d)		Finisher (25-35d)	
Ingredients (%)	**PC**	**NC**	**PC**	**NC**	**PC**	**NC**
Maize	43.10	26.08	45.11	27.77	50.23	32.86
SBM (45% CP)	39.13	34.33	36.82	31.53	31.61	27.37
Wheat	10.00	20.00	10.00	20.00	10.00	20.00
Triticale	-	10.00	-	10.00	-	10.00
Sunflower Meal (34% CP)	-	2.28	-	3.00	-	2.00
Soybean oil	3.42	2.88	4.24	3.81	4.71	4.25
Limestone	1.40	1.42	1.27	1.28	1.13	1.15
MCP	0.94	0.91	0.76	0.73	0.62	0.60
NaCl	0.26	0.25	0.25	0.24	0.23	0.23
Sodium Bic.	0.12	0.13	0.06	0.07	0.05	0.05
HCl-Lys	0.20	0.28	0.13	0.20	0.12	0.18
DL-Met	0.33	0.32	0.30	0.28	0.24	0.23
L-Thr	0.10	0.12	0.05	0.08	0.04	0.07
Premix (vit/min)[1]	1.00	1.00	1.00	1.00	1.00	1.00
Phytase 5000[2]	0.01	0.01	0.01	0.01	0.01	0.01
Nutrients (%)	**PC**	**NC**	**PC**	**NC**	**PC**	**NC**
Crude Protein	22.50	22.15	21.50	21.15	19.50	19.15
Crude Fat	5.74	4.81	6.59	5.75	7.13	6.28
Crude Fiber	3.19	3.45	3.12	3.49	2.98	3.30
Ca	1.00	4.00	0.91	0.91	0.82	0.82
dig P	0.49	0.49	0.45	0.45	0.41	0.41
Na	0.18	0.18	0.16	0.16	0.15	0.15
Cl	0.24	0.25	0.22	0.23	0.21	0.22
DigLYS	1.24	1.22	1.126	1.100	1.000	0.980
DigMET	0.618	0.598	0.579	0.551	0.500	0.480
DigMET+CIS	0.910	0.890	0.862	0.833	0.760	0.740
DigTHR	0.800	0.788	0.730	0.718	0.650	0.638
DigTRP	0.244	0.236	0.232	0.224	0.207	0.20
DigVAL	0.912	0.877	0.874	0.84	0.790	0.756
DigILE	0.851	0.811	0.813	0.772	0.727	0.690
DigARG	1.376	1.317	1.312	1.256	1.170	1.111
AME (Kcal/kg)	2950	2885	3035	2970	3125	3060
Feed cost (€/ton)	**294.7**	**282.0**	**294.7**	**281.6**	**288.5**	**276.9**

[1]mineral and vitamin premix provides per kg diet: IU: vit. A 11250, cholecalciferol 2500; mg: vit. E 80, menadione 2.50, vit. B12 0.02, folic acid 1.17, choline 379, D-pantothenic acid 12.5, riboflavin 7.0, niacin 41.67, thiamin 2.17, D-biotin 0.18, pyridoxine 4.0, ethoxyquin 0.09, Mn 73, Zn 55, Fe 45, Cu 20, I 0.62, Se 0.3.
[2]phytase 5000 provides 0.15% dig P, 0.165% Ca and 0.035 Na.

Results

PERFORMANCE

The effect of supplementing different enzyme preparations to broiler diets on feed intake (FI), body weight gain (BWG) and feed conversion ratio (FCR) is presented in Table 2.

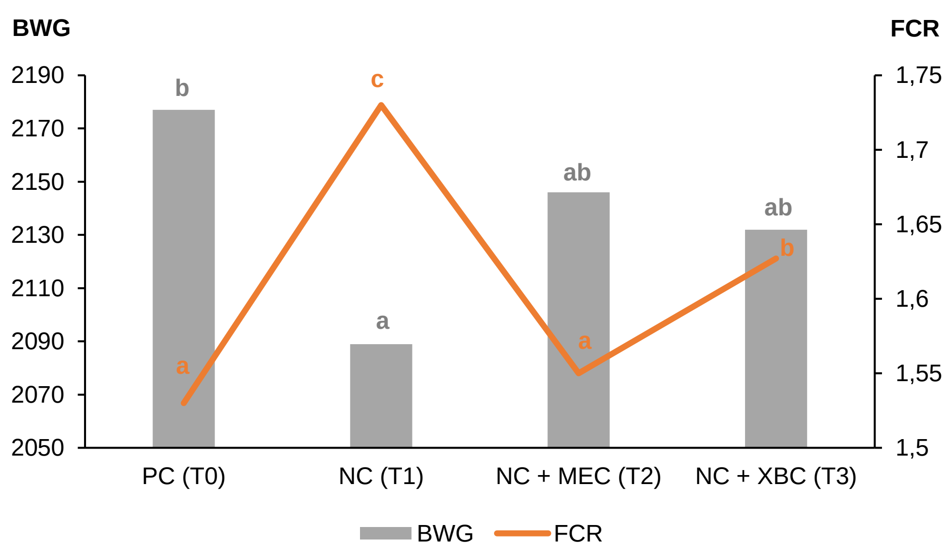
Table 2 Growth performance of broiler chickens fed different diets supplemented with different enzymes

	Starter (1-11 d)			Grower (12-24 d)			Finisher (25-35 d)			Total (1-35 d)			
	BWG	FI	FCR	BWG	FI	FCR	BWG	FI	FCR	BWG	FI	FCR	FCR_a*
T0	234	269	1.152	837^{ab}	1531^{a}	1.830^{a}	1106	1519^{ab}	1.381^{a}	2177^{b}	3319^{a}	1.526^{a}	1.531
T1	223	266	1.190	812^{b}	1600^{b}	1.976^{b}	1054	1753^{c}	1.666^{c}	2089^{a}	3618^{c}	1.732^{c}	1.757
T2	225	266	1.183	829^{ab}	1552^{a}	1.877^{a}	1092	1507^{a}	1.380^{a}	2146^{ab}	3325^{a}	1.549^{a}	1.561
T3	228	274	1.200	866^{a}	1599^{b}	1.850^{a}	1039	1596^{b}	1.539^{b}	2132^{ab}	3468^{b}	1.627^{b}	1.642
P	0.358	0.681	0.253	0.142	0.0067	0.0020	0.164	<0.0001	<0.0001	0.087	0.0001	0.001	-

T0: positive control (PC) without enzymes; T1: negative control (NC), PC reformulated to reduce apparent metabolizable energy, digestible aminoacids and crude protein by 65 kcal/kg and 2% respectively T2: NC + MEC (xylanase + betaglucanase + cellulase + amylase + protease) at 250 g/ton; T3: NC + a commercial xylanase + betaglucanase complex (XBC) at 50 g/ton
a–c Means without a common superscript differ significantly at P < 0.05.
*FCR_a is adjusted FCR at 2.2 kg BWG calculated per Ross 308 Management Handbook 2014.

For the whole experimental period (1-35 d), no statistical difference was found between PC (T0) and NC + MEC (T2) birds for BWG, FI or FCR, whereas FCR of NC (T1) and NC + XBC birds was significantly worse (P<0.05) compared to PC (T0) and NC + MEC birds (T2). Overall feed intake was the highest (P<0.05) for NC birds (T1) and NC + XBC birds (T3). There were no differences in growth performance during starter period (1-11 d). During the grower period (12-24 d), the highest feed intake (P<0.05) and worst FCR (P<0.05) was recorded for NC birds (T1). During the finisher period (25-35 d) the worst FCR (P<0.05) was recorded for both NC (T1) and NC + XBC birds (T3).

Figure 1. Overall trial BWG (g) and FCR



DIGESTIBILITY

The effect of supplementing different enzyme preparations to broiler diets on nutrient retention and total tract digestibility is presented in Table 3.

Table 4. Digestibility and retention of nutrients from 18 to 21d of age.

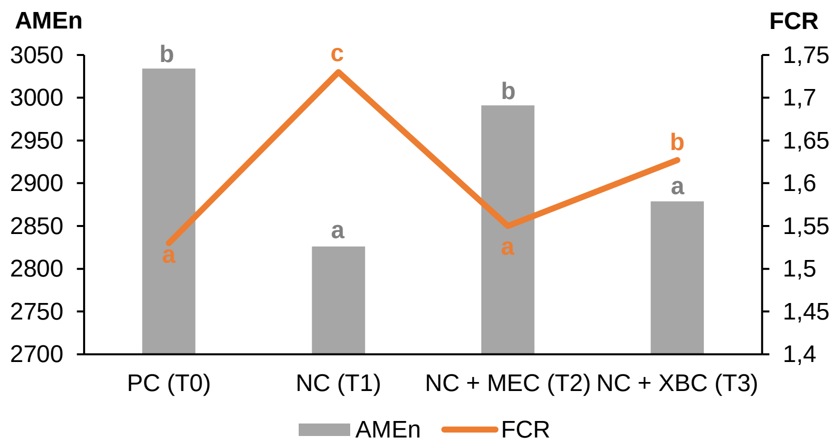
	Retention		Total tract digestibility			
	Dry matter	**Nitrogen**	**Crude Fat**	**Starch**	**Gross Energy**	**AMEn(kcal/kg)**
T0	70.9[c]	62.9[c]	79.6	95.4[b]	73.4[c]	3034[b]
T1	67.0[a]	56.8[a]	77.8	93.2[a]	68.9[a]	2826[a]
T2	68.8[b]	60.8[bc]	80.6	97.0[c]	71.6[b]	2991[b]
T3	68.1[ab]	60.2[b]	79.2	95.7[b]	70.4[ab]	2879[a]
P-value	0.0001	0.0002	0.396	<0.0001	<0.0001	<0.0001

T0: positive control (PC) without enzymes; T1: negative control (NC), PC reformulated to reduce apparent metabolizable energy, digestible amino acids and crude protein by 65 kcal/kg and 2% respectively T2: NC + MEC (xylanase + beta-glucanase + cellulase + amylase + protease) at 250 g/ton; T3: NC + a commercial xylanase + beta-glucanase complex (XBC) at 50 g/tonne a–c Means without a common superscript differ significantly at P < 0.05.

There were significant differences (P=0.0001) in dry matter and nitrogen retention. Birds from PC treatment (T0) were characterized by the highest DM retention, while NC + MEC birds (T2) showed higher dry matter retention compared to NC (T1). Nitrogen retention of the NC birds (T1) was the lowest compared to all other treatments (P<0.05). There were no differences in total tract crude fat digestibility. NC + MEC birds (T2) were characterized by the highest starch total tract digestibility (P<0.05) while birds from negative control treatment (T1) were characterized by the lowest. Total tract digestibility of GE was significantly better (P<0.05) in birds from PC (T0) and from NC + MEC (T2) compared to the NC (T1).

AMEn of the diets fed to the PC (T0) and NC + MEC birds (T2) was not significantly different, despite of the gap created by reformulation with the proposed nutritional matrix. This effect is consistent with the lack of significant differences in FCR and BWG. AMEn of the diet fed to the NC (T1) and NC + XBC birds (T3) was neither significantly different, however that of the NC birds was lower (P<0.05) compared to the PC (T0) and NC + MEC birds (T2), which is also consistent with the FCR results (Figure 2).

Figure 2. Overall trial FCR and AMEn



The results of the present study confirm the previous findings, that a MEC contributes to improving growth and FCR when added to broiler diets (Adams, 1993). Feed enzymes are commonly added to poultry diets to counteract the potential anti-nutritional effects caused by non-starch polysaccharides (NSP). In the early life of the chicken, its digestive capacity is not yet fully developed. According to Noy and Sklan (1995) net duodenal secretion of amylase, trypsin, and lipase is low at 4 days of age and increases 100-, 50-, and 20-fold, respectively, by day 21. A MEC containing NSP degrading enzymes, together with an amylase and protease can increase the digestive capacity of the chicken: by supplying multiple NSPases to attack different portions of the cell wall at once, and by providing other hydrolases such as protease and alpha-amylase, enhancing the action of the endogenous digestive enzymes to ensure the most efficient energy and amino acid release from the feed.

Conclusions

This trial demonstrates, including a commercial complex of a xylanase, β-glucanase, cellulase, amylase and a protease at 250 g/tonne of broiler feed in a reformulation (reducing apparent metabolizable energy, digestible aminoacids and crude protein by 65 kcal/kg and 2% respectively) can reduce feed cost by 12 €/tonne of feed, compared to a non-supplemented, non-reformulated standard diet without compromising bird performance. The commercial blend with only a xylanase and β-glucanase did not show the ability to recover the nutritional gap following reformulation.

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