Effects Of Maxigrain® Supplementation Of Sugarcane Scrapping Meal-Based Diets On The Growth Rate, Nutrient Digestibility And Cost Implication Of Japanese Quail (*Cortunix Cortunix Japonica*) Chicks

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ABSTRACT

The feeding trial aimed at examining the effect of Maxigrain® enzyme supplementation of sugarcane scrapping meal-based diets on the growth rate and cost implication of producing Japanese quail chicks using 400 day-old Japanese quails chicks in a 3 week experiment. The birds were randomly allocated to 6 dietary treatments tagged T_5, $T_5$100, $T_5$200, T_{10}, T_{10}100 and T_{10}200 at rate of 80 birds per diet. Each treatment was replicated 4 times in a 3x2 factorial arrangement having 20 birds per replicate. The 6 experimental diets were compounded to be isonitrogenous (28% crude protein) and isocaloric (2950Kcal/Kg ME) with two levels of crude fibre. Treatments T_5, $T_5$100 and $T_5$200 contained 5% crude fibre (normal fibre level) while treatments T_{10}, T_{10}100 and T_{10}200 contained 10% crude fibre level. The exogenous enzyme was included at 0, 100 and 200ppm thus, treatments T_5 and T_{10} contained 0ppm, $T_5$100 and T_{10}100 contained 100ppm and $T_5$200 and T_{10}200 contained 200ppm of the enzyme such that treatments T_5 and T_{10} served as the control for treatments $T_5$100, and $T_5$200 and T_{10}100 and T_{10}200 for low and high fibre diets respectively. The results showed that enzyme supplementation improved ($P<0.05$) weight gain (2.28 vs. 2.27 and 2.33g/bird/day),water intake (107.10 vs. 147.50 and 91.20 ml/bird/day) and revenue generated while dietary fibre significantly improved ($P<0.05$) daily feed intake (10.77 vs. 15.18g/bird/day), protein efficiency ratio (0.77 vs.0.53) and cost benefit parameters but reduced feed conversion ratio (4.67 vs.6.65). The interaction of the enzyme and dietary fibre did not affect all the growth and cost benefit parameters. Based on the results of this finding, production of quail chicks using 100ppm of the exogenous enzyme supplemented to sugarcane scrapping meal-based diets is recommended for optimum performance.

Keywords: Maxigrain®, Japanese quail chicks, growth rate, cost implication, sugarcane scrapping meal

INTRODUCTION

The shortage and high price of animal protein have been aggravated by the high cost of conventional feed ingredients. The current high cost of commercial feeds is well known and reported by Oruseibio and Omu (2000), Alokan (2000), Ikani and Adesehinwa (2000), Babatunde *et al.* (2000) and Iyeghe-Erakpotobo and Muhammad (2004). Adegbola (1989) reported that feed accounts for 60-80% of production cost of monogastric animals in developing countries compared to about 50-65% in developed countries. The low level of cereal and oil seed production and processing, the ravages of drought and the competition from direct human consumption have all contributed to the high cost of feed, which in turn has led to folding up of many poultry farms, especially small to medium-scale farms, and general decline in livestock production.

Nutritionists have the long-term challenge for research into least cost rations in order to sustain the farmers in production (Oruseibio and Omu, 2000). These workers have reported that the challenge is ever-increasing due to the current economic problems in Nigeria. The scenario pointed above has therefore forced animal nutritionists to expand the raw material base for livestock feed formulation to include an ever-increasing range of agro-industrial by-products and other unconventional feed resources. The incorporation of agro-industrial by-products into animal feeds holds tremendous potentials for alleviating the short supply and high cost of feed (Babatunde *et al.,* 2000). The use of unconventional feedstuffs as substitutes for grains and other feedstuffs have been suggested thus, the search for non-conventional feedstuffs has been the most active area of animal nutrition research in the tropical world (Ikani and Adesehinwa, 2000). Many of these agro- industrial by-products are fibrous in nature and their use in monogastric farm animal diets is therefore limited due to the fibre handling abilities of the livestock, which is about 5–7 percent (NRC, 1977 and Olomu, 1979).

Fibrous food ingredients are in abundant supply and cheaply too (Dogari, 1984). Efforts at evaluating the nutritional value of these by-products such as rice offal, maize offal, wheat offal and brewer's spent grains have been in progress for sometime in Nigeria with significant achievements (Babatunde *et al.,* 1975, and Adebowale and Ademosun, 1981). These fibrous feedstuffs have been shown to result in increased feed intake, lowering the rate of live weight gain and in poorer feed conversion ratios when they replaced maize in diets (Nelson, 1984; Maisamari, 1986; Atteh *et al.,* 1993; Tuleun *et al*., 1998 and Oluolokun and Olaloku, 1999).

Non-ruminant animals lack the enzyme cellulase that can digest the components of the fibre in rice offal and other fibrous by products. This is so, at least in the small intestinal tract, which is the site for most nutrient absorption (Holness, 1991). There is evidence that pre-digestion or any attempt to initiate the hydrolysis of feed components often enhances the digestibility and utilization when fed in animal diets. One of such techniques is the use of exogenous enzyme preparations with feedstuff (Bio–Ingredients Ltd, 2004). Although the use of commercial feed enzymes has gained world – wide acceptability, its use in Nigeria is still not popular. The use of exogenous enzymes is known to help in the digestibility of feed ingredients and allow for the use of cheaper and poorer quality materials to obtain optimum performance. There is a sizeable body of literature on the value of enhanced digestibility of roughages through the use of these enzymes with favourable results on growth performance, feed conversion efficiencies and on profitability of the enterprise (Broz and Frigg, 1993; Viveros *et al.,* 1994 and Tuleun *et al*., 1998). The use of enzymes has been common in many industries for some years. For instance, enzyme uses in the food processing, brewing and leather-working industries are well documented (Partridge and Wyatt, 1995). An increased understanding of the properties of enzymes and their function has led to their introduction in the animal-feed industry, although the application of enzyme technology is relatively new for the livestock feed industry.

Enzymes have been approved for use in poultry feed because they are natural products of fermentation and therefore pose no threat to the animal or the consumer, (Vukic Vranjes and Wenk, 1993). Their use in poultry feeds has predominantly been related to the hydrolysis of fibre or non-starch polysaccharide (NSP) fraction of cereal grains. These NSPs cannot be digested by the endogenous enzymes of poultry and can have anti-nutritive effects.

They cause an increase in viscosity of intestinal content and entrap large amounts of well digestible nutrients like starch and proteins. This leads to an impaired digestion and digestive problems, (Almirall *et al.*, 1995).

Numerous researchers have demonstrated that the soluble NSP fraction and not the total NSP fraction are responsible for anti-nutritive responses. These NSPs can bind to large amounts of water and as a result, the viscosity of fluids in the digestive tract is increased. The increased viscosity causes problems in the small intestines because it reduces nutrient availability (particularly fat) and results in increased amount of sticky droppings (Choct *et al.,* 1995).

Quails are small bodied birds of the galliforme family. They are highly prolific and hardy. Since they were introduced into the Nigerian poultry industry in 1992 (Haruna *et al.*, 1997), they have gained tremendous interest among Nigerian populace especially because of their short generation interval, fast growth rate and less susceptibility to common poultry diseases. Japanese quails in the wild, feed on insects, grains, grasses and various seeds. They have also been found to thrive well and grow efficiently in captivity when fed high protein diets (NVRI, 1996). Nevertheless, little research work has been done in the area of comparative ingredient evaluation for quail birds. The need for poultry species with lesser demand and low cost of production is more realistic when feed ingredients that are less competitive and available are used. This is the reason for considering sugarcane scrapping meal as an alternative feed source in quail diet. The aim of the stud was to investigate the effects of exogenous enzyme supplementation of sugarcane scrapping meal-based diets on the growth rate and cost implication of quail chicks.

MATERIALS AND METHODS

Study area

The experiment was carried out at the Teaching and Research Farm of the Faculty of Agriculture, Nasarawa State University, Keffi, Shabu – Lafia Campus. It is located in the guinea savanna zone of North Central Nigeria. It is found on latitude 08^0 35'N and longitude 08^0 33' E. The mean monthly maximum and minimum temperatures are 35. 06 and 20.16^0C respectively while the mean monthly relative humidity is 74 %. The rainfall is about 1168. 90mm. (NIMET, 2008)

Sugarcane scrapping

Sugarcane scrapings were sourced from local sugarcane marketers within Lafia metropolis, sun-dried and milled to form the sugarcane scrapping meal (SCSM).

Source of Maxigrain® enzyme

Maxigrain® enzyme a multi-enzyme compound of β-glucanase, xylanase, phytase, arabinoxylanase and a mixture of yeast and minerals was purchased from Animal Care, Abuja.

Description and preparation of diets for starter quails

A total of 400 day-old quail chicks were used for the experiment which lasted for 3 weeks. The birds were randomly allocated to 6 dietary treatments tagged T_5, $T_5$100, $T_5$200, $T_{10,}$ T_{10}100 and T_{10}200 at rate of 80 birds per diet. Each treatment was replicated 4 times in a 3x2 factorial arrangement having 20 birds per replicate. All experimental birds were given weighed amount of feed and water *ad – libitum.* The 6 experimental diets T_5, $T_5$100, $T_5$200, $T_{10,}$ T_{10}100 and T_{10}200 were compounded to be isonitrogenous (28% crude protein) and isocaloric

(2950Kcal/Kg ME) with two levels of crude fibre. Treatments T_5, $T_5$100 and $T_5$200 contained 5% crude fibre (normal fibre level) while treatments T_{10}, T_{10}100 and T_{10}200 contained 10% crude fibre level (high fibre level). The enzyme was included at 0, 100 and 200ppm thus, treatments T_5 and T_{10} contained 0ppm, $T_5$100 and T_{10}100 contained 100ppm and $T_5$200 and T_{10}200 contained 200ppm of the enzyme such that treatments T_5 and T_{10} served as the control for treatments $T_5$100, and $T_5$200 and T_{10}100 and T_{10}200 for low and high fibre diets respectively. Other ingredients were included at the recommended levels to meet the nutrient requirements of the birds. The composition of the experimental diets is presented in Table 1.

Management of experimental birds

The birds were fed *ad-libitum* and had access to drinking water at all times. Adequate heat source was improvised using kerosene stoves to the birds warm through out the brooding period. Lighting source was provided using electricity bulbs during the night. The birds were administered anti-stress drug orally at the recommended dosage on arrival before the commencement of the experiment. The birds were housed in a deep litter pens constructed using wire mesh to allow for adequate ventilation. Other routine management practices were adopted as outlined by Musa *et al.* (2007).

Data collection

The growth performance included body weight gain which was computed as the difference between the final weight and the initial weight of the birds, feed intake determined as the difference between the amount of feed fed and the leftover. Feed conversion ratio was calculated as the rate of feed intake to live weight gain while protein efficiency ratio was computed as the as the gain in body weight to the protein consumed. Water consumption determined accounting for evaporative loss using the procedure outlined by Oluyemi and Robert (2002). Mortality record was kept throughout the experimental period.

Statistical analysis

Data obtained were subjected to one way analysis of variance (ANOVA). The separation of means was effected using least significant difference method and tested at probability level of 5% as described by Steel and Torrie (1980). The following statistical model was used:

$$Y_{ij}=\mu+A_i+B_j+(AB)_{ij}+€_{ijk}$$

Where Y_{ij}= Individual observation

μ = general Mean

A_i =effect of Factor A

B_j =effect of Factor B

$(AB)_{ij}$=effect of interaction AB

$€_{ijk}$=experimental error

RESULTS AND DISCUSSION

Proximate composition of sugarcane scrapping

Table 1 shows the proximate composition of sugarcane scrapping which indicates that the calculated metabolizable energy from the proximate composition data using the formula as described by Pauzenga (1985), ME (kcal/kg) = 37x % cp x 81.1 x % EE + 35.5 x % NFE was about 29070.45. The test ingredient contain low (8.25%) crude protein, high crude fibre (36.48%) and low (3.36%) either extract. The dry matter was about 90.67% while ash and nitrogen free extract were about 9.98 and 67.40% respectively. This composition makes sugarcane scrapping a fibrous feed material which will require some level of processing or pre-digestion if it must be fed to monogastric animals.

Growth rate and water intake

The increased (P<0.05) weight gain (2.28 vs.2.27 and 2.33 g/bird/day), water intake (107.10 vs. 147.50 and 91.20 ml/bird/day) and revenue generated (227.60 vs.227.40 and 233.60 ₦) due to enzyme supplementation (Table 3) suggest that enzyme supplementation improved the utilization of fibrous feeds. Birds fed the 200ppm enzyme supplemented diets gained more weight that the non-enzyme and 100ppm enzyme supplemented diets. This observation is in agreement with the report of Makanjuola and Iyayi (2010) who investigated the utilization of maize bran-based diets supplemented with Raxazyme G2G by broiler and observed that increased weight gain and feed intake were noted in birds fed the enzyme supplemented diets. The observation made from this study could be attributed to the fact that Maxigrain® enzyme broke down the fibre component in the feed thereby making available the nutrients to the birds. This is consistent with the earlier report of Adeola and Olukosi (2008) who reported that exogenous enzymes complement the digestive enzyme of poultry to enhance the utilization of non-starch polysaccharides in cereals and their by products. It could also be associated with improved retention of protein and crude fibre. The values reported in this study were slightly higher than the 1.58-1.78g as reported by Tuleun *et al.* (2009) but close to the 3.08-3.32 g/bird/day as reported by Chantiratikul *et al.* (2010) for weight gain. The significant variation observed in the water intake suggested that enzyme supplementation improved water intake.

Dietary fibre did not affect final live weight gain and water intake of the quails but significant improvement (P<0.05) was observed in feed intake (10.77 and 15.18 g/bird/day), protein efficiency ratio (0.77 and 0.53) and gross margin (183.03 and 198.94 ₦); fibre reduced (P<0.05) feed conversion ratio (4.67 and 6.65), feed cost per weight gain (20.79 and 12.75 ₦/kg) and cost of production (48.05 and 29.06 ₦/bird). This observations are similar to the findings of Duru and Dafwang (2010) who investigated the effect of Maxigrain® enzyme supplementation of diets with or without rice offal on the performance of broiler chicks and noted that there was no significant variation in final body weight gain but feed intake was increased significantly due to rice offal inclusion. Generally, birds tend to eat more feed when the level of fibre increases in the diets; this is in order to meet the calorie requirement of the bird. In this study, chicks fed the high fibre diets ate significantly higher than those fed the low fibre diets. The values obtained in this study were within the range of 12.53-13.91g/bird/day for feed intake as earlier reported by Bawa (2012a).

The non-significant variation (P>0.05) in the growth parameters due to enzyme supplementation and dietary fibre (Table 4) on growth performance of starter quails did not tally with the findings of Duru and Dafwang (2010) and Esuga *et al.* (2008). Duru and Dafwang (2010) investigated the effect of Maxigrain® supplementation of diets with or without rice offal on the performance of broiler chicks and noted significant improvement in growth performance when rice offal was substituted for maize on a weight to weight basis which gives rise to lower energy diets. The result obtained confirms that Maxigrain® supplementation is suitable only with the use of feeds that exceed the recommended dietary fibre levels for optimum growth.

Table 5 summarizes the effect of enzyme supplementation or dietary fibre on nutrient digestibility by starter quails. The improvement in the digestibility of crude protein, crude fibre, ether extract, nitrogen free extract and fibre fraction components such as neutral detergent fibre, acid detergent fibre, acid detergent lignin and hemicellulose due to enzyme supplementation supports the general assertion that exogenous enzyme supplementation improves digestibility of nutrient (Adeola and Olukosi, 2008). Furthermore, Omole *et al*. (2011) investigated the performance and nutrient digestibility of broiler birds fed diets containing exogenous Hamecozyme® and observed significant improvement in crude protein and crude fibre digestibility as the level of Hamecozyme increased in the diets. Similarly, Alu *et al*. (2009) conducted an experiment using weaner pigs to investigate the effect of Nutrase Xyla® enzyme supplementation on nutrient digestibility where high and low fibre diets were fed to weaner pigs and noted significant improvement in the digestibility of neutral detergent fibre and hemicellulose.

Dietary fibre significantly depressed the digestibility of nutrients except for crude fibre (80.50 and 74.90 %), ether extract (73.50 and 70.10 %) and cellulose (47.70 and 48.90 %) which were not influenced (P>0.05), are in consonance with the earlier reports of Olomu (2011), McDonald *et al*. (1995) and Atteh (2002). Reports (Woodman and Evans, 1947b and Crampton and Harris, 1954) suggest that older animals utilize fibrous diets more than the young ones. The test ingredient used in this experiment was sourced from matured sugarcane ready for consumption. The degree of lignifications of fibre also affects it digestibility (Mecy, 1942). The most important anti-nutritional NSPs are the arabinoxylans and these are recognized to increase the viscosity of digesta by their water binding capacity which means the animals own enzyme are constrained or limited in catalyzing the digestion of dietary nutrients (Van de Mierop, 2001 and Graham, 1996). The observation could also be attributed to the fact that non-starch polysaccharides, by their gel-forming property, encapsulate or enclose the nutrients and thus make them unavailable to animals for absorption.

The report of this experiment is also in line with the earlier findings (Alu *et al*., 2009), which reported significant reduction in the digestibility of dry matter, neutral detergent fibre and hemicellulose when Nutrase xyla**®** was supplemented in low and high fibre diets of weaner pigs. The values obtained in this experiment are close to 71.92 - 85.15% for crude protein and 83.93 - 97.60% for ether extract reported by Ijaiya *et al*. (2012). There was improvement in the digestibility of nutrients due to the interaction of dietary fibre and enzyme supplementation in the diets and this agrees with the findings of Adeola and Olukosi (2008) who observed that high dietary fibre can only be properly digested and utilized in monogastric animals if exogenous enzymes are added to the diets. The authors maintained that when enzyme is added to feed, they break down the anti-nutritional factors that are present, many of which are not susceptible to digestion by the animals endogenous enzymes.

The non-significant variation in the digestibility of crude fibre and some of the fibre fractions (ADL and hemicellulose) due to the interaction of dietary fibre and enzyme (Table 6) suggests that the supplemented enzyme in the low and high fibre diets leveled the performance of birds in terms of digestibility. The result of these findings is supported by the earlier works (Feng *et al*., 1996; Oduguwa *et al*., 2001 and Petty *et al*., 2000).

CONCLUSION

Based on the conditions of this experiment, supplementing high level of sugarcane scrapping meal-based diets using Maxigrain® at 100ppm is safe and economical for starter chicks of quail.

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Table 1. Proximate and energy composition of sugarcane scrapping

Nutrient	**%**
Crude protein	8.25
Crude fat	3.36
Crude fibre	36.48
Ash	9.98
Dry matter	90.67
Nitrogen-free extract	67.40
[a]Energy (Kcal/kg ME)	2970.45

[a]Calculated from Pauzenga (1985)

Table 2. Proximate and chemical composition of starter quails (*Cortunix cortunix japonica*) diets (%)

Nutrients	**T5**	**$T5_{100}$**	**$T5_{200}$**	**T10**	**$T10_{100}$**	**$T10_{200}$**
Dry matter	90.16	92.26	91.89	91.57	90.24	89.18
Crude protein	28.37	28.46	28.29	28.49	28.25	28.25
Crude fibre	5.97	5.86	5.17	10.47	10.08	10.95
Ether extract	4.86	5.78	5.15	5.29	5.18	4.86
Ash	7.46	5.89	5.78	6.89	7.72	5.93
Nitrogen-free extract	53.34	54.01	60.78	59.33	58.85	60.96
Neutral detergent fibre	42.15	39.96	42.16	41.78	56.38	40.69
Acid detergent fibre	37.25	19.21	20.34	20.34	38.21	19.75
Acid detergent lignin	6.13	5.92	6.35	6.35	6.37	6.21
Hemicellulose	24.90	20.75	21.19	21.44	18.17	20.94
Cellulose	13.12	13.29	14.48	13.99	25.84	14.54
[a]Calcium	1.07	1.07	1.07	1.01	1.01	1.01
[a]Phosphorus	0.85	0.85	0.85	0.75	0.75	0.75
[b]Energy (Kcal/kg ME)	3137.41	3143.92	3098.11	3132.48	3110.46	3110.39

[a] Calculated from NRC (1979), [b] Calculated from Pauzenga (1985)

Table 3. Effect of Maxigrain® enzyme supplementation or dietary fibre on growth performance, water intake and economics of production of quail chicks

Performance indices	ENZYME TREATMENT MEANS					FIBRE TMENT MEANS			
	No Enzyme	**100ppm Enzyme**	**200ppm Enzyme**	**SEM**	**LOS**	**Low fibre**	**High fibre**	**SEM**	**LOS**
Live weight (g/bird)	6.69	6.82	6.62	0.07	NS	6.72	6.70	0.06	NS
Final live weight (g/bird)	54.59	54.67	55.87	0.33	NS	55.36	54.73	0.27	NS
Daily weight gain (g/bird/day)	2.28[b]	2.27[b]	2.33[a]	0.02	*	2.31	2.28	0.01	NS
Daily feed intake (g/bird/day)	12.68	13.21	13.03	0.23	NS	10.77[b]	15.18[a]	0.18	*
Feed conversion ratio	5.58	5.81	5.59	0.12	NS	4.67[b]	6.65[a]	0.10	*
Protein efficiency ratio	0.65	0.65	0.66	0.01	NS	0.77[a]	0.53[b]	0.01	*
Water intake (ml/bird/day)	107.10[b]	147.50[a]	91.20[c]	14.52	*	128.20	102.40	11.86	NS
Economics of production parameters									
Feed cost/kg (₦/kg)	90.64	90.81	90.99	-	-	96.79	84.48	-	-
Feed cost/weight gain (₦/kg)	16.85	16.43	17.02	0.34	NS	20.79[a]	12.75[b]	0.59	*
Cost of production (₦/bird)	38.49	37.37	39.81	0.72	NS	48.05[a]	29.06[b]	0.59	*
Revenue (₦)	227.60[b]	227.40[b]	233.60[a]	2.46	*	231.10	228.00	1.42	NS
Gross margin(₦)	189.13	190.00	193.81	2.88	NS	183.03[b]	198.94[a]	1.66	*

a,b,- Means on the same row bearing different superscript differ significantly ($P < 0.05$), **NS** = No significant difference ($P > 0.05$), **LOS** = Level of significant difference

Table 4. Effects of Maxigrain® enzyme supplementation and dietary fibre on growth performance, water intake and economics of production of starter quails

Performance indices	Main		Treatment		Means			
	T5	**$T5_{100}$**	**$T5_{200}$**	**T10**	**$T10_{100}$**	**$T10_{200}$**	**SEM**	**LOS**
Live weight (g/bird)	6.56	6.82	6.78	6.82	6.81	6.47	0.10	NS
Final live weight (g/bird)	55.28	54.68	56.10	53.90	54.66	55.63	0.47	NS
Daily weight gain (g/bird/day)	2.32	2.27	2.35	2.24	2.28	2.33	0.03	NS
Daily feed intake (g/bird/day)	10.89	10.73	10.68	15.47	15.69	15.38	0.32	NS
Feed conversion ratio	4.70	4.72	4.58	6.46	6.89	6.60	0.18	NS
Protein efficiency ratio	0.76	0.78	0.78	0.55	0.52	0.53	0.02	NS
Water intake (ml/bird/day)	109.40	170.20	104.90	104.90	124.90	77.60	20.54	NS
Mortality (%)	0.00	0.00	10.00	5.00	10.00	0.00	-	-
Economics of production parameters								
Feed cost/kg (₦/kg)	96.79	96.96	97.14	84.48	84.65	84.83	-	-
Feed cost/weight gain (₦/kg)	20.60	20.56	21.20	13.10	12.30	12.85	0.48	NS
Cost of production (₦/bird)	47.67	46.77	49.79	29.31	27.98	29.90	1.02	NS
Revenue (₦)	231.50	227.20	234.50	223.80	227.5	232.80	2.46	NS
Gross margin (₦)	183.83	180.48	184.74	194.44	199.52	202.85	2.88	NS

a,b- Means on the same row bearing different superscript differ significantly ($P < 0.05$), **NS** = No significant difference ($P > 0.05$), **LOS** = Level of significant difference

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Table 5. Effect of Maxigrain® enzyme supplementation or dietary fibre on coefficient of nutrient digestibility by starter quails (%)

Nutrients	ENZYME TREATMENT MEANS					FIBRE TREATMENT MEANS			
	No Enzyme	100ppm Enzyme	200ppm Enzyme	SEM	LOS	Low fibre	High Fibre	SEM	LOS
Dry matter	50.81 [b]	58.08 [a]	62.10 [a]	1.65	*	63.36 [a]	50.63 [b]	1.34	*
Crude protein	72.12 [b]	75.57 [a]	79.95 [a]	2.22	*	78.80 [a]	72.97 [b]	1.81	*
Crude fibre	69.90 [b]	77.90 [a]	85.30 [a]	2.22	*	80.50	74.90	2.64	NS
Ether extract	68.00	72.50	74.90	3.06	NS	73.50	70.10	2.50	NS
Nitrogen-free extract	30.90 [b]	30.00 [b]	38.80 [a]	1.90	*	36.90 [a]	29.70 [b]	1.55	*
Neutral detergent fibre	35.60 [b]	52.50 [a]	46.10 [a b]	2.22	*	54.20 [a]	35.30 [b]	1.81	*
Acid detergent fibre	53.00 [a]	38.80 [b]	38.20 [b]	4.20	*	52.10 [a]	34.60 [b]	3.43	*
Acid detergent lignin	29.50 [b]	45.40 [a]	49.10 [a]	4.20	*	33.20 [b]	49.40 [a]	3.43	*
Hemicellulose	56.20 [b]	56.20 [b]	63.70[a]	1.94	*	65.10 [a]	52.30 [b]	1.58	*
Cellulose	41.30	47.80	55.70	4.46	NS	47.70	48.90	3.6	NS

a,b- Means on the same row bearing different superscript differ significantly ($P < 0.05$), **NS**- No significant difference ($P > 0.05$), **LOS**- Level of significant difference.

Table 6. Effects of Maxigrain® enzyme supplementation and dietary fibre on coefficient of nutrient digestibility by starter quails (%)

Nutrients	MAIN TREATMENT MEANS							
	T5	**$T5_{100}$**	**$T5_{200}$**	**T10**	**$T10_{100}$**	**$T10_{200}$**	**SEM**	**LOS**
Dry matter	59.25	62.75	68.10	42.37	53.42	56.11	2.33	NS
Crude protein	75.69	78.81	91.91	68.56	72.34	78.00	3.14	NS
Crude fibre	77.10	78.60	85.80	62.10	77.30	85.20	4.57	NS
Ether extract	69.30	75.00	76.00	66.80	69.70	63.60	4.32	NS
Nitrogen-free extract	30.10^{b}	32.20^{b}	48.30^{a}	31.80^{b}	27.90^{c}	29.40^{bc}	2.69	*
Neutral detergent fibre	51.70^{a}	51.40^{a}	59.40^{a}	49.40^{b}	53.60^{a}	32.80^{c}	3.14	*
Acid detergent fibre	37.30^{b}	37.60^{b}	35.70^{b}	48.40^{a}	35.70^{b}	40.00^{b}	5.93	*
Acid detergent lignin	22.80	32.60	44.20	36.20	58.10	54.00	5.94	NS
Hemicellulose	62.60	64.20	68.60	49.80	48.20	58.90	2.74	NS
Cellulose	51.40	39.50	52.10	31.20	56.10	59.30	6.31	*

a, b- Means on the same row bearing different superscript differ significantly ($P < 0.05$)**, NS-** No significant difference ($P > 0.05$), **LOS-** Level of significant difference