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EFFECT OF PROTEASE SUPPLEMENTATION ON THE PERFORMANCE AND DIGESTIBILITY OF BROILERS

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Premise of the study was to validate the growth promoting effect of protease on the performance and to explore its digestion enhancer effect in broiler chicks. For this purpose 4 commercial diets were divided into two types (low and high density) and were enriched with protease using a completely randomized design with 4 replicates per diet having 10 chicks each having totaled 200 poultry broiler chickens (day-old). Until 14 days, no effects were observed on chicks however at day 14; little variations were observed on weight gain, feed intake and FCR (feed conversion ratio) among the enzyme enriched diets. At day 28, prominent response of protease supplementation in low protein was procured. The chicks gained 10.06 and 8.0 % more weight on CFP1 than CFG1 and CFG2, respectively. Similar response in FCR was observed and was found to be 0.20 and 0.15 points better on CFP1 than on CFG1 and CFG2, respectively. However, CFP2 failed to show protease efficacy declining the weight gain by 23.01 % while the FCR by 0.49 points as compared with CFP1. This suggested that the nature of feed ingredients in the diets is important for obtaining maximum benefit of protease supplementation. The overall performance indicated significant response to enzyme supplemented diets. Among the low protein diets CP digestibility remained unchanged but they were different in sparing AME (apparent metabolizable energy) for chicks. The CFP2 spared 98.21 kcal/Kg more AME than CFP1. However, this increased AME values did not help to boost the performance and was attributed to the widening ratio between CP and AME. These results demonstrated that the overall growth response of chicks was improved on low protein diet enriched with protease. It showed higher CP digestibility and AME values than good quality diets. However, the inconsistent results observed within the two types of diets revealed that the nature of diets might have influenced the efficacy of protease.

Key words: Broilers, digestibility, protease, FCR, Feed intake.

Introduction. In the feed industry the major improvements in terms of increased birds performance, enhanced nutritional value of ingredients and minimize feed cost is achieved by the supplementation of the exogenous enzymes. Enzymes mostly used in the poultry feed industry are phytases, proteases and amylases[14, 18]. Several researches have been conducted on the efficacy of addition of enzymes to the broiler chickens feed that shown better utilization of nutrients resulted in improved performance of body growth [2, 21]. Exogenous enzymes supplementation in broiler diets has gained popularity due to better nutrients utilization in low protein fed diets [5, 19].

The enzymes are produced by the poultry birds itself inside the body for the degradation of different feed particles but are not sufficient especially in the earlier age to support the optimum digestion of available substrate in the digestive tract. This necessitates the supplementation of enzymes to improve bird's performance. Protease has improved the consumption of feed nutrients and degrades anti-nutrients of broiler diets [10, 17]. Recently Bacillus licheniformis origin Protease is gaining popularity in low protein broiler diets due to its ability to convert large protein molecules for improved utilization of nutrients and amino acids in the gut [3].

In other experiments [12, 24, 25] performed a study to analyze the effect of supplementation of proteases and amylases on the degradation of nutrients and its effect on 1st fifteen days of poultry body growth. The supplementation of exogenous enzymes doesn't show any improvement in the FCR and body weight gain of broilers. They also evaluate the effect of exogenous addition of the protease into broiler grower diet on growth parameters (body weight and feed conversion ratio) and carcass characteristic (carcass weight and yield). The trial revealed no impact on broiler growth when enzymes were added to low protein feed and also on carcass weight.

Barekatainet et al.[4] demonstrated an experimental trial to analyse the nutritive values of the feed which contain sorghum distileer dried grains when added with protease and xylanase enzymes,this study were conducted on poultry broilers birds. After the study of 21 days it was found that the addition of protease enzyme increased consumption of feed and body weight gain of broilers by ($p<0.001$).

Protease in the form of Poultry Grow-250 has been claimed to ameliorate the digestion of CP. It is hypothesized that the dietary Poultry Grow-250 will enhance the protein digestion of low CP diets by assisting the digestive enzymatic activities and will compensate the growth to that having high CP levels. It is also expected to assist the system in partial degrading of anti-nutrients that may hamper the biological activities. The purpose of study is to investigate the growth promoting effects of protease (Poultry Grow-250) supplementation on the broiler chick's performance and protease supplementation as a digestion enhancer in broiler chicks.

Materials and Methods. This study was conducted to investigate the effect of protease supplementation on the performance and nutrients utilization in broiler chicks. The experimental trial was carried out at the Directorate of Livestock, Research and Development under the supervision of Animal nutrition department, The University of Agriculture, Peshawar (UAP) Pakistan.

Rearing and management practices. A total of 200 poultry broiler chickens (day-old) of K&N Company was procured from the local market, Peshawar. All chicks were brooded in an electrically heated battery brooder for a period of 5 days and were fed ad libitum commercial available starter diet, with free access to water. The experimental trial was last for 28 days and the chicks were given diet from day 7 (1-st day of trial) to 28 days of trial. Routine schedule of vaccination was practiced during the trial.

Experimental design and feeding practices. The poultry chickens were brooded on the commercial starter diets during the first 5 days. After brooding (at day-5), all chicks were weighed individually and a total of 120 chicks of similar weight and size were randomly distributed among 4 treatment groups having each 3 replicates of 10 chicks per each replicate. The protease (Poultry Grow-250) was supplemented in these diets 250 g per ton of feed (company recommended dose). The amount of protease was mixed in the ration manually. The treatment group in the experiment were 4 diets consist of 2 poor feeds (PF-1, PF-2) and 2 good feeds (GF-1 and GF-2).The selected chicks was preconditioned on the experimental diets (ad libitum) for 2 days (during 5 to 7 days) of age. Total duration of the experimental trial was from1 to 35 days of trial. Trial period was from day 7 to day 35.

Measuring parameters and data collection. At day 7, the initial average body weight of chicks was recorded. During the experiment, weekly average body weight and feed intake (F1) on day 7, 14, 21 and 28 was recorded. The weekly average body weight gain (BWG) was calculated by subtracting the initial BW at the start of week from the BW recorded at the end of each week. The feed intake in each week were calculated from the quantity of feed offered minus the feed refused while (FCR) was calculated as a unit weight gain on a unit feed intake.

At day 28 of the experiment, average body weight and leftover feed at each replicate was weighed. For the determination of nutrient utilization, total feces collection method was used. The faeces from each replicate during the last two day of experiment was collected and weighed. A sample of 10% was frozen until analysed for the proximate analysis (especially crude protein and energy). The feed and poultry chicks faeces samples was analysed particularly for (DM), (CP) contents. For the determination ofenergy content of the samples the method of bomb calorimeter were used.

Statistical Analysis. Microsoft Excel Worksheets was used for entering and sorting the data obtained from the trial and lab analysis. Basic statistics was applied to make it ready for the final analysis. Analysis of variance (ANOVA) tool was used to analyze the data using general linear model (GLM) procedure of the Statistical Analysis System [20]. Means was separated by the application of Duncan multiple range tests. A probability (*P)* value of less or equal to 0.05 was considered statistically significant.

Main results of the study. Overall average weight gain, feed intake and feed efficiency from 7 to 35 days of age. The overall performance from day 7 to 35 days of age in term of feed conversion ratio, weight gain and feed intake are shown in Table 1. The weight gain indicated highly (P<0.01) significant response to enzyme supplemented diets. The response to enzyme supplementation was highest (1466.53 g/chick) on CF_{P1} among all diets. The chicks on CF_{P1} were 233.15 g per chick higher in weight gain than chicks on CF_{P2} (1466.53 vs 1233.38 g/chick). The response of protease supplementation in low protein diet was also higher than good quality diets. The weight gain in chicks on CF_{P1} (1466.53 g/chick) showed an enhancement of 77.24 g and 141.15 g per chicks than chicks on CF_{G1} (1389.29 g/chick) and CF_{G2} (1325.38 g/chick), respectively.

The consequence of giving various enzyme supplemented diets was significant (P<0.01) on the overall feed intake. The CFG2 determined to be a good quality diet showed the lowest (P<0.05) feed intake of 2285.42 g per chicks when enriched with protease. This diet CF_{G2} in comparison to CF_{G1} revealed a decline of 6.71 g/chick/day in feed intake (2426.39 vs 2285.42 g/chick for 21 days).The chicks on low quality protein CF_{P2} diet consumed the highest (P<0.05) feed of 2556.78 g/chick. Supplementation of protease to CF_{P2} diet was not effective when compared with CF_{P1}. The broiler chicks reared on CF_{P1} enriched with protease consumed 5.73 g/chick/day less feed than chicks on CF_{P2} and was similar to the feed intake of chicks on good quality CF_{G1} diet.

The response of enzyme supplemented diets on the overall feed conversion ratio during 7 to 35d of age was highly (P<0.01) significant (Table 1). Enzyme supplementation in both good and poor commercial diet enhanced FCR. It was the best (P<0.05) in chicks on the low protein enzyme supplemented CF_{P1} diet and showed 1g gain in weight for each 1.66 g feed consumed. The FCR on low protein CF_{P1} diet when supplemented by protease showed an enhancement of 0.41 points over low protein CF_{P2} diet (1.66 vs 2.07).Among the good quality diets the enzyme supplementation tended to enhance FCR in CF_{G2} but statistically not significantly different than CF_{G1} (1.72 vs 1.75). The poorest (P<0.05) FCR of 2.07 was revealed in chicks on CF_{P2} that determined to be low protein diet.

Crude Protein (CP) digestibility and Apparent Metabolizable Energy (AME). The results pertaining to the fecal crude protein (CP) digestibility and (AME) values of recorded in trial are presented in Table 2. Protease supplemented feeds demonstrated significant (P<0.05) effect on the CP digestibility. Digestibility of crude protein in chicks on both low protein diets was higher (P<0.05) than chicks on good quality diets. The chicks retained 69.49 and 70.27 % CP on CF_{P1} and CF_{P2}, respectively which was approximately 2 to 3.5 % higher than good quality diets. Among the low protein diet, protease was equally effective in improving the CP digestibility. Similar was the case for protease supplementation in good quality diets, however, the chicks on these diets was lower in retaining the CP in their body as compared to diets determined to be lower in protein content than NRC [16] recommendation.

The AME values was revealed to be significantly (P<0.01) affected by diets enriched with protease (Table 2). The response of protease supplementation in providing AME to the chicks was generally higher in low protein diets than good

Table 1 – **The effect of different commercial ration on the overall feed conversion ratio, average body weight gain, feed intake of poultry broiler chicks at 28th day of trial**

Diets[1]	Weight gain, g	Feed intake, g	Feed conversion ratio
CF_{G1}	1389.29b±40.59	2426.39b±45.14	1.75b±0.04
CF_{G2}	1325.38b±50.18	2285.42c±26.02	1.72bc±0.05
CF_{P1}	1466.53a±20.27	2436.52b±16.42	1.66c±0.04
CF_{P2}	1233.38c±41.99	2556.78a±38.72	2.07a±0.05

Means with the same letter in each column are not significantly different at 0.05

[1]represents commercial broiler diets where CF_{G1} and CF_{G2} satisfy while the CF_{P1} and CF_{P2} are below the minimum require-

Table 2 – **The effect of different commercial rations on the digestibility of crude protein and AME (apparent metabolizable energy) in poultry broiler chicks**

Diets[1]	CP (%)	AME (kcal/kg)
CF_{G1}	$66.49^{b}\pm0.95$	$2992.09^{bc}\pm36.74$
CF_{G2}	$67.79^{b}\pm0.72$	$2976.08^{c}\pm25.25$
CF_{P1}	$69.56^{a}\pm0.58$	$3050.77^{b}\pm14.33$
CF_{P2}	$70.27^{a}\pm0.62$	$3148.98^{a}\pm48.99$

Means with the same letter in each column are not significantly different at 0.05

[1]represents commercial broiler diets where CF_{G1} and CF_{G2} satisfy while the CF_{P1} and CF_{P2} are below the minimum requirement of NRC [16].

quality diets. The AME value observed for low protein CF_{P1} diet was similar to the good quality CF_{G1} diet (3050.77 vs 2992.09 kcal/kg). However, the protease supplementation in the second low protein CF_{P2} diet revealed the highest ($P<0.05$) AME values of 3148.98 kcal/kg among all diets. Comparing the low protein diets, the chicks on CF_{P2} diet obtained 98.21 kcal per kg more AME than chicks on CFP1 diet (3148.98 vs 3050.77 kcal/kg).The efficacy of protease in sparing AME for chicks on CF_{G2} was similar to the chicks on CF_{G1} (2976.08 vs 2992.09 kcal/kg) but were less ($P<0.05$) than the lesser protein diets. CF_{G2} was 74.69 and 172.9 kcal/kg reduced provider of apparent metabolizible energy to poultry broiler chicken than CF_{P1} and CF_{P2}, respectively.

Discussion. Poultry Grow-250 consisted of protease had been claimed to have growth promoting and digestion enhancer effect in broiler chicks. It was assumed that this protease would enhance the availability of wide range of nutrients especially protein and amino acids in low density diets and would expose them for further hydrolysis resulting in performance similar to the high density diets. The hypothesis of ameliorating the CP digestion in low protein diets by dietary protease supplementation resulting in improved growth performance was confirmed.

Weekly growth, feed intake and feed conversion ratio

At day 14, the chicks on enriched protease CF_{G2} diet consumed less feed than chicks on CF_{G1}. The tendency towards improvement in FCR on CF_{G2} was attributed to the decreased feed intake.

Among the low protein diets, the FCR on CF_{P1} tended to improve as compared to CF_{P2} diet. At day 21, the effect of protease supplementation became more clarified. The response of dietary protease in both low protein diets on weight gain was similar to the good quality CF_{G1} diet. Among the good quality diets, the weight gain was declined by 8.20 % on CF_{G2} when compared with CF_{G1}. This might be the result of decreased feed intake observed to be 7.11 g/chick/day less on CF_{G2} than CF_{G1}. Similarly the protease supplementation in low protein CF_{P2} diet did not show its efficacy in improving the FCR. The increased feed intake on CF_{P2} could be the reason of poor FCR. This envisaged that the efficacy of dietary protease might vary from diet to diet. Kocher et al. [15] observed variations in performance due to dietary formulation when enriched with proteases suggested that the efficacy of protease might be depended upon the feed ingredients used in the balanced ration. Thus this study suggested that the nature of the feed ingredients and their adjustments in the diets is of upmost important to obtain maximum benefit of protease supplementation.

At day 28, prominent response of protease supplementation in low protein was determined. The chicks gained 10.06 and 8.0 % more weight on CF_{P1} than CF_{G1} and CF_{G2}, respectively. Similar response in FCR was observed and was found to be 0.20 and 0.15 points better on CF_{P1} than chicks on CF_{G1} and CF_{G2}, respectively. However, enzyme supplementation in CF_{P2} failed to show its efficacy declining the weight gain by 23.01 % while the FCR by 0.49 points when compared with the other low protein CF_{P1} diet. It demonstrated that a diet obviously showing higher CP value might not necessary meant to have potential of improved growth performance. Feed ingredients having the same total amino acids would be different in sparing the digestible amino acids content due to differences in the digestibility coefficient. Another possible reason of reduced growth performance on the high density diets might be the presence of anti-nutrients in the diets that might have rendered the biological activity in the gut resulted in reduced growth performance [1].

Overall body weight gain, Feed intake and Feed conversion ratio. The overall performance in terms of weight gain, feed intake and FCR indicated significant response to enzyme supplemented diets. The broiler chicks on low protein CF_{P1} diet enriched with protease revealed 11.10 g/chick/day more weight gain, 0.41 points enhancement in FCR and consumed 5.73 g/chick/day less feed than chicks reared on the other low protein CF_{P2} diet. The low protein CF_{P1} diet enriched with

protease also showed an enhancement of 3.68 g/chick/day and 6.72 g/chick/day more weight than chicks on CF_{G1} and CF_{G2}, respectively while consuming the similar feed intake indicated that the supplementation of protease might be more beneficial in low protein diet than diets having higher CP content. The chicks on CF_{P1} showed 1g gain in weight for each 1.66 g feed consumed. These results coincided with the findings of Torres et al. [22] who investigated that broiler chicks on low protein diets supplemented with enzymes resulted similar response to those fed on the normal diets. Other research work conducted by Fru-Nji et al. [9] had shown improvement in FCR and weight gain in low protein diets supplemented with dietary protease.

Many researchers had been determined that growth performance varied with the dietary CP levels. The performance was not supported when low protein diets were fed compared to high protein diets. Especially reduction in growth and poor feed efficiency had been reported in chicks fed on low protein diets [5, 19]. In the study, the growth performance was decreased when the CP level in the diet was declined from 23 to 19 %. However, when low protein diets were enriched with enzymes showed similar response to chicks fed on normal diets [22]. Generally improving the nutrients utilization through enzymes supplementation not only enhanced the performance [6, 7, 8] but also lessened the environmental pollution by minimizing the nutrients wastage.

Digestibility of CP and apparent metabolizable energy (AME). The chicks on low protein diets retained more CP and procured more AME than good quality diets. As feed intake was observed the same among the low protein and high protein diets, it indicated that the enhanced growth performance on low protein diets enriched with protease might have been due to improved nutrients digestibilities. Similar to our results, Ferket et al. [7] found improved performance and minimized nutrient wastage and attributed it due to increased digestibility and absorption of nutrients when supplemented by enzymes. Wang et al. [23] observed improvement in the breast meat which was attributed to the enhanced amino acids utilization when enriched with akeratinase-based feed additive named Versazyme.

Abdollahi et al. [1] speculated that the protein matrix around the starch granule reduced the access of enzyme to the starch granule and mostly inhibit the complete starch digestion in the small intestine. Han and BeMiller [11] determined that protease supplementation help assist in partially degrading protein matrix thereby expose that starch granules for more amylolytic activity. These results assumed that the protease might have improved the proteolysis as well as the starch digestibility by disrupting the starch-protein complexes thus resulting in improved CP and energy digestibility.

Among the low protein diets CP digestibility remained unchanged but they were different in sparing AME for chicks. The CF_{P2} diet spared 98.21 kcal/Kg more AME for chicks than on CF_{P1} diet. However, this increase in AME on CF_{P2} did not help to boost the performance and was attributed to the widening ratio between CP and AME. Similar results were determined that unbalanced diets by CP and energy i.e. with low CP and high energy led to more abdominal fat and resulted less breast meat. The possible mechanism might be the increased lipogenesis in the body where the extra energy is deposited in the carcass in the form of fat rather than to deposit the protein in the carcass resulted in low carcass yields [19].

Among the quality diets the efficacy of protease in retaining CP and sparing AME for chicks on CF_{G2} was similar to the chicks on CF_{G1} but was lower than the low protein diets. The CF_{G2} was 74.69 and 172.9 kcal/kg less provider of AME to the chicks than CF_{P1} and CF_{P2}, respectively. The exact reason of why the protease did not show its efficacy in the high density diets is yet to be elucidated. However, the possible reason might be that the chicks on high quality diets were already getting sufficient amount of protein needed for the body. So any further improvement in the nutrients digestibility that could have taken place in the digestive tract by protease supplementation was less beneficial. Another possible explanation is that generally the manufacturer added enzymes to maximize the feed efficiency of chicks. Literature revealed [13] that protease had a closed association with other enzymes and lost its efficacy in the presence of xylanase and phytase. The comparatively low response in chicks on high protein diets enriched with protease might be the result of this phenomenon.

Briefly, the overall growth response of chicks was improved on low protein diet enriched with protease. It showed higher CP digestibility and AME values than good quality diets. However, the inconsistent results observed within the two types of diets revealed that the nature of diets might have influenced the efficacy of protease. The poor performance on CF_{G2} (good quality) and CF_{P2} (poor protein) diets was attributed to the widening ratio between the CP and AME value. The decline in AME value on good quality CF_{G2} diet was attributed to the reduced feed intake might have negatively affected the growth performance.

Conclusions. The efficacy of supplementing protease (Poultry Grow-250) in the good and low

protein commercial diets was tested to investigate its influence as a growth promoter on the growth performance and nutrient utilization of broiler chicks. The following conclusion and recommendation were drawn from the domain of present study.

- The overall growth response of chicks was improved on low protein diet enriched with protease.
- The efficiency of protease supplementation depended on the nature of diets, as protease supplementation in one commercial low protein diet improved the growth but in other did not support the optimum growth.
- The feed intake was decreased on the commercial good quality CF_{G2} while the low protein CF_{P2} diet supplemented by the protease, it was worse on the other low protein diet.
- The protease supplementation negatively affected the feed intake on good quality CF_{G2} diet even from the first week of experiment.
- The observed improvement in FCR on CF_{G2} could be the result of reduced feed intake.
- The low protein diets showed higher CP digestibility and AME values than good quality diets.
- The decline AME value on good quality CF_{G2} diet was attributed to the reduced feed intake might have negatively affected the growth performance.
- The protease supplementation showed unbalance between the CP and AME value on CF_{G2} (good quality) and CF_{P2} (poor protein) diets.

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Вплив доповнення раціонів протеазою на продуктивність та перетравність поживних речовин кормів у бройлерів

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Метою дослідження було підтвердити зростаючий стимулюючий вплив протеази на продуктивність та дослідити її вплив на перетравлення кормів у курчат-бройлерів. Для цього 4 промислові групи комбікормів було розділено на два типи (низької та високої щільності) та збагачено протеазою, використовуючи повністю рандомізовану конструкцію із 4-ма повторами на раціон, по 10 пташенят, кожна з яких налічувала 200 курчат-бройлерів добового віку. До 14-добового віку жодних ефектів у пташенят не спостерігали, однак на 14 добу серед раціонів, збагачених ферментами, з'явилися невеликі відмінності щодо збільшення ваги, споживання корму та коефіцієнта конверсії корму (FCR). На 28 добу було відмічено виразну реакцію на додавання протеази у групи з низьким вмістом білка. Пташенята набирали на 10,06 та 8,0 % більше ваги у групі CF_{P1}, ніж CF_{G1} та CF_{G2} відповідно. Аналогічну відповідь спостерігали для коефіцієнта конверсії корму і виявили, що у групі CF_{P1} на 0,20 та 0,15 балів краще, ніж у CF_{G1} та CF_{G2} відповідно. Однак у групі CF_{P2} не виявилася ефективність протеази, знизивши приріст ваги на 23,01 %, тимчасом коефіцієнт конверсії корму – на 0,49 пункту порівняно з CF_{P1}. Це свідчить про те, що характер кормових інгредієнтів у раціонах є важливим для отримання максимальної користі від протеазних добавок. Загальна ефективність довела значну реакцію на раціони, доповнені ферментами. Серед раціонів із низьким вмістом білків засвоюваність сирого протеїну (СР) залишалася незмінною, однак вони вирізнялися порівняно з обмінною енергією (АМЕ) для пташенят. CF_{P2} зекономив на 98,21 ккал/кг більше АМЕ, ніж CF_{P1}. Однак це підвищення значень АМЕ не допомогло підвищити продуктивність і пояснювалося збільшенням співвідношення між СР та АМЕ. Доведено, що загальна реакція на зростання пташенят покращувалася на раціоні з низьким вмістом білка, збагаченим протеазою. Він показав кращі показники засвоюваності СР та АМЕ, ніж раціони хорошої якості. Однак непослідовні результати, виявлені в межах двох типів живлення, довели, що природа раціонів могла вплинути на ефективність протеази.

Ключові слова: бройлери, засвоюваність, протеаза, коефіцієнт конверсії, споживання корму.

Влияние дополнения рационов протеазой на производительность и переваримость питательных веществ корма у бройлеров

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Целью исследования было подтвердить растущее стимулирующее влияние протеазы на производительность и исследовать ее влияние на переваривание кормов у цыплят-бройлеров. Для этого 4 промышленные группы комбикормов были разделены на два типа (низкой и высокой плотности) и обогащены протеазой, используя полностью рандомизированную конструкцию с 4-мя повторами на рацион, по 10 птенцов, каждая из которых насчитывала 200 цыплят-бройлеров (суточного возраста). До 14-суточного возраста никаких эффектов у птенцов не наблюдали, однако на 14 сутки среди рационов, обогащенных ферментами, появились небольшие различия по увеличению веса, потреблению корма и коэффициента конверсии корма (FCR). На 28 сутки была отмечена отчетливая реакция на добавление протеазы в группы с низким содержанием белка. Птенцы набирали на 10,06 и 8,0 % больше веса в группе CF_{P1}, чем CF_{G1} и CF_{G2} соответственно. Аналогичный ответ наблюдали для коэффициента конверсии корма и выявили, что в группе CF_{P1} на 0,20 и 0,15 баллов лучше, чем в CF_{G1} и CF_{G2} соответственно. Однако в группе CF_{P2} не выявили эффективности использования протеазы, поскольку привес снизился на 23,01 %, тогда как коэффициент конверсии корма –на 0,49 пункта по сравнению с CF_{P1}. Это свидетельствует о том, что характер кормовых ингредиентов в рационах является важным для получения максимальной пользы от протеазных добавок. Общая эффективность доказала значительную реакцию на рационы, дополненные ферментами. Среди рационов с низким содержанием белков усвояемость сырого протеина (СР) оставалась неизменной, но они отличались по сравнению с обменной энергией (АМЕ) для птенцов. CF_{P2} сэкономил на 98,21 ккал/кг больше энергии, чем CF_{P1}. Однако это повышение уровня АМЕ не помогло повысить производительность и объяснялось увеличением соотношения между СР и АМЕ. Доказано, что общая реакция на рост птенцов улучшалась на рационе с низким содержанием белка, обогащенным протеазой. Он показал более высокие показатели усвояемости СР и АМЕ, чем рационы хорошего качества. Однако непоследовательные результаты, обнаруженные в пределах двух типов питания, доказали, что природа рационов могла повлиять на эффективность протеазы.

Ключевые слова: бройлеры, усвояемость, протеаза, коэффициент конверсии, потребление корма.