

EFFECT OF GUANIDINO ACETIC ACID WITH OR WITHOUT AMINO ACIDS AND FEED ENZYME ON PERFORMANCE, CARCASS CHARACTERISTICS AND ECONOMIC EFFICIENCY IN BROILERS FED A CORN/SOY- BASED DIETS

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SUMMARY

The aim of this study was to evaluate the effect of adding Guanidino acetic acid mixture (GAA), Amino Acids (A.A.; Meth. + Lys. + Thr. + Arg.) or both (GAA + A.A.) and β -mannanase (Hemicell HT) to a typical corn soybean meal diets on growth performance, carcass characteristics and economical efficiency of broiler chicks. A total number of 225 day old Hubbard broiler chicks were classified into 5 equal groups, each was subdivided into 3 replicates with 15 chicks. The control group was fed basal (starter, grower and finisher) diets without supplementation, while the other groups (T₁), (T₂), (T₃) and (T₄) were fed the basal diets supplemented with 600mg G.A.A/kg.; 1450 mg A.A. kg. diet or both (600mg GAA + 1450 mg A.A.) and 300mg β -mannanase/kg diet, respectively. Diets and water were provided throughout the experimental period (1-35) days of age. The results indicated that: Live body weight, daily weight gain and daily feed intake for the broiler chicks fed basal diets supplemented with GAA + A.A., (T₃) or β -mannanase, (T₄) reflected the highest significant results than those fed control basal diets at 1-35 days of age. Chicks fed T₁, T₂ and T₃ diets had significant better FCR compared with those fed control or T₄ diets. The best protein (PCR), energy (ECR) conversion ratio and the highest performance index (PI) and production efficiency factor (PEF) were recorded for the group supplied with GAA + A.A., (T₃) compared with other dietary treatments. The group of chicks fed AA mixture recorded significantly higher percentages of dressing and ready to look comparing to control group. While, the same group (T₂) showed lower value of giblets % as comparing to unsupplemented treatment. Economical evaluation, the chicks fed basal diets supplemented with different feed additives (T₁₋₄) supported the calculated economic efficiency percentages compared to control group and the corresponding increasing values were 15.73, 1.35, 35.89 and 14.14% respectively.

Keywords: *CreAmino, Amino Acids, B-mannanase, broiler and economic efficiency.*

INTRODUCTION

Guanidine acetic acid (GAA) is considered as the only immediate precursor for creatine in the body of animals. Moreover, it is more stable and less expensive than creatine and it could make a good additive for poultry Joroslav *et al.* (2014) and Mousavi *et al.* (2013).

In Egypt, poultry feed is consisting mainly of corn and soybean meal and there is a ban of animal by-product use in poultry industry. Therefore, poultry feed might be a deficiency in the semi-nutrient, creatine, since corn and soybean (plant origin) are lacking in this nutrient (Ringet *et al.*, 2007) and among be thus deficient in all- vegetable diets. GAA as a creatine source is more stable and less expensive than creatine itself (Baker, 2009). Moreover, GAA could be beneficial in broiler diets, because it may be able to spare arginine, which is considered as the fifth limiting amino acid in typical corn-soybean diets for broilers (Dilger *et al.*, 2013) and GAA play central roles in energy metabolism (Lemme *et al.* 2007b and 2010). Recently, (Michiels *et al.* 2012 and Mousavi *et al.*, 2013) suggested that supplementing GAA to vegetable diets improves broilers performance and carcass characteristics as well as improve FCR and energy efficiency.

On the other hand, formulating diets based on amino acids allowed nutritionists to formulate diets closer to the various classes of poultry requirement, thereby reducing waste and cost has been the subject of numerous investigation.

However, due to technological advances some essential amino acids (Methionine (Meth.), Lysine (Lys.), Threonine (Thr.) and Arginine (Arg.)) have become commercially available in recent years and there is a good possibility that others will be available in the future. DL-methionine is normally considered to be the first limiting amino acid (LAA) in poultry diets. In general, amino acids balance and nitrogen retention are improved by methionine supplementation. However, supplementation of lysine (Second, LAA) and methionine to practical poultry diets improved production performance, only if no other amino acid is limiting (Harms and Ivey, 1993). Additionally, formulating broiler diets to be adequate in threonine (Third, LAA) is relatively critical, because threonine deficiency may decrease efficiency of lysine utilization. Lysine and threonine have been shown to interact in such a way that broiler body weight gain and breast fillet yields are increased (Canogullari *et al.* 2009 and Baylan *et al.* 2006). Additionally, Barkley and Wallis (2001) observed that, increasing dietary threonine concentration to 7.29/kg improved growth performance and feed conversion ratio of broilers.

In addition, it is well documented that enzyme supplementation in poultry diets can improve efficiency of converting low- quality protein feedstuffs into high-quality broiler meat protein for humans (Bedford and Morgan, 1996). Daskiran *et al.* (2004) reported that B-mannanase improved feed: gain, water: feed ratio and total dry fecal output of broilers by degrading B-mannans. Jackson *et al.* (2004) demonstrated that B-mannanase inclusion at 80 million units per tonne improved both body weight gains and feed conversion of broilers fed corn/soybean diets.

Therefore, the objective of the present study was to evaluate the efficacy of a supplementing GAA, mixture of Amino Acids (Meth. + Lys. + Thr. + Argi) or both (GAA + AA) and β -mannanase (trade name Hemicell HT®, Elanco) to corn soybean meal diets, on performance, carcass characteristics and economic efficiency of broiler chickens from 1 to 35 days of age.

MATERIALS AND METHODS

Materials:

- a- Cre AMINO: Contains 94% Guanidine Acetic Acid (GAA), and purchased from Evonik Industries.
- b- Methionine
Lysine
Threonine
Arginine
- c- β -mannanase: -Hemicell HT®

Birds, Diets and treatments:

A total of 225, day – old Hubbard male broiler chicks were obtained from a commercial hatchery. Chicks were housed in battery cages and divided equally into 5 groups of 45 chicks in 3 replications, 15 bird each.. Birds were vaccinated for Newcastle disease virus on d 8 and 18, for infections bronchitis on d 1 and 14, and for Gumboro disease on d 15 and 24. Chicks were fed corn-soybean based diets during the starter (1-4 days), grower (15-28 days) and finisher (29-35 days old) phases of growth.

The experiment consisted of 5 dietary treatments as follow:

- 1- Control (C), corn-soybean-based diet.
- 2- C supplemented with 600mg GAA/kg diet.
- 3- C supplemented with mixture of amino acids (250mg Meth. + 600mg Lys. + 400 mg Thyr. + 200mgArgi)/kg diet.
- 4- C supplemented with (600mg GAA +250mg Meth. + 600mg lys. + 400mg thre. + 200mg Argi) /kg diet.
- 5- C supplemented with 300mg β -mannanase / kg diet.

Feed and water offered ad libitum all over the experimental period and experimental diets were formulated to meet the NRC (1994) nutritional recommendations for broilers as presented in Table (1).

Measurements:

Measurements of live body weight and daily feed intake were recorded at the end of experimental period (35 d) daily weight gain and feed conversion ratio were calculated during whole experimental period. The protein (PCR) and energy (ECR) conversion ratio were calculated during experimental period. Performance index according to North (1981) and production efficiency factor according to Emmert (2000) were also calculated. At day 35, four birds per treatment were selected for calculation of

dressing percentage and ready to cook parentage. The percentages of liver, heart gizzard and giblets were calculated on the basis of live body weight.

Economical efficiency:

At the end of the study, economical efficiency for live weight was expressed as broiler-production throughout the study and calculated using the following equation:

Economical efficiency (%) = (Net return LE/total feed cost LE) x 100

Where:

Net return = Total return – the cost of feeding.

Statistical Analysis:

The statistical analysis for the Data were performed by using the general linear model (GLM) procedures according to **SAS (2004)** and the significant mean differences among treatments means were determined using Duncan's Multiple Rang test (**Duncan, 1955**).

The statistical model was:

$$Y_{ij} = \mu + T_i + e_{ij}$$

Where:

Y_{ij} : observation of the parameter measured, μ : overall mean, T_i : effect of treatment (i: 1 to 6) and e_{ij} : random error.

RESULTS AND DISCUSSION

Productive performance:

Live body weight (g) and daily weight gain (g/day):

The live body weight (g) at 35 d of age and daily weight gain (g/day) of broilers as affected by dietary treatments are illustrated in Table (2). It is worth to note that, the chicks fed (CreAmino + A.A., T_3) and (β -mannanase, T_4) diets during overall period (1-35 days) reflected the highest significant ($P < 0.01$) results in both live body weight and daily weight gain compared with other treatments either control, T_1 or T_2 . The enhancement in T_3 and T_4 was 27.5% and 9.7%, respectively compared with the control group. On the other hand, chicks fed basal diet + GAA, (T_1) showed increasing in body weight and daily weight gain being (4.5%) compared to those fed control basal diet (1911.67 versus 18630.0, g and 53.47 versus 51.14 g/day) respectively the differences were statistically none significant. In addition, chicks fed basal diet + A.A. (T_2) showed the lowest body weight and daily weight gain being compared with the control group and other groups. The reduction was 1.5% comparing to control without significant differences as shown in Table (2).

Daily feed intake and feed conversion ratio:

Result present in Table (2) indicate that daily feed intake per chick (g/day) was significantly ($P < 0.01$) increased by feeding GAA + A.A., (T_3) and β -mannanase, (T_4) diets compared with those fed other dietary treatments and the corresponding values were 84.01g (c), 84.04g (T_1) and 79.57g (T_2) versus 102.97g (T_3) and 191.06g (T_4) respectively.

Increasing daily feed consumption (g/d) could be related to the fact that broiler chicks consume more feed to meet energy requirements; moreover genetically, broiler chicks require more dietary energy to maximize growth during short rearing periods. According to Scott and Neshein (1982) and Lesson and Summers (1991) birds have the ability to meet their energy requirements to certain extent by increasing feed consumption.

Feed conversion ratio (FCR) show the same trend since experimental treatments with different feed additives from T_1 - T_3 gave significant compared with control. The values of FCR indicated significant differences between birds fed diets containing GAA, (T_1); A.A., (T_2) or both GAA + A.A. (T_3) compared with those fed control or (T_4) diets. The best FCR was detected for the chicks fed diets incorporated with GAA (T_1 , 1.55) or A.A. (T_2 , 1.58) or both (T_3 , 1.57). On the other hand, the worst FCR were found in chicks fed (T_4 , 1.62) or control (1.64) diets, which could be due to the lowest daily weight gain and higher daily feed intake (Table 2). Growth rate: Table (2) shows the effect of different experimental treatments on growth rate for chicks during experimental period (1-35) days of age. It was

clearly noted that inclusion different feed additives in chicks diets, except T₃ had no significant effect on growth rate. The corresponding values for growth rate ranged between 1.91 and 1.93. On the other hand, the chicks fed control diet gave the lowest figure, while chicks fed T₃ diets gave the highest figure and the differences were significant.

Similar observations were reported by other investigators, Lemme *et al.* (2007a), Michiels *et al.* (2012) in broiler chicks and Lemme *et al.* (2010) in turkeys. They concluded that supplementing GAA (CreAmino) in all-vegetable diets improves performance and significantly improved feed conversion ratio and efficiency of AME. On the other hand, dietary ME levels could be adjusted in small increments to lower the cost of feed without jeopardizing the performance, so based on that, it is recommended to lower the ME level by 50 kcal/kg for each growing period and supplement diets with GAA (Alaeldin *et al.*, 2014). On the same order, Hassan *et al.* (2003) and Abdalla *et al.* (2005) found insignificant difference on final body weight by increasing dietary methionine level in Mandarrah strain. Also, Abdalla *et al.* (2005) came to the same conclusion in Gimmizah strain..

On the other hand, the results were consistent with the findings of Jackson *et al.* (2004), Zou *et al.* (2006) and Kong *et al.* (2011), who reported that supplemented B-mannanase improved weight gain of broilers fed different level of B-mannanase with corn-soybean meal based diets.

Protein (PCR), energy (ECR) conversion ratio; performance index (PI) and Production Efficiency Factor (PEF)

Results listed in Table (3) show the effect of GAA, AA. or β -mannanase supplementation to control basal diets on PCR, ECR, PI and PEF during whole experimental period (1-35 days of age). It was clearly noted that inclusion different feed additives in chicks diets (from T₁-T₄) had significant effect on studied parameters (PCR, ECR, PI and PEF). The corresponding values for PCR ranged between 0.33 and 0.35. While ECR values varied between 4.92 and 5.36, performance index (PI) values ranged between 111.41 and 148.48. While those of PEF ranged between 318.32 and 424.23 and differences between treatments were significant (P<0.01). On the other hand, the worst PCR and ECR values were detected for the chicks fed control diets (0.35 and 5.36) respectively.

However, the best values were found in chicks fed diets incorporated with GAA + A.A., (T₃) and the corresponding rates being 0.32 and 4.92 respectively and in most cases differences between treatments were significant. In the same order, performance index (PI) and (PEF) values showed the same trend, in which (T₃) treatment reflected the highest figures compared with other treatments and the corresponding figures being 148.48 and 424.23 respectively. While, chicks fed control diets had the lowest figures being (111.41 and 318.32) respectively and differences among treatments were significant. These results are in agreement with several reports demonstrating that positive impact on bird performance and energy utilization of supplementing the diet with GAA (Michielset *al.* 2012), Amino acids (El-Faham and Ibrahim, 2004) and β -mannanase (Kong *et al.* 2011).

Carcass characteristics

Table (4) shows the effect of different treatments on carcass characteristics at the end of 35 days of age. Experimental treatments with different feed additives from T₁-T₄ had significant effect on most studied parameters (Dressed carcass %, Giblets % and Ready to Cook %) compared with control. The corresponding values for dressing percentages ranged between 70.41% and 74.28%, while giblets percentages ranged between 4.33% and 5.32%, while ready to cook percentages ranged between 75.74% and 78.62%. On the other hand, the chicks fed A.A. diets, (T₂) gave the highest values for dressing and ready to cook % and reflected the lowest rate for giblets % compared with those fed control diets.

Moreover chicks fed control diets showed the highest liver % (2.88%) and chicks fed A.A. diets (T₂) gave the highest heart % (0.55%). The differences among treatments were not significant.

Similar results have been reported by Elamin and Abbas (2011); Abudabos and Aljumaah (2012); Rattana *et al.* (2011) and Nasr and Kheiri (2011) they concluded that higher amino acids density levels had a beneficial effect on carcass characteristics of broiler chicks.

Economical evaluation

Data for economical evaluation are summarized in Table (5 and 6). The economical evaluation were calculated according to the input-output, economical efficiency and relative economical efficiency. The price for fed ingredients and selling price of live broiler chicks in Egypt, during March 2017. The average cost/ton of final experimental diets, starter, grower and finisher (T₁-T₄) relatively increased the cost final diets compared with the control Table (5). Thus differences could be explained on the basis that feed additives (GAA, A.A. and β -mannanase) treatments raised the feed cost as compared to control basal diets and the corresponding increasing values were 0.7, 2.0, 2.7 and 0.5% respectively.

As shown in Table (6), It's interesting to state that under the condition of the present study, the chicks fed control basal diets supplemented with different feed additives (T₁-T₄) supported the calculated economical efficiency % of chicks and the corresponding increasing were 15.73, 1.35, 35.89

and 14.14% respectively, similar observations have been reported by **Roland *et al.* (2000)**; **Liu *et al.* (2005)** **Onu *et al.* (2010)**; **Selim *et al.* (2016)**. They concluded that, economic analysis revealed that different feed additives supplementation of broiler diets were more profitable than feeding un-supplemented diets.

CONCLUSION

From the present study, it could be concluded that supplemental basal diet during starter, grower and finisher with 600mg GAA+ 1450mg A.A. mixture/kg diet would have a positive effects on productive performance and economical efficiency of broiler chicks without adverse effect on carcass characteristics.

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تأثير جوانيدو استيك مع أو بدون الأحماض الأمينية وإضافة الإنزيمات على الأداء الإنتاجي وصفات الذبيحة والكفاءة الاقتصادية لدجاج التسمين المغذى على علائق أذرة - صويا

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أجريت تجربة تقييم الأداء الإنتاجي وصفات الذبيحة والعائد الاقتصادي لبدارى التسمين (هبرد) المغذى على علائق نباتية مضاف إليها [(جوانيدو استيك اسيد) أو مخلوط الأحماض الأمينية (ميثيونين + ليسين + ثريونين + أرجينين) أو كليهما (جوانيدو استيك أسيد + أحماض أمينية) أو (بيتا- مننانيز)]. استخدمت فى التجربة ٢٢٥ ككتوت هبرد عمر يوم قسمت إلى ٥ مجموعات موزعة على ٣ مكررات (١٥ طائر/مكرر).

غذيت الكتاكيت على ٥ علائق نباتية (أذرة صفراء/ كسب فول صويا) كالاتى: مجموعة المقارنة: غذيت على عليقة نباتية خلال فترات (بادئ ونامى ونهاى بدون إضافات بينما المجموعات الأخرى الأولى (T₁) والثانية (T₂) والثالثة (T₃) والرابعة (T₄) غذيت على عليقة نباتية مضاف إليها ٦٠٠ ملجم جوانيدو استيك اسيد أو ١٤٥٠ ملجم مخلوط أحماض أمينية أو كليهما (٦٠٠ ملجم جوانيدو استيك اسيد + ١٤٥٠ ملجم مخلوط أحماض أمينية) أو ٣٠٠ ملجم بيتا مننانيز/كجم عليقة على التوالى. وقد تم تقديم الغذاء والماء بصورة حرة خلال فترة الدراسة التى استمرت من ١- ٣٥ يوم. وكانت أهم النتائج المتحصل عليها:

١- وزن الجسم ووزن المكتسب اليومي واستهلاك العلف اليومي تأثر معنوياً بإضافة جوانيدو استيك اسيد + مخلوط الأحماض الأمينية (T₃) أو بيتا مننانيز (T₄) مسجلاً أعلى قيم معنوية بالمقارنة بمجموعة المقارنة.

٢- معامل التحويل الغذائى تأثر معنوياً بالمعاملات الغذائية حيث سجلت الكتاكيت فى المعاملات T₁ و T₂ و T₃ أفضل النتائج معنوياً بالمقارنة بالكنترول.

٣- معامل تحويل البروتين (PCR) والطاقة (ECR) والأداء الإنتاجى (PI) وقيمة العائد الإنتاجى (PEF) سجلت أفضل النتائج معنوياً للمجموعة المغذاة على جوانيدو استيك اسيد + مخلوط الأحماض الأمينية (المجموعة الثالثة) مقارنة بالمعاملات الأخرى.

٤- قياسات الذبيحة تأثرت معنوياً بالمعاملات الغذائية حيث سجلت الكتاكيت المغذاة على مخلوط الأحماض الأمينية (T₂) أعلى النتائج لـ % للذبيحة و % للأجزاء الكلية المأكولة وأقل قيم معنوية لـ % للحوائج بالمقارنة بمجموعة المقارنة.

٥- بالنسبة للعائد الاقتصادى أظهرت المعاملات الغذائية المختلفة (المعاملة ١ حتى المعاملة ٤) أفضل عائد اقتصادى بالمقارنة بمجموعة المقارنة حيث تفوقت عليها بمعدلات ١٥.٧٣ و ١.٣٥ و ٣٥.٨٩ و ١٤.١٤ % على التوالى.

نستخلص من هذه الرسالة أن إضافة ٦٠٠ ملجم جوانيدو استيك اسيد/كجم علف + ١٤٥٠ ملجم مخلوط أحماض أمينية/كجم علف إلى علائق بدراى التسمين النباتية حسن معنوياً وزن الجسم المكتسب ومعامل التحويل الغذائى والعائد الاقتصادى بدون التأثير على صفات الذبيحة.

Table (1): Feed ingredients and calculated analyses of experimental basal diets.

Ingredients	Experimental Basal Diets		
	Starter (1-14) d	Grower (15-28) d	Finisher (29-35) d
Yellow Corn	51.55	57.23	62.59
Soybean meal 44%	35.00	29.79	24.70
Corn Gluten Meal 60%	5.20	4.90	4.60
Limestone (CaCO ₃)	1.35	1.10	1.08
Di-Ca Phosphate	1.90	1.68	1.55
Salt (NaCl)	0.40	0.40	0.40
Premix*	0.30	0.30	0.30
Soy Oil	3.50	4.00	4.25
DL-Methionine	0.31	0.24	0.21
Lysine - HCl	0.32	0.25	0.23
Anti-Oxidant	0.17	0.11	0.09
Total	100	100	100
Calculated analysis**			
Crude Protein %	23.01	21.01	19.04
ME Kcal/ Kg diet	3046	3159	3238
Calcium %	1.07	0.90	0.85
Available Phosphorus %	0.51	0.45	0.42
Lysine %	1.45	1.25	1.10
Methionine & Cysteine %	0.69	0.60	0.54
Price/ Ton (L.E.)	6707	6449	6199

Each 3 Kg of premix contains: Vit. A: 12000000 IU; Vit. D3 2000000 IU; Vit. E: 10000 mg; Vit. K3: 2000 mg; Vit. B1:1000 mg; B2: 5000 mg; B6:1500 mg; B12: 10 mg; Biotin: 50 mg; Choline chloride: 250000 mg; Pantothenic acid: 10000 mg; Nicotinic acid: 30000 mg; Folic acid: 1000 mg; Mn: 60000 mg; Zn: 50000 mg; Fe: 30000 mg; Cu: 10000 mg; I: 1000 mg; Se: 100 mg and Co: 100 mg.

Table (2): Effect of different dietary treatments on productive performance.

Items	Dietary Treatments					Sig.
	Control	T ₁	T ₂	T ₃	T ₄	
Live body weight (g)	1830.00 ^{cd} ±47.25	1911.67 ^c ±21.66	1803.33 ^d ±23.15	2333.33 ^a ±29.05	2006.67 ^b ±20.48	**
Daily weight gain (g/ day)	51.14 ^{cd} ±1.34	53.47 ^c ±0.61	50.38 ^d ±0.65	65.52 ^a ±0.83	56.19 ^b ±0.58	**
Daily Feed intake (g/ day)	84.01 ^c ±2.03	84.04 ^c ±1.90	79.57 ^c ±1.26	102.97 ^a ±1.43	91.06 ^b ±2.01	**
Feed conversion ratio (feed/ gain)	1.64 ^a ±0.01	1.55 ^b ±0.01	1.58 ^b ±0.01	1.57 ^b ±0.01	1.62 ^a ±0.01	**
Growth rate	1.91 ^b ±0.01	1.92 ^b ±0.01	1.91 ^b ±0.01	1.93 ^a ±0.01	1.92 ^b ±0.01	**

a, b, c, d Means within the same row with different superscripts are significantly different. Sig. = Significance, ** (P≤0.01)

*1- control (C). 2- C+ GAA (T₁). 3- C+ AA. (T₂). 4- GAA + A.A. (T₃) 5- C+ β-mananase (T₄)

Table (3): Effect of different dietary treatments on PCR, ECR, PI and PEF.

Items	Dietary Treatments					Sig.
	Control	T ₁	T ₂	T ₃	T ₄	
PCR: Protein conversion ratio (g protein/ g gain)	0.35 ^a ±0.01	0.33 ^{bc} ±0.01	0.33 ^b ±0.01	0.32 ^c ±0.01	0.34 ^b ±0.01	**
ECR: Energy conversion ratio (Kcal/ g gain)	5.36 ^a ±0.08	5.04 ^{bc} ±0.05	5.15 ^b ±0.01	4.92 ^c ±0.01	5.19 ^b ±0.04	**
Performance Index ¹ (PI)	111.41 ^c ±3.35	123.13 ^b ±0.59	114.18 ^c ±1.14	148.48 ^a ±1.67	123.85 ^b ±0.28	**
Production Efficiency Factor ² (PEF)	318.32 ^c ±9.59	351.80 ^b ±1.70	326.23 ^c ±3.27	424.23 ^a ±4.79	353.87 ^b ±0.82	**

a, b, c Means within the same row with different superscripts are significantly different. Sig. = Significance ** (P≤0.01). 1: North (1981); 2: Emmert (2000).

*1- control (C). 2- C+ GAA (T₁). 3- C+ AA. (T₂). 4- GAA + A.A. (T₃) 5- C+ β-mananase (T₄)

Table (4): Effect of dietary treatments on some carcass characteristics.

Items	Dietary Treatments					Sig.
	Control	T ₁	T ₂	T ₃	T ₄	
Dressed carcass %	70.41 ^b ±0.67	71.57 ^b ±1.26	74.28 ^a ±0.31	71.29 ^b ±0.72	71.59 ^b ±0.50	*
Liver %	2.88 ±0.04	2.83 ±0.25	2.29 ±0.23	2.45 ±0.04	2.79 ±0.34	NS
Gizzard %	1.89 ^a ±0.09	1.54 ^b ±0.09	1.48 ^b ±0.02	1.58 ^b ±0.03	1.43 ^b ±0.02	*
Heart %	0.54 ±0.04	0.49 ±0.01	0.55 ±0.01	0.53 ±0.01	0.51 ±0.05	NS
Giblets %	5.32 ^a ±0.17	4.87 ^{ab} ±0.29	4.33 ^b ±0.25	4.57 ^{ab} ±0.04	4.74 ^{ab} ±0.37	*
Ready to Cook %#	75.74 ^b ±0.58	76.44 ^{ab} ±1.11	78.62 ^a ±0.11	75.87 ^b ±0.71	76.33 ^{ab} ±0.56	*

Sig. = Significance, NS = Non-Significant. * Giblets = Liver + Gizzard + Heart, # Ready to Cook = (Carcass weight + Giblets weight)

*1- control (C). 2- C+ GAA (T₁). 3- C+ AA. (T₂). 4- GAA + A.A. (T₃) 5- C+ β-mananase (T₄)

Table (5): Prices (L.E./ Ton) of different experimental diets .

Items	Dietary Treatments				
	Control	T ₁	T ₂	T ₃	T ₄
starter (1-14) days	6707	6755	6838	6886	6743
grower (15-28) days	6449	6497	6580	6628	6485
finisher (29-35) days	6199	6247	6329	6377	6235

*1- control (C). 2- C+ GAA (T₁). 3- C+ AA. (T₂). 4- GAA + A.A. (T₃) 5- C+ β-mananase (T₄)

Table (6): Effect of different dietary treatments on some economic traits.

Items	Dietary Treatments				
	Control	T ₁	T ₂	T ₃	T ₄
Average feed intake (Kg)	2.94±0.06	2.91±0.06	2.78±0.04	3.60±0.04	3.18±0.06
Feed Cost (LE)	18.91±0.44	18.83±0.42	18.32±0.28	23.71±0.32	20.57±0.44
Total Cost (LE) #	31.91±0.44	31.83±0.41	31.32±0.28	36.71±0.32	33.57±0.44
Total Return (LE) *	45.75±1.18	47.79±0.54	45.08±0.57	58.33±0.72	50.17±0.51
Net Return (LE)	13.84±0.77	15.96±0.15	13.76±0.28	21.62±0.39	16.60±0.08
Economic Efficiency	43.33±1.92	50.14±0.42	43.92±0.52	58.88±0.56	49.46±0.46
Relative Economic Efficiency	100.00±0.00	115.73±0.98	101.35±1.20	135.89±1.29	114.14±1.06

Total cost = (feed cost + price of one-day live chicks + incidental costs);

* According to the local price of Kg sold carcass which was 25.00 L.E.

*1- control (C). 2- C+ GAA (T₁). 3- C+ AA. (T₂). 4- GAA + A.A. (T₃) 5- C+ β-mananase (T₄)

