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EFFECTS OF SEVERE DIETARY RESTRICTION AND INCREASED LEVELS OF ENERGY AND PROTEIN AFTERWARDS ON HEAD, BRAIN, LUNGS, TESTES, KIDNEYS, CROP, PROVENTRICULUS AND PANCREAS CHARACTERISTICS OF BROILERS

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ABSTRACT

An experiment was conducted with 11 treatments and 3 replications included 10 one-day male chickens per replicate using a 5 × 2 factorial arrangement based on completely randomized design. All process of management, vaccination, ventilation and other environmental conditions, were similar for all treatments. Chickens fed with diets based on guide catalogue of Ross 308 during 1^{st}-7^{th} days of age. From 8^{th}-15^{th} days of age, 2 severely limits (as much as 10 and 20% relative to the recommended amount of guide catalogue of Ross 308) were applied on the quantity of feed. After finishing of restriction period (16^{th} day of age), the 5 levels of energy and protein (0, 2.5, 5, 7.5 and 10 percentage more than the recommended guide catalogue of Ross 308) was applied. Organ characteristics were recorded. Feed restriction level had not significant effect on crop and pancreas weight (P>0.05), however feed restriction as much as 20 and 10% less than recommended amount by guide catalogue of Ross 308 had the higher crop weight numerically (11.536 and 5.378 g respectively). Also, increased dietary energy and protein level after feed restriction removal had significant effect on crop weight (P>0.05), however increased dietary energy and protein level as much as 2.5 and 5.0% higher than recommended level by guide catalogue of Ross 308 had the highest crop weight numerically (16.728 and 5.457 g respectively).

Key words: Quantitative Restriction, Energy, Protein, Broiler, Gut

INTRODUCTION

There are some reports about positive / negative effects of feed restriction on broiler productivity **[1, 2, 3, 4, 5, 6]**. There are similar reports in ruminants such as sheep **[7]**. Meanwhile there are few reports about effects of feed restriction on organ characteristics **[8, 9, 10, 11]** and welfare **[12, 13, 14]** in broilers. However, little research exists evaluating organ characteristics of commercial broilers affected by severe quantitative feed restrictions and fed differing in excess energy and protein after finishing of restriction period. Hence, the objective of this study was to determine the effect of different levels of feed restriction (10 and 20% lower than Ross 308 guide catalogue) and excess energy and protein (0, 2.5, 5.0, 7.5, and 10% more than Ross 308 guide catalogue) on some organ characteristics of broiler. Broiler brain, lung, testes, kidney, crop, proventriculus and pancreas characteristics was investigated.

MATERIALS AND METHODS

This experiment conducted in August-September 2014 in the commercial poultry facility.

Three hundred and thirty (330) male Ross 308 (Aviagen, Newbridge, Scotland, UK 35805) chicks (body weight=40.89 g) were assigned to one of nine following treatments (each treatment included three replications):

Treatment 1 (Control): Feed restriction (0%) - Increased energy and protein (0%)

Treatment 2: Feed restriction (10%) - Increased energy and protein (0%)

Treatment 3: Feed restriction (10%) - Increased energy and protein (2.5%)

Treatment 4: Feed restriction (10%) - Increased energy and protein (5%)

Treatment 5: Feed restriction (10%) - Increased energy and protein (7.5%)

Treatment 6: Feed restriction (10%) - Increased energy and protein (10%)

Treatment 7: Feed restriction (20%) - Increased energy and protein (0%)

Treatment 8: Feed restriction (20%) - Increased energy and protein (2.5%)

Treatment 9: Feed restriction (20%) - Increased energy and protein (5%)

Treatment 10: Feed restriction (20%) - Increased energy and protein (7.5%)

Treatment 11: Feed restriction (20%) - Increased energy and protein (10%)

Treatments were randomly assigned and each group (replication) of 10 birds was raised in a 1 m x 1.5 m wire mesh pens within the hall. Facility and equipment were disinfected prior to bird placement.

Ingredients of diets used in this study are shown in the **Tables 1-6**. Meanwhile, nutrient composition of diets used in this study are shown in the **Tables 7-12**. Diets were

developed to be were iso-energetic and iso-nitrogenous. The diets met or exceeded Ross 308 catalogue recommendations **[15]**.

All birds were given 4 different vaccinations (Avian Influenza: AI; infectious bronchitis virus: IBV; Newcastle disease virus: NDV; Gumboro virus: GV) on varying time intervals. Avian Influenza was provided at d 1. Infectious bronchitis virus (IBV) strain H120 was provided at d 1, and d 16. Newcastle disease virus NDV strain *Viscerotropic velogenic* was provided at d 8, and d 20. Gumboro virus: GV was provided at d 14, and d 23. Vaccines were prepared per vendor recommendation and were supplied via drinking water after a period of water removal for three hours.

On the final day of the experiment, one bird from each replication was slaughtered. Organ weights were used to calculate the percent of total body mass associated with the organ. Data were analyzed by analysis of variance using a 2×5 factorial arrangement with 2 restriction levels (10, 20% more than Ross 308 guide catalogue), and 5 energy-protein levels (0, 2.5, 5.0, 7.5 and 10% more than Ross 308 guide catalogue), using a two-way ANOVA procedure **[16]** and based on Yijk= μ+Ai+Bj+ABij+eijk formula.

Secondly, using a completely randomized experimental design involving 11 treatments (included 10 treatments and control treatment, data were subjected to statistical analysis using the General Linear Model procedures of the Statistical Analysis System v8 **[16]**.

The Duncan post hoc test was used if the initial test result was significant at $P \leq 0.05$. Statements of significance were based on $P \leq 0.05$.

RESULTS AND DISCUSSION

Obtained results are summarized in **Tables 13-15**. From obtained results, it is showed that feed restriction level had not significant effect on head weight ($P>0.05$), although feed restriction as much as 20% less than recommended amount by guide catalogue of Ross 308 had the higher head weight numerically (61.590 g). Also, increased dietary energy and protein level after feed restriction removal had significant effect on head weight ($P\leq0.05$), so increased dietary energy and protein level as much as 7.5% more than recommended level by guide catalogue of Ross 308 had the highest head weight significantly (66.552 g). Eleven studied treatments had significant difference for head weight ($P\leq0.05$), so feed restriction as much as 10% lower than recommended amount by guide catalogue of Ross 308 and increased energy and protein as much as 7.5% more than recommended level by guide

catalogue of Ross 308 had the highest head weight significantly (66.727 g).

Feed restriction level had not significant effect on brain weight (P>0.05), although feed restriction as much as 10% less than recommended amount by guide catalogue of Ross 308 had the higher brain weight numerically (2.604 g). Also, increased dietary energy and protein level after feed restriction removal had not significant effect on brain weight (P>0.05), however increased dietary energy and protein level as much as 2.5% more than recommended level by guide catalogue of Ross 308 had the highest brain weight numerically (2.677 g). Eleven studied treatments had not significant difference for brain weight (P>0.05), however feed restriction as much as 10% lower than recommended amount by guide catalogue of Ross 308 and increased energy and protein as much as 2.5% more than recommended level by guide catalogue of Ross 308 had the highest brain weight numerically (62.723 g).

Feed restriction level had not significant effect on lungs weight (P>0.05), although feed restriction as much as 20% less than recommended amount by guide catalogue of Ross 308 had the higher lungs weight numerically (11.836 g). Also, increased dietary energy and protein level after feed restriction removal had not significant effect on lungs weight (P>0.05), however increased dietary energy and protein level as much as recommended level by guide catalogue of Ross 308 had the highest lungs weight numerically (12.587 g). Eleven studied treatments had not significant difference for lungs weight (P≤0.05), so feed restriction as much as 20% lower than recommended amount by guide catalogue of Ross 308 and increased energy and protein as much as recommended level by guide catalogue of Ross 308 had the highest lungs weight significantly (13.280 g).

From obtained results, it is showed that feed restriction level had not significant effect on testes weight (P>0.05), although feed restriction as much as 10% less than recommended amount by guide catalogue of Ross 308 had the higher testes weight numerically (0.8593 g). Also, increased dietary energy and protein level after feed restriction removal had significant effect on testes weight (P≤0.05), so increased dietary energy and protein level as much as recommended level by guide catalogue of Ross 308 had the highest testes weight significantly (0.658 g). Eleven studied treatments had significant difference for testes weight (P≤0.05), so feed restriction as much as 10% lower than recommended amount by guide catalogue of Ross 308 and increased

energy and protein as much as recommended level by guide catalogue of Ross 308 had the highest testes weight significantly (0.727 g).

Feed restriction level had not significant effect on kidneys weight (P>0.05), although feed restriction as much as 10% less than recommended amount by guide catalogue of Ross 308 had the higher kidneys weight numerically (15.285 g). Also, increased dietary energy and protein level after feed restriction removal had significant effect on kidneys weight (P≤0.05), so increased dietary energy and protein level as much as recommended level by guide catalogue of Ross 308 had the highest kidneys weight significantly (16.922 g). Eleven studied treatments had significant difference for kidneys weight (P≤0.05), so feed restriction as much as 20% lower than recommended amount by guide catalogue of Ross 308 and increased energy and protein as much as recommended level by guide catalogue of Ross 308 had the highest kidneys weight significantly (17.230 g).

From obtained results, it is showed that feed restriction level had not significant effect on back thoracic vertebrae weight (P≤0.05), so feed restriction as much as 10% less than recommended amount by guide catalogue of Ross 308 had the higher back thoracic vertebrae weight significantly (34.418 g). Also, increased dietary energy and protein level after feed restriction removal had significant effect on back thoracic vertebrae weight (P>0.05), however increased dietary energy and protein level as much as 5.0% higher than recommended level by guide catalogue of Ross 308 had the highest back thoracic vertebrae weight numerically (33.692 g). Eleven studied treatments had significant difference for back thoracic vertebrae weight (P≤0.05), so feed restriction as much as 10% lower than recommended amount by guide catalogue of Ross 308 and increased energy and protein as much as 10% higher than recommended level by guide catalogue of Ross 308 had the highest back thoracic vertebrae weight significantly (37.257 g).

Feed restriction level had not significant effect on crop weight (P>0.05), however feed restriction as much as 20% less than recommended amount by guide catalogue of Ross 308 had the higher crop weight numerically (11.536 g). Also, increased dietary energy and protein level after feed restriction removal had significant effect on crop weight (P>0.05), however increased dietary energy and protein level as much as 2.5% higher than recommended level by guide catalogue of Ross 308 had the highest crop weight numerically (16.728 g). Eleven studied treatments had significant difference

for crop weight (P≤0.05), so feed restriction as much as 20% lower than recommended amount by guide catalogue of Ross 308 and increased energy and protein as much as 2.5% higher than recommended level by guide catalogue of Ross 308 had the highest crop weight significantly (24.853 g).

From obtained results, it is showed that feed restriction level had not significant effect on proventriculus weight (P≤0.05), so feed restriction as much as 10% less than recommended amount by guide catalogue of Ross 308 had the higher proventriculus weight significantly (10.733 g). Also, increased dietary energy and protein level after feed restriction removal had significant effect on proventriculus weight (P≤0.05), so increased dietary energy and protein level as much as recommended level by guide catalogue of Ross 308 had the highest proventriculus weight significantly (12.117 g). Eleven studied treatments had significant difference for proventriculus weight (P≤0.05), so feed restriction as much as 20% lower than recommended amount by guide catalogue of Ross 308 and increased energy and protein as much as than recommended level by guide catalogue of Ross 308 had the highest proventriculus weight significantly (12.697 g). Feed restriction level had not significant effect on pancreas weight (P>0.05), although feed restriction as much as 10% less than recommended amount by guide catalogue of Ross 308 had the higher pancreas weight numerically (5.378 g). Also, increased dietary energy and protein level after feed restriction removal had not significant effect on pancreas weight (P>0.05), however increased dietary energy and protein level as much as 5.0% higher than recommended level by guide catalogue of Ross 308 had the highest pancreas weight numerically (5.457 g). Eleven studied treatments had not significant difference for pancreas weight (P>0.05), however feed restriction as much as 10% lower than recommended amount by guide catalogue of Ross 308 and increased energy and protein as much as 5.0% higher than recommended level by guide catalogue of Ross 308 had the highest pancreas weight numerically (5.710 g). Obtained results confirm important effects of dietary restriction on body organs in broilers.

There are few reports about effects of feed restriction on organ characteristics of broiler **[8, 9, 10, 11]**. Hence, our findings clarify new aspects of relationship between feed restriction and body organs.

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Table 1: Feed ingredients of used diets during the starter (1st-14th days of age) period

Ingredient (gr/kg)	Starter period (1st-14th days of age)
Corn	558
Soybean meal	370.7
Soybean oil	27.8
Wheat bran	0.1
Ca%22P%18	19
CaCO3	12.7
Vitamin premix	3
Mineral premix	3
NaCl	2.5
Sodium bicarbonate (NaHCO3)	1.5
DL-Methionine	1.3
Lysine-Hydro-Chloride	0.4

Table 2: Feed ingredients of used diets during the grower (15th-28th days of age) and finisher (29th-42nd days of age) periods for control treatment

Ingredient (gr/kg)	Grower period (15th-28th days of age)	Ingredient (gr/kg)	Finisher period (29th-42nd days of age)
Corn	24.03	Corn	39.100
Meat meal	2.00	Soybean meal	22.460
Soybean oil	2.31	Gluten meal	1.030
Soybean meal	28.54	Meat meal	2.000
Wheat	40.00	Wheat	27.700
DL-Methionine	0.26	Soybean oil	4.47
Lysine-Hydro-Chloride	0.21	Ca%22P%18	1.180
L-Threonine	0.08	CaCO3	1.930
Choline Chloride	0.02	Vitamin premix*	0.250
Ca%22P%18	0.65	Mineral premix**	0.250
CaCO3	1.01	NaCl	0.140
Sodium bicarbonate (NaHCO3)	0.06	Sodium bicarbonate (NaHCO3)	0.210
NaCl	0.21	DL-Methionine	0.09
Vitamin and mineral premix	0.50	Lysine-Hydro-Chloride	0.07
Enzyme	0.06	Salinomycin	0.050
Salinomycin	0.06	Enzyme	0.070
Phytase enzyme	0.01		

Table 3: Feed ingredients of used diets during the grower (15th-28th days of age) and finisher (29th-42nd days of age) periods for nutrients as much as 2.5% more than Ross 308 guide catalogue

Ingredient (gr/kg)	Grower period (15th-28th days of age)	Ingredient (gr/kg)	Finisher period (29th-42nd days of age)
Corn	25.74	Corn	53.900
Meat meal	2.00	Soybean meal	20.750
Soybean oil	4.00	Gluten meal	1.830
Soybean meal	30.18	Meat meal	4.100
Full fat soybean	34.94	Wheat	11.940
DL-Methionine	0.28	Soybean oil	5.000
Lysine-Hydro-Chloride	0.21	Ca%22P%18	0.730
L-Threonine	0.08	CaCO3	0.740
Choline Chloride	0.02	Vitamin premix*	0.250
Ca%22P%18	0.65	Mineral premix**	0.250
CaCO3	1.00	NaCl	0.120
Sodium bicarbonate (NaHCO3)	0.05	Sodium bicarbonate (NaHCO3)	0.155
NaCl	0.21	DL-Methionine	0.065
Vitamin and mineral premix	0.50	Lysine-Hydro-Chloride	0.050
Enzyme	0.06	Salinomycin	0.050
Salinomycin	0.06	Enzyme	0.070
Phytase enzyme	0.01		

Table 4: Feed ingredients of used diets during the grower (15th-28th days of age) and finisher (29th-42nd days of age) periods for nutrients as much as 5% more than Ross 308 guide catalogue

Ingredient (gr/kg)	Grower period (15th-28th days of age)	Ingredient (gr/kg)	Finisher period (29th-42nd days of age)
Corn	49.70	Corn	57.000
Gluten meal	3.74	Soybean meal	18.680
Meat meal	2.00	Gluten meal	8.000
Soybean oil	4.00	Meat meal	0.000
Soybean meal	28.45	Wheat	6.860
Wheat	8.80	Soybean oil	5.390
DL-Methionine	0.285	Ca%22P%18	1.600
Lysine-Hydro-Chloride	0.295	CaCO3	1.170
L-Threonine	0.09	Vitamin premix*	0.250
Ca%22P%18	0.69	Mineral premix**	0.250
CaCO3	1.01	NaCl	0.130
Sodium bicarbonate (NaHCO3)	0.11	Sodium bicarbonate (NaHCO3)	0.320
NaCl	0.20	DL-Methionine	0.000
Vitamin and mineral premix	0.50	Lysine-Hydro-Chloride	0.230
Enzyme	0.06	Salinomycin	0.050
Salinomycin	0.06	Enzyme	0.070
Phytase enzyme	0.01		

Table 5: Feed ingredients of used diets during the grower (15th-28th days of age) and finisher (29th-42nd days of age) periods for nutrients as much as 7.5% more than Ross 308 guide catalogue

Ingredient (gr/kg)	Grower period (15th-28th days of age)	Ingredient (gr/kg)	Finisher period (29th-42nd days of age)
Corn	54.24	Corn	60.000
Gluten meal	4.05	Soybean meal	15.040
Meat meal	2.00	Gluten meal	11.100
Soybean oil	4.00	Meat meal	0.640
Soybean meal	22.93	Wheat	3.240
Wheat	9.45	Soybean oil	6.000
DL-Methionine	0.29	Ca%22P%18	1.470
Lysine-Hydro-Chloride	0.30	CaCO3	1.130
L-Threonine	0.10	Vitamin premix*	0.250
Ca%22P%18	0.68	Mineral premix**	0.250
CaCO3	1.00	NaCl	0.09
Sodium bicarbonate (NaHCO3)	0.12	Sodium bicarbonate (NaHCO3)	0.360
NaCl	0.20	DL-Methionine	0.000
Vitamin and mineral premix	0.50	Lysine-Hydro-Chloride	0.310
Enzyme	0.06	Salinomycin	0.05
Salinomycin	0.06	Enzyme	0.07
Phytase enzyme	0.01		

Table 6: Feed ingredients of used diets during the grower (15th-28th days of age) and finisher (29th-42nd days of age) periods for nutrients as much as 10% more than Ross 308 guide catalogue

Ingredient (gr/kg)	Grower period (15th-28th days of age)	Ingredient (gr/kg)	Finisher period (29th-42nd days of age)
Corn	51.24	Corn	59.090
Gluten meal	3.05	Soybean meal	14.850
Meat meal	2.00	Gluten meal	14.850
Soybean oil	4.00	Meat meal	0.000
Soybean meal	22.93	Wheat	0.000
Wheat	9.45	Soybean oil	7.000
DL-Methionine	0.29	Ca%22P%18	1.600
Lysine-Hydro-Chloride	0.30	CaCO3	1.210
L-Threonine	0.10	Vitamin premix*	0.250
Ca%22P%18	0.68	Mineral premix**	0.250
CaCO3	1.00	NaCl	0.110
Sodium bicarbonate (NaHCO3)	0.12	Sodium bicarbonate (NaHCO3)	0.360
NaCl	0.20	DL-Methionine	0.000
Vitamin and mineral premix	0.50	Lysine-Hydro-Chloride	0.310
Enzyme	0.06	Salinomycin	0.050
Salinomycin	0.06	Enzyme	0.070
Phytase enzyme	0.01		

Table 7: Nutrient analysis of used diets during the starter (1st-14th days of age) period

Nutrient	Starter period (1st-14th days of age)
Dry Matter (%)	90.154
Metabolizable energy (kcal/kg)	3025
Crude protein (%)	23.003
Ether extract (%)	5.271
Linoleic Acid (%)	2.794
Crude fiber (%)	2.674
Calcium (%)	1.051
Total Phosphorus (%)	0.741
Available Phosphorus (%)	0.500
Potassium (%)	0.920
Chloride (%)	0.199
Mn (mg/kg)	120.441
Na (%)	0.162
Zn (mg/kg)	100.175
Choline (g/kg)	1600
Fulic acid (mg/kg)	2.218
Arg (%)	1.502
Gly (%)	0.944
Cer (%)	1.126
Glycine + Cerine (%)	2.441
Hys (%)	0.603
Iso-Leucine (%)	0.948
Leucine (SID) (%)	1.945
Lysine (%)	1.272
Methionine (%)	0.476
Cysteine (%)	0.367
Methionine + Cysteine (%)	0.844
Phe (%)	1.080
Tyr (%)	0.890
Phe + Tyr (%)	1.970
Threonine (%)	0.855
Tryptophan (%)	0.308
Valine (%)	1.046

Table 8: Nutrient analysis of used diets during the grower (15th-28th days of age) and finisher (29th-42nd days of age) periods for control treatment

Nutrient	Grower period (15^{th}-28^{th} days of age)	Nutrient	Finisher period (29^{th}-42^{nd} days of age)
Dry Matter (%)	89.95	Dry Matter (%)	87.773
Crude protein (%)	21.69	Metabolizable energy (kcal/kg)	3.200
Metabolizable energy (kcal/kg)	3150.0	Crude protein (%)	19.004
Lysine (%)	1.10	Ether extract (%)	6.847
Methionine (%)	0.53	Linoleic Acid (%)	3.235
Methionine + Cysteine (%)	0.84	Crude fiber (%)	2.588
Threonine (%)	0.73	Calcium (%)	0.835
Tryptophan (%)	0.22	Total Phosphorus (%)	0.642
Arginine (%)	1.20	Available Phosphorus (%)	0.423
Iso-Leucine (%)	0.75	Ca: P	0.003
Leucine (%)	1.46	Potassium (%)	0.699
Valine (%)	0.87	Chloride (%)	0.165
Calcium (%)	0.90	Mn (mg/kg)	399.832
Total Phosphorus (%)	0.45	Na (%)	0.161
Na (%)	0.16	Zn (mg/kg)	325.353
Potassium (%)	0.85	Choline (g/kg)	1.398
Chloride (%)	0.23	Fulic acid (mg/kg)	1.634
DCAB	221.38	Arg (%)	1.135
Choline (%)	1.50	Gly (%)	0.868
Linoleic Acid (%)	1.48	Cer (%)	0.918
Crude fiber (%)	3.70	Glycine + Cerine (%)	2.010
		Hys (%)	0.471
		Iso-Leucine (%)	0.761
		Leucine (%)	1.565
		Lysine (%)	0.975
		Methionine (%)	0.385
		Cysteine (%)	0.318
		Methionine + Cysteine (%)	0.703
		Phe (%)	0.872
		Tyr (%)	0.710
		Phe + Tyr (%)	1.582
		Threonine (%)	0.677
		Tryptophan (%)	0.233
		Valine (%)	0.851

Table 9: Nutrient analysis of used diets during the grower (15th-28th days of age) and finisher (29th-42nd days of age) periods for nutrients as much as 2.5% more than Ross 308 guide catalogue

Nutrient	Grower period (15^{th}-28^{th} days of age)	Nutrient	Finisher period (29^{th}-42^{nd} days of age)
Dry Matter (%)	90.02	Dry Matter (%)	88.482
Crude protein (%)	21.99	Metabolizable energy (kcal/kg)	3.279
Metabolizable energy (kcal/kg)	3228.000	Crude protein (%)	19.474
Lysine (%)	1.13	Ether extract (%)	7.807
Methionine (%)	0.55	Linoleic Acid (%)	3.830
Methionine + Cysteine (%)	0.86	Crude fiber (%)	2.662
Threonine (%)	0.75	Calcium (%)	0.849
Tryptophan (%)	0.23	Total Phosphorus (%)	0.630
Arginine (%)	1.23	Available Phosphorus (%)	0.423
Iso-Leucine (%)	0.77	Ca: P	-0.002
Leucine (%)	1.49	Potassium (%)	0.661
Valine (%)	0.88	Chloride (%)	0.162
Calcium (%)	0.90	Mn (mg/kg)	394.376
Total Phosphorus (%)	0.45	Na (%)	0.159
Na (%)	0.16	Zn (mg/kg)	323.628
Potassium (%)	0.86	Choline (g/kg)	1.333
Chloride (%)	0.23	Fulic acid (mg/kg)	1.576
DCAB	224.51	Arg (%)	1.163
Choline (%)	1.50	Gly (%)	0.950
Linoleic Acid (%)	1.82	Cer (%)	0.901
Crude fiber (%)	3.70	Glycine + Cerine (%)	2.059
		Hys (%)	0.489
		Iso-Leucine (%)	0.754
		Leucine (%)	1.707
		Lysine (%)	0.970
		Methionine (%)	0.383
		Cysteine (%)	0.320
		Methionine + Cysteine (%)	0.703
		Phe (%)	0.883
		Tyr (%)	0.701
		Phe + Tyr (%)	1.584
		Threonine (%)	0.690
		Tryptophan (%)	0.220
		Valine (%)	0.873

Table 10: Nutrient analysis of used diets during the grower (15th-28th days of age) and finisher (29th-42nd days of age) periods for nutrients as much as 5% more than Ross 308 guide catalogue

Nutrient	Grower period (15^{th}-28^{th} days of age)	Nutrient	Finisher period (29^{th}-42^{nd} days of age)
Dry Matter (%)	89.51	Dry Matter (%)	87.127
Crude protein (%)	22.24	Metabolizable energy (kcal/kg)	3.360
Metabolizable energy (kcal/kg)	3307.00	Crude protein (%)	19.953
Lysine (%)	1.16	Ether extract (%)	8.066
Methionine (%)	0.59	Linoleic Acid (%)	4.078
Methionine + Cysteine (%)	0.89	Crude fiber (%)	2.251
Threonine (%)	0.77	Calcium (%)	0.851
Tryptophan (%)	0.21	Total Phosphorus (%)	0.636
Arginine (%)	1.20	Available Phosphorus (%)	0.423
Iso-Leucine (%)	0.79	Ca: P	-0.003
Leucine (%)	1.78	Potassium (%)	0.606
Valine (%)	0.89	Chloride (%)	0.165
Calcium (%)	0.90	Mn (mg/kg)	396.159
Total Phosphorus (%)	0.45	Na (%)	0.160
Na (%)	0.16	Zn (mg/kg)	320.367
Potassium (%)	0.78	Choline (g/kg)	1.179
Chloride (%)	0.23	Fulic acid (mg/kg)	1.494
DCAB	205.01	Arg (%)	1.049
Choline (%)	1.51	Gly (%)	0.736
Linoleic Acid (%)	2.10	Cer (%)	0.957
Crude fiber (%)	3.34	Glycine + Cerine (%)	1.880
		Hys (%)	0.482
		Iso-Leucine (%)	0.754
		Leucine (%)	2.118
		Lysine (%)	0.974
		Methionine (%)	0.391
		Cysteine (%)	0.341
		Methionine + Cysteine (%)	0.732
		Phe (%)	0.986
		Tyr (%)	0.797
		Phe + Tyr (%)	1.783
		Threonine (%)	0.694
		Tryptophan (%)	0.201
		Valine (%)	0.892

Table 11: Nutrient analysis of used diets during the grower (15th-28th days of age) and finisher (29th-42nd days of age) periods for nutrients as much as 7.5% more than Ross 308 guide catalogue

Nutrient	Grower period (15^{th}-28^{th} days of age)	Nutrient	Finisher period (29^{th}-42^{nd} days of age)
Dry Matter (%)	89.37	Dry Matter (%)	87.328
Crude protein (%)	22.58	Metabolizable energy (kcal/kg)	3.443
Metabolizable energy (kcal/kg)	3386.00	Crude protein (%)	20.428
Lysine (%)	1.19	Ether extract (%)	8.812
Methionine (%)	0.60	Linoleic Acid (%)	4.442
Methionine + Cysteine (%)	0.91	Crude fiber (%)	2.184
Threonine (%)	0.79	Calcium (%)	0.850
Tryptophan (%)	0.21	Total Phosphorus (%)	0.628
Arginine (%)	1.23	Available Phosphorus (%)	0.421
Iso-Leucine (%)	0.81	Ca: P	-0.004
Leucine (%)	1.83	Potassium (%)	0.542
Valine (%)	0.91	Chloride (%)	0.160
Calcium (%)	0.90	Mn (mg/kg)	393.553
Total Phosphorus (%)	0.45	Na (%)	0.161
Na (%)	0.16	Zn (mg/kg)	319.467
Potassium (%)	0.81	Choline (g/kg)	1.085
Chloride (%)	0.23	Fulic acid (mg/kg)	1.369
DCAB	205.01	Arg (%)	1.002
Choline (%)	1.52	Gly (%)	0.745
Linoleic Acid (%)	2.93	Cer (%)	0.964
Crude fiber (%)	3.26	Glycine + Cerine (%)	1.859
		Hys (%)	0.481
		Iso-Leucine (%)	0.771
		Leucine (%)	2.325
		Lysine (%)	0.972
		Methionine (%)	0.385
		Cysteine (%)	0.351
		Methionine + Cysteine (%)	0.781
		Phe (%)	1.024
		Tyr (%)	0.818
		Phe + Tyr (%)	1.841
		Threonine (%)	0.695
		Tryptophan (%)	0.181
		Valine (%)	0.907

Table 12: Nutrient analysis of used diets during the grower (15th-28th days of age) and finisher (29th-42nd days of age) periods for nutrients as much as 10% more than Ross 308 guide catalogue

Nutrient	Grower period (15^{th}-28^{th} days of age)	Nutrient	Finisher period (29^{th}-42^{nd} days of age)
Dry Matter (%)	89.43	Dry Matter (%)	87.250
Crude protein (%)	23.37	Metabolizable energy (kcal/kg)	3.521
Metabolizable energy (kcal/kg)	3465.00	Crude protein (%)	21.902
Lysine (%)	1.24	Ether extract (%)	9.765
Methionine (%)	0.63	Linoleic Acid (%)	4.929
Methionine + Cysteine (%)	0.93	Crude fiber (%)	2.072
Threonine (%)	0.81	Calcium (%)	0.853
Tryptophan (%)	0.21	Total Phosphorus (%)	0.631
Arginine (%)	1.25	Available Phosphorus (%)	0.422
Iso-Leucine (%)	0.83	Ca: P	-0.004
Leucine (%)	1.85	Potassium (%)	0.532
Valine (%)	0.93	Chloride (%)	0.165
Calcium (%)	0.90	Mn (mg/kg)	393.364
Total Phosphorus (%)	0.45	Na (%)	0.161
Na (%)	0.16	Zn (mg/kg)	319.092
Potassium (%)	0.82	Choline (g/kg)	1.041
Chloride (%)	0.23	Fulic acid (mg/kg)	1.351
DCAB	214.24	Arg (%)	1.028
Choline (%)	1.61	Gly (%)	0.743
Linoleic Acid (%)	3.55	Cer (%)	1.043
Crude fiber (%)	3.15	Glycine + Cerine (%)	1.934
		Hys (%)	0.507
		Iso-Leucine (%)	0.826
		Leucine (%)	2.648
		Lysine (%)	0.972
		Methionine (%)	0.384
		Cysteine (%)	0.378
		Methionine + Cysteine (%)	0.768
		Phe (%)	1.132
		Tyr (%)	0.903
		Phe + Tyr (%)	2.035
		Threonine (%)	0.742
		Tryptophan (%)	0.182
		Valine (%)	0.973

Table 13: Mean (±SEM) of invaluable body parts at 42nd days of age in Ross 308 broilers affected by two different feed restriction and five different amounts of increased energy and protein after restriction removal[*]

Trait / Treatment		Head weight (gr)	Relative weight of head (%)	Brain weight (gr)	Relative weight of brain (%)	Lungs weight (gr)	Relative weight of lungs (%)
Feed restriction (%)	10.0	60.826 [a]	2.645 [b]	2.604 [a]	0.113 [a]	11.779 [a]	0.512 [a]
	20.0	61.590 [a]	2.865 [a]	2.439 [a]	0.113 [a]	11.836 [a]	0.549 [a]
P		0.693	0.014	0.171	0.978	0.929	0.239
SEM (Standard Error of Means)		1.348	0.057	0.082	0.004	0.442	0.021
Increased dietary energy and protein after feed restriction removal (%)	0	58.583 [b]	2.473 [c]	2.478 [a]	0.105 [b]	12.587 [a]	0.529 [a]
	2.5	57.637 [b]	2.561 [bc]	2.677 [a]	0.119 [ab]	11.592 [a]	0.516 [a]
	5	61.958 [ab]	2.772 [ab]	2.335 [a]	0.104 [b]	11.560 [a]	0.522 [a]
	7.5	66.552 [a]	3.028 [a]	2.492 [a]	0.113 [ab]	11.695 [a]	0.530 [a]
	10	61.310 [ab]	2.938 [a]	2.627 [a]	0.126 [a]	11.605 [a]	0.555 [a]
P		0.065	0.002	0.392	0.081	0.811	0.934
SEM (Standard Error of Means)		2.131	0.091	0.129	0.006	0.699	0.033
[Control] Feed restriction (0%) - Increased energy and protein (0%)		51.393 [c]	2.427 [de]	2.410 [a]	0.114 [ab]	9.783 [b]	0.463 [a]
Feed restriction (10%) - Increased energy and protein (0%)		55.880 [bc]	2.359 [e]	2.600 [a]	0.110 [ab]	11.893 [ab]	0.503 [a]
Feed restriction (10%) - Increased energy and protein (2.5%)		57.467 [abc]	2.482 [cde]	2.723 [a]	0.118 [ab]	10.940 [ab]	0.471 [a]
Feed restriction (10%) - Increased energy and protein (5%)		61.563 [ab]	2.621 [bcde]	2.493 [a]	0.107 [ab]	11.430 [ab]	0.487 [a]
Feed restriction (10%) - Increased energy and protein (7.5%)		66.727 [a]	2.812 [abcd]	2.640 [a]	0.111 [ab]	12.620 [ab]	0.533 [a]
Feed restriction (10%) - Increased energy and protein (10%)		62.493 [ab]	2.950 [ab]	2.563 [a]	0.121 [ab]	12.013 [ab]	0.567 [a]
Feed restriction (20%) - Increased energy and protein (0%)		61.287 [abc]	2.588 [bcde]	2.357 [a]	0.100 [b]	13.280 [a]	0.556 [a]
Feed restriction (20%) - Increased energy and protein (2.5%)		57.807 [abc]	2.641 [bcde]	2.630 [a]	0.120 [ab]	12.243 [ab]	0.560 [a]
Feed restriction (20%) - Increased energy and protein (5%)		62.353 [ab]	2.923 [abc]	2.177 [a]	0.102 [b]	11.690 [ab]	0.556 [a]
Feed restriction (20%) - Increased energy and protein (7.5%)		66.377 [a]	3.244 [a]	2.343 [a]	0.115 [ab]	10.770 [ab]	0.527 [a]
Feed restriction (20%) - Increased energy and protein (10%)		60.127 [abc]	2.926 [abc]	2.690 [a]	0.131 [a]	11.197 [ab]	0.543 [a]
P		0.062	0.004	0.495	0.303	0.456	0.724
SEM (Standard Error of Means)		3.024	0.135	0.174	0.008	0.944	0.045

[*] Means (± standard error of means) within each column of dietary treatments with no common superscript differ significantly at P<0.05.

Table 14: Mean (±SEM) of other invaluable body parts at 42nd days of age in Ross 308 broilers affected by two different feed restriction and five different amounts of increased energy and protein after restriction removal*

Trait / Treatment		Testes weight (gr)	Relative weight of testes (%)	Kidneys weight (gr)	Relative weight of kidneys (%)	Back thoracic vertebrae (notarium) weight (gr)	Relative weight of back thoracic vertebrae (notarium) (%)
Feed restriction (%)	10.0	0.593 [a]	0.026 [a]	15.285 [a]	0.664 [a]	34.418 [a]	1.499 [a]
	20.0	0.521 [a]	0.024 [a]	14.064 [a]	0.648 [a]	31.617 [b]	1.466 [a]
P		0.301	0.585	0.192	0.687	0.014	0.459
SEM (Standard Error of Means)		0.047	0.002	0.637	0.027	0.731	0.030
Increased dietary energy and protein after feed restriction removal (%)	0	0.658 [a]	0.028 [ab]	16.922 [a]	0.712 [a]	33.688 [a]	1.425 [b]
	2.5	0.582 [ab]	0.026 [ab]	14.862 [ab]	0.658 [ab]	33.353 [a]	1.484 [ab]
	5	0.555 [ab]	0.025 [ab]	12.695 [b]	0.566 [b]	33.692 [a]	1.499 [ab]
	7.5	0.390 [b]	0.018 [b]	14.222 [ab]	0.640 [ab]	30.713 [a]	1.394 [b]
	10	0.600 [ab]	0.029 [a]	14.673 [ab]	0.702 [ab]	33.642 [a]	1.611 [a]
P		0.171	0.183	0.102	0.170	0.323	0.043
SEM (Standard Error of Means)		0.075	0.003	1.008	0.043	1.156	0.048
[Control] Feed restriction (0%) - Increased energy and protein (0%)		0.657 [ab]	0.031 [a]	13.113 [abc]	0.618 [a]	30.810 [bcd]	1.456 [bc]
Feed restriction (10%) - Increased energy and protein (0%)		0.727 [a]	0.030 [a]	16.613 [ab]	0.700 [a]	34.920 [abc]	1.473 [bc]
Feed restriction (10%) - Increased energy and protein (2.5%)		0.647 [ab]	0.028 [a]	15.253 [abc]	0.657 [a]	31.123 [bcd]	1.347 [c]
Feed restriction (10%) - Increased energy and protein (5%)		0.530 [ab]	0.023 [a]	13.033 [abc]	0.557 [a]	36.470 [ab]	1.552 [abc]
Feed restriction (10%) - Increased energy and protein (7.5%)		0.437 [ab]	0.019 [a]	17.103 [a]	0.724 [a]	32.320 [abcd]	1.362 [c]
Feed restriction (10%) - Increased energy and protein (10%)		0.623 [ab]	0.030 [a]	14.423 [abc]	0.681 [a]	37.257 [a]	1.760 [a]
Feed restriction (20%) - Increased energy and protein (0%)		0.590 [ab]	0.025 [a]	17.230 [a]	0.725 [a]	32.457 [abcd]	1.377 [bc]
Feed restriction (20%) - Increased energy and protein (2.5%)		0.517 [ab]	0.023 [a]	14.470 [abc]	0.659 [a]	35.583 [abc]	1.622 [ab]
Feed restriction (20%) - Increased energy and protein (5%)		0.580 [ab]	0.027 [a]	12.357 [bc]	0.575 [a]	30.913 [bcd]	1.446 [bc]
Feed restriction (20%) - Increased energy and protein (7.5%)		0.343 [b]	0.017 [a]	11.340 [c]	0.556 [a]	29.107 [d]	1.426 [bc]
Feed restriction (20%) - Increased energy and protein (10%)		0.577 [ab]	0.028 [a]	14.923 [abc]	0.723 [a]	30.027 [cd]	1.462 [bc]
P		0.400	0.406	0.088	0.313	0.028	0.024
SEM (Standard Error of Means)		0.102	0.004	1.375	0.059	1.691	0.074

* Means (± standard error of means) within each column of dietary treatments with no common superscript differ significantly at P<0.05.

Table 15: Mean (±SEM) of cranial gut segments at 42nd days of age in Ross 308 broilers affected by two different feed restriction and five different amounts of increased energy and protein after restriction removal*

Trait / Treatment		Crop weight (gr)	Relative weight of crop (%)	Proventriculus weight (gr)	Relative weight of proventriculus (%)	Pancreas weight (gr)	Relative weight of pancreas (%)
Feed restriction (%)	10.0	8.443 ^{a}	0.364 ^{a}	10.733 ^{a}	0.465 ^{a}	5.378 ^{a}	0.233 ^{a}
	20.0	11.536 ^{a}	0.523 ^{a}	9.710 ^{b}	0.446 ^{a}	5.279 ^{a}	0.244 ^{a}
P		0.343	0.264	0.050	0.387	0.734	0.346
SEM (Standard Error of Means)		2.245	0.098	0.344	0.015	0.203	0.008
Increased dietary energy and protein after feed restriction removal (%)	0	9.703 ^{a}	0.401 ^{a}	12.117 ^{a}	0.512 ^{a}	5.362 ^{a}	0.226 ^{a}
	2.5	16.728 ^{a}	0.741 ^{a}	10.680 ^{ab}	0.474 ^{ab}	5.295 ^{a}	0.235 ^{a}
	5	8.255 ^{a}	0.367 ^{a}	10.048 ^{b}	0.445 ^{ab}	5.457 ^{a}	0.242 ^{a}
	7.5	7.787 ^{a}	0.352 ^{a}	9.132 ^{b}	0.413 ^{b}	5.332 ^{a}	0.242 ^{a}
	10	7.475 ^{a}	0.357 ^{a}	9.130 ^{b}	0.436 ^{ab}	5.198 ^{a}	0.249 ^{a}
P		0.351	0.355	0.006	0.074	0.985	0.726
SEM (Standard Error of Means)		30.550	0.154	0.545	0.024	0.320	0.012
[Control] Feed restriction (0%) - Increased energy and protein (0%)		10.167 ^{ab}	0.473 ^{b}	10.000 ^{bcd}	0.471 ^{abc}	4.843 ^{a}	0.229 ^{a}
Feed restriction (10%) - Increased energy and protein (0%)		8.723 ^{b}	0.36 ^{b}	11.537 ^{ab}	0.488 ^{abc}	5.160 ^{a}	0.217 ^{a}
Feed restriction (10%) - Increased energy and protein (2.5%)		8.603 ^{b}	0.367 ^{b}	10.300 ^{abcd}	0.443 ^{abc}	5.623 ^{a}	0.243 ^{a}
Feed restriction (10%) - Increased energy and protein (5%)		8.863 ^{b}	0.375 ^{b}	11.453 ^{ab}	0.486 ^{abc}	5.710 ^{a}	0.244 ^{a}
Feed restriction (10%) - Increased energy and protein (7.5%)		7.987 ^{b}	0.337 ^{b}	10.053 ^{bcd}	0.423 ^{abc}	5.440 ^{a}	0.230 ^{a}
Feed restriction (10%) - Increased energy and protein (10%)		8.040 ^{b}	0.379 ^{b}	10.320 ^{abcd}	0.487 ^{abc}	4.957 ^{a}	0.234 ^{a}
Feed restriction (20%) - Increased energy and protein (0%)		10.683 ^{ab}	0.441 ^{b}	12.697 ^{a}	0.536 ^{a}	5.563 ^{a}	0.234 ^{a}
Feed restriction (20%) - Increased energy and protein (2.5%)		24.853 ^{a}	1.115 ^{a}	11.060 ^{abc}	0.504 ^{ab}	4.967 ^{a}	0.227 ^{a}
Feed restriction (20%) - Increased energy and protein (5%)		7.647 ^{b}	0.358 ^{b}	8.643 ^{cd}	0.405 ^{bc}	5.203 ^{a}	0.240 ^{a}
Feed restriction (20%) - Increased energy and protein (7.5%)		7.587 ^{b}	0.367 ^{b}	8.210 ^{d}	0.402 ^{bc}	5.223 ^{a}	0.255 ^{a}
Feed restriction (20%) - Increased energy and protein (10%)		6.910 ^{b}	0.334 ^{b}	7.940 ^{d}	0.385 ^{c}	5.440 ^{a}	0.264 ^{a}
P		0.407	0.369	0.008	0.086	0.900	0.778
SEM (Standard Error of Means)		4.810	0.209	0.791	0.034	0.017	0.433

* Means (± standard error of means) within each column of dietary treatments with no common superscript differ significantly at P<0.05.