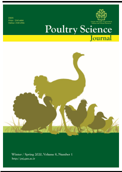

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Comparison of Multi-Step Phase-Feeding Programs (Eight or Thirteen Steps) with a Commercial Three-Step Feeding Program for Broiler Chickens

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Abstract
Two trials were conducted to study the effect of multi-steps phase-feeding (PF) program on growth performance of broiler chickens from 1 to 24 and 1 to 39 d of age. The control group was the nutrient recommendation of Aviagen (2019) with a three-step PF program (1-10, 11-24 and 25-39 d of age). In the first trial, the control group was compared with an eight-step PF program (PF8), and in the second trial, it was compared with a thirteen-step PF program (PF13). A gradual increase of metabolizable energy and a decrease of crude protein and amino acids were applied in PF8 and PF13 over time of life. Treatments were replicated in 5 pens of 15 males per each. Feed conversion ratio, lysine intake efficiency and feed cost efficiency were improved ($P \leq 0.05$) by the PF8 and PF13. In trial 1 (during 1 to 24 and 1 to 39 d of age) and trial 2 (during 1 to 39 d of age), energy intake efficiency was increased ($P \leq 0.05$) by the multi-step PF program. In trial 1 (during 1 to 24 and 1 to 39 d of age) and trial 2 (during 1 to 24 d of age), average daily gain was not improved ($P > 0.05$) by the multi-step PF program compared to the control group; however, the PF13 increased ($P \leq 0.05$) average daily gain during 1 to 39 d of age. In conclusion, the current study shows the eight-step or thirteen-step phase feeding program improves feed conversion ratio compared to the current commercial three-step feeding program. Meanwhile, the thirteen-step phase feeding program increases weight gain from 1 to 39 d of age.

Introduction

The nutrient requirement of broiler chickens is different as they grow older; therefore, the re-balance of the diet in order to meet the nutrient requirements of broiler chickens according to their age is unavoidable. Emmert and Baker (1997) described phase-feeding (PF) term for broiler nutrition, in which the levels of dietary amino acids are reduced steadily over time in order to decrease feed cost associated with excess dietary amino acids or protein supply. Pope *et al.* (2002) suggested PF as an approach for changing diet several times throughout the growth period in an attempt to meet the nutrient requirement of modern broiler chickens. In this respect, several works have been conducted (Pope *et al.,* 2004; Pope and Emmert, 2001; Roush *et al.,* 2004; Warren and Emmert, 2000). However, except the work of Warren and Emmert (2000), all the previous researches (Pope *et al.*, 2004; Pope and Emmert, 2001; Roush *et al.,* 2004) have investigated the PF approach from around 21 or 40 d of age.

It has been known that energy requirement can be different throughout the rearing period as it is mentioned in Aviagen's recommendation for Ross 308 Broiler Nutrition Specifications (Aviagen, 2019), but the most published kinds of literature have focused on just gradual reduction of dietary amino acids and protein in the course of broiler's life (Pope *et al.,* 2004; Pope and Emmert, 2001; Roush *et al.,* 2004; Warren and Emmert, 2000). Two studies (Brewer *et al.,* 2012a,b) have been conducted to examine increasing metabolizable energy (ME) and decreasing crude protein (CP) and amino acids over time, but they investigated such a PF approach just from 18 d of age. In addition, the difference between the lowest and highest ME levels in their PF diets was just 50 kcal/kg of the diet and this difference may not

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be large enough to affect the performance of broiler chickens.

The objective of the present study was to increase the steps of the Aviagen PF program from 3 (starter, grower and finisher) to 8 (trial 1) or 13 (trial 2) steps during 1 to 39 d of age. It was assumed that these new PF approaches may meet closer the daily bird's requirements and they can enhance feed efficiency. Meanwhile, with regard to the genetic development and the recent nutrient recommendations such as Aviagen's recommendation for Ross 308 Broiler Nutrition Specifications (Aviagen, 2019), it may be necessary to re-evaluate the PF approach in the current years.

Materials and Methods

All procedures were approved by the Animal Care and Use Committee guidelines of the University. Two trials were conducted in two different times and in each trial, a total of 150 one-d-old male Ross 308 broiler chicks were randomly divided into 10 pens from 1 to 39 d of age. Each trial had two treatments with 5 replicates per each. Each replicate was assigned to a pen (1.5×1.5 m) with 15 broilers. Mean body weight (BW) of the chicks in all pens was similar (± 0.5 g). Birds were reared in an environmentally controlled house on litter-floor pens and exposed to a 21:3 L:D cycle. Room temperature was kept at 30°C during the first 3 d of life, and then, it was reduced gradually until reaching 20◦C at 24 d of age. The birds were given ad libitum access to water (one bell drinker/pen) and diets (one tube feeder/pen).

In both trials, the control group was the recommendation of Aviagen (2019) with a three-step PF program (1-10, 11-24 and 25-39 d of age). In the first trial, the control group was compared with an eight-step PF program (PF8, Table 1), i.e. 1-5, 6-10, 11-15, 16-20, 21-24, 25-29, 30-34 and 35-39 d of age. In the second trial, it was compared with a thirteen-step PF program (PF13, Table 2), i.e. 1-3, 4-6, 7-9, 10-12, 13-15, 16-18, 19-21, 22-24, 25-27, 28-30, 31-33, 34-36 and 37-39 d of age. All diets were based on corn and soybean meal. The preventive recommended dose of Salinomycin was included in all diets from 10 d of age to the end of the trials. The diets were analyzed for CP (method 984.13) concentration according to the standard procedures of AOAC (1995).

The BW of chicks and feed consumption were determined by pen at 24 and 39 d of age, and average daily feed intake (ADFI), average daily gain (ADG) and feed conversion ratio (FCR) were determined from 1 to 24 and 1 to 39 d of age. Feed intake was adjusted for mortalities, and their ADG was included in the calculation of FCR. Feed cost efficiency ($ feed cost/kg weight gain), energy intake efficiency (g weight gain/kcal ME intake) and lysine intake efficiency (g weight gain/g lysine intake) were also calculated from 1 to 24 and 1 to 39 d of age.

At 39 d of age, 3 chicks/pen (15 chicks/treatment) were randomly selected, weighed individually, and killed to measure the relative weight (RW, g/100 g live body weight) of carcass, breast, thigh+drumstick and abdominal fat pad. The pen was the experimental unit for all parameters. Each trial had two groups; therefore, the T-test was applied for statistical analysis (SAS, 2001) in each trial separately. All statements of significance are based on $P \leq 0.05$ and the tendency is based on $0.05 < P \leq 0.10$.

Results and Discussion

The mortality rate was not affected ($P > 0.05$) by the treatments in both trials and data are not shown here. The results of growth performance parameters from 1 to 24 and 1 to 39 d of age are presented, respectively, in Tables 3 and 4. The FCR and lysine intake efficiency were improved ($P \leq 0.05$) by the PF8 and PF13. In trial 1 (during 1 to 24 and 1 to 39 d of age) and trial 2 (during 1 to 39 d of age), energy intake efficiency was increased ($P \leq 0.05$) by the multi-step PF program, though during 1 to 24 d of age, the PF13 tended ($P = 0.10$) to increase energy intake efficiency. In trial 1 (during 1 to 24 and 1 to 39 d of age) and trial 2 (during 1 to 24 d of age), ADG was not affected ($P > 0.05$) by the multi-step PF program compared to the control group; however, the PF13 increased ADG ($P \leq 0.05$) during 1 to 39 d of age.

In contrast to our study, Hauschild *et al.* (2015) reported that a fourteen-step PF program (by switching diets every 3 days) did not decrease the FCR compared to that of the control group with the three-step feeding program. Warren and Emmert (2000) did not find any improvements in FCR or amino acid intake efficiency when the NRC (1994) starter (1 to 21 d of age) diet switched every 7 days. However, there are some studies investigating the PF approach from around 21 or 40 d of age that show the improved FCR (Pope *et al.,* 2004; Brewer *et al.,* 2012b) and nutrients' intake efficiency (Warren and Emmert, 2000; Pope and Emmert, 2001). Since other essential amino acids were decreased simultaneously by a constant ratio in the diets when dietary lysine was decreased, the intake efficiency of other essential amino acids was the same as lysine (data are not shown here). The beneficial effect of PF8 and PF13 on feed efficiency shows a good match between the nutrients supply and the nutrients requirements. The magnitude of improved feed efficiency and nutrient intake efficiency may be large enough from the point of view for modern industrial applications especially in big rearing farms. Nevertheless, formulation and preparation of PF diets over short intervals is not so feasible, particularly when considering the cost of feed delivery (Pope *et al.,* 2002).

Table 1. Ingredient composition and nutrient content of diets in trial 1 (g/kg, as-fed basis, unless otherwise indicated)

	Aviagen recommendation			Eight-step phase-feeding program (PF8)							
	1-10 d	11-24 d	25-39 d	1-5 d	6-10 d	11-15 d	16-20 d	21-24 d	25-29 d	30-34 d	35-39 d
Ingredient											
Corn	457.9	515.5	572.3	457.9	478.3	494.9	515.5	535.4	557.4	572.3	578.6
Soybean meal (44%)	448.2	389.4	331.2	448.2	426.0	411.9	389.4	367.7	348.8	331.2	321.0
Soybean oil	49.5	54.0	58.5	49.5	51.1	52.2	54.0	55.7	55.8	58.5	62.4
Calcium carbonate	10.2	9.3	8.4	10.2	10.2	9.3	9.3	9.3	8.4	8.4	8.4
Dicalcium phosphate	17.9	16.0	14.2	17.9	18.2	15.8	16.0	16.3	14.0	14.2	14.3
Common Salt	3.1	3.2	3.2	3.1	3.1	3.2	3.2	3.1	3.1	3.2	3.2
Sodium bicarbonate	2.4	2.3	2.3	2.4	2.4	2.3	2.3	2.3	2.3	2.3	2.3
DL-Methionine	3.6	3.2	2.9	3.6	3.4	3.4	3.2	3.0	3.1	2.9	2.8
L-Lysine HCl	1.5	1.5	1.5	1.5	1.6	1.4	1.5	1.5	1.5	1.5	1.5
L-Threonine	0.7	0.7	0.5	0.7	0.7	0.7	0.7	0.7	0.6	0.5	0.5
Vitamin premix[1]	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Mineral premix[2]	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Calculated analysis											
ME (kcal/kg)	3000	3100	3200	3000	3033	3066	3100	3133	3166	3200	3233
Crude protein	238	216	195	238	230	225	216	208	202	195	191
Lysine	14.40	12.90	11.50	14.4	13.90	13.40	12.90	12.40	11.96	11.50	11.27
Methionine + Cystine	10.80	9.90	9.00	10.80	10.42	10.28	9.90	9.52	9.36	9.00	8.82
Threonine	9.70	8.80	7.80	9.70	9.36	9.14	8.80	8.46	8.11	7.80	7.64
Valine	10.99	10.0	9.01	10.99	10.62	10.39	10.00	9.63	9.32	9.01	8.82
Isoleucine	10.03	9.03	8.05	10.03	9.65	9.42	9.03	8.66	8.35	8.05	7.87
Arginine	15.71	14.07	12.44	15.71	15.08	14.70	1.407	13.46	12.94	12.44	12.15
Tryptophan	3.58	3.17	2.77	3.58	3.42	3.33	3.17	3.02	2.90	2.77	2.70
Leucine	19.50	18.05	16.61	19.50	18.94	18.61	18.05	17.50	17.06	16.61	16.32
Calcium	9.6	8.7	7.8	9.6	9.6	8.7	8.7	8.7	7.8	7.8	7.8
Non-phytate phosphorus	4.8	4.35	3.9	4.8	4.8	4.35	4.35	4.35	3.9	3.9	3.9
Sodium	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Chloride	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
Potassium	10.4	9.4	8.38	10.4	10.0	9.76	9.37	8.99	8.68	8.38	8.19
Determined analysis											
Crude protein	233	210	191	233	225	220	210	206	199	191	190

[1]Provided the following per kilogram of diets: vitamin A, 9,000 IU (retinyl acetate); cholecalciferol, 2,000 IU; vitamin E, 36 IU (dl-α-tocopheryl acetate); vitamin B_{12}, 0.015 mg; menadione, 2 mg; riboflavin, 6.6 mg; thiamine, 1.8 mg; pantothenic calcium, 10 mg; niacin, 30 mg; folic acid, 1 mg; biotin, 0.1 mg; pyridoxine, 3 mg.

[2]Provided the following per kilogram of diets: manganese ($MnSO_4 \cdot H_2O$), 100 mg; zinc (ZnO), 85 mg; iron ($FeSO_4 \cdot 7H_2O$), 50 mg; copper ($CuSO_4 \cdot 5H_2O$), 10 mg; selenium (Na_2SeO_3), 0.2 mg; iodine (calcium iodate), 1 mg; choline (choline chloride), 250 mg.

Table 2. Ingredient composition and nutrient content of diets in trial 2 (g/kg, as-fed basis, unless otherwise indicated).

	Aviagen recommendation			Thirteen-step phase-feeding program (PF13)												
	1-10 d	11-24 d	25-39 d	1-3 d	4-6 d	7-9 d	10-12 d	13-15 d	16-18 d	19-21 d	22-24 d	25-27 d	28-30 d	31-33 d	34-36 d	37-39 d
Ingredient																
Corn	461.2	520.2	571.7	459.3	461.2	476.4	488.6	504.1	520.2	530.5	540.8	553.5	562.6	571.7	580.7	589.8
Soybean meal (44%)	442.2	382.5	328.6	445.5	442.2	425.6	416.7	399.9	382.5	370.8	359.1	349.8	339.2	328.6	318.0	307.4
Soybean oil	49.7	53.9	59.4	48.6	49.7	51.0	51.5	52.8	53.9	55.2	56.5	56.3	57.8	59.4	60.9	62.4
Calcium carbonate	15.7	14.3	13.1	15.6	15.7	15.7	14.2	14.2	14.3	14.3	14.4	13.0	13.0	13.1	13.1	13.1
Monocalcium phosphate	14.7	13.2	11.8	14.6	14.7	14.9	12.9	13.0	13.2	13.3	13.4	11.6	11.7	11.8	11.9	12.0
Common Salt	3.1	3.1	3.1	3.1	3.1	3.1	3.2	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1
Sodium bicarbonate	2.4	2.3	2.3	2.4	2.4	2.4	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3
DL-Methionine	3.6	3.2	2.9	3.7	3.6	3.4	3.5	3.3	3.2	3.1	3.0	3.1	3.0	2.9	2.8	2.7
L-Lysine HCl	1.7	1.6	1.6	1.6	1.7	1.7	1.5	1.5	1.6	1.6	1.7	1.6	1.6	1.6	1.6	1.6
L-Threonine	0.8	0.7	0.5	0.8	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.5	0.5	0.5	0.5	0.5
Vitamin premix[1]	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Mineral premix[2]	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Calculated analysis																
ME (kcal/kg)	3000	3100	3200	2975	3000	3025	3050	3075	3100	3120	3140	3160	3180	3200	3220	3240
Crude protein	238	216	197	244	238	232	229	223	216	212	208	205	201	197	193	189
Lysine	14.40	12.90	11.60	14.78	14.40	14.03	13.65	13.28	12.90	12.64	12.38	12.12	11.86	11.60	11.34	11.08
Methionine + Cystine	10.80	9.90	9.10	11.08	10.80	10.52	10.48	10.19	9.90	9.70	9.51	9.50	9.30	9.10	8.90	8.69
Threonine	9.70	8.80	7.80	9.96	9.70	9.45	9.31	9.06	8.80	8.62	8.44	8.15	7.98	7.80	7.63	7.45
Valine	11.00	10.00	9.10	11.29	11.00	10.72	10.58	10.29	10.00	9.80	9.60	9.46	9.27	9.10	8.91	8.72
Isoleucine	10.00	9.00	8.10	10.29	10.00	9.72	9.58	9.30	9.00	8.81	8.61	8.46	8.28	8.10	7.92	7.74
Arginine	15.64	14.00	12.50	16.11	15.64	15.18	14.94	14.47	14.00	13.66	13.33	13.09	12.79	12.50	12.19	11.90
Tryptophan	3.55	3.14	2.78	3.66	3.55	3.43	3.38	3.26	3.14	3.06	2.98	2.92	2.85	2.78	2.70	2.63
Leucine	19.60	18.17	16.86	20.02	19.60	19.19	19.01	18.60	18.17	17.88	17.58	17.40	17.13	16.86	16.59	16.32
Calcium	9.6	8.7	7.9	9.6	9.6	9.6	8.7	8.7	8.7	8.7	8.7	7.9	7.9	7.9	7.9	7.9
Non-phytate phosphorus	4.8	4.35	3.95	4.8	4.8	4.8	4.35	4.35	4.35	4.35	4.35	3.95	3.95	3.95	3.95	3.95
Sodium	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Chloride	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
Potassium	10.26	9.24	8.32	10.56	10.27	9.98	9.83	9.54	9.24	9.04	8.84	8.69	8.50	8.32	8.14	7.95
Determined analysis																
Crude protein	237	217	194	245	237	233	226	221	217	215	208	202	201	194	193	188

[1]Provided the following per kilogram of diets: vitamin A, 9,000 IU (retinyl acetate); cholecalciferol, 2,000 IU; vitamin E, 36 IU (dl-α-tocopheryl acetate); vitamin B_{12}, 0.015 mg; menadione, 2 mg; riboflavin, 6.6 mg; thiamine, 1.8 mg; pantothenic calcium, 10 mg; niacin, 30 mg; folic acid, 1 mg; biotin, 0.1 mg; pyridoxine, 3 mg.

[2]Provided the following per kilogram of diets: manganese ($MnSO_4 \cdot H_2O$), 100 mg; zinc (ZnO), 85 mg; iron ($FeSO_4 \cdot 7H_2O$), 50 mg; copper ($CuSO_4 \cdot 5H_2O$), 10 mg; selenium (Na_2SeO_3), 0.2 mg; iodine (calcium iodate), 1 mg; choline (choline chloride), 250 mg.

Table 3. Effect of multi-step phase-feeding program on growth performance and nutrient intake efficiency of broiler chickens during 1 to 24 d of age

	ADFI[1] (g)	ADG[2] (g)	BW[3] (g)	FCR[4] (g/g)	Feed cost efficiency[5] ($/kg)	Energy intake efficiency[6] (g/kcal)	Lysine intake efficiency[7] (g/g)
Trial 1							
Aviagen	58.3	40.8	1023	1.43	0.224	0.227	53.2
PF8[8]	54.2	40.0	1003	1.36	0.214	0.238	56.3
SEM[9] (n = 5)	0.71	0.80	19.4	0.012	0.0019	0.0020	0.51
P-value	0.01	0.47	0.47	0.01	0.01	0.01	0.01
Trial 2							
Aviagen	57.8	38.1	958	1.52	0.238	0.213	49.9
PF13[10]	55.8	38.0	956	1.47	0.229	0.220	52.3
SEM (n = 5)	0.80	0.81	20.9	0.014	0.0028	0.0024	0.65
P-value	0.09	0.93	0.94	0.05	0.05	0.10	0.03

[1]Average daily feed intake. [2]Average daily gain. [3]Body weight. [4]Feed conversion ratio. [5]$ feed cost/kg weight gain. [6]g weight gain/kcal ME intake. [7]g weight gain/g lysine intake. [8]Eight-step phase-feeding program. [9]Standard Error of the Mean. [10]Thirteen-step phase-feeding program.

Table 4. Effect of multi-step phase-feeding program on growth performance and nutrient intake efficiency of broiler chickens during 1 to 39 d of age

	ADFI[1] (g)	ADG[2] (g)	BW[3] (g)	FCR[4] (g/g)	Feed cost efficiency[5] ($/kg)	Energy intake efficiency[6] (g/kcal)	Lysine intake efficiency[7] (g/g)
Trial 1							
Aviagen	88.0	53.6	2136	1.64	0.266	0.193	50.1
PF8[8]	82.7	52.4	2088	1.58	0.257	0.201	52.0
SEM[9] (n = 5)	1.42	1.08	42.3	0.019	0.0028	0.0023	0.59
P-value	0.02	0.44	0.44	0.04	0.05	0.05	0.05
Trial 2							
Aviagen	89.5	50.5	2015	1.77	0.272	0.179	46.2
PF13[10]	90.0	53.3	2123	1.69	0.259	0.188	48.9
SEM (n = 5)	1.50	0.90	35.1	0.023	0.0041	0.0026	0.74
P-value	0.81	0.05	0.05	0.04	0.05	0.05	0.03

[1]Average daily feed intake. [2]Average daily gain. [3]Body weight. [4]Feed conversion ratio. [5]$ feed cost/kg weight gain. [6]g weight gain/kcal ME intake. [7]g weight gain/g lysine intake. [8]Eight-step phase-feeding program. [9]Standard Error of the Mean. [10]Thirteen-step phase-feeding program.

In agreement to the result of trial 1, PF diets did not improve weight gain of broiler in the of works of Warren and Emmert (2000), Pope and Emmert (2001), Pope *et al.* (2002) and Brewer *et al.* (2012a,b); however, our study indicates that increasing the steps of PF program from 8 to 13 improves ADG compared to that of Aviagen recommendation. In agreement to the results of PF13 (in trial 2), Hauschild *et al.* (2015) reported that a fourteen-step PF program (by switching diets every 3 days) increases the ADG compared to that of the control group with three-step feeding program from 1 to 42 d of age, not from 1 to 21 d of age. The work of Pope *et al.* (2004) showed that the PF approach increased the weight gain of broiler from 21 to 63 d of age. Surbakti *et al.* (2003) reported that multiple feeding program has the potential to reduce production cost. In our study, feed cost efficiency was improved ($P \leq 0.05$) by PF diet ($P \leq 0.05$) in both trials. Pope and Emmert (2001), Pope *et al.* (2002, 2004) and Brewer *et al.* (2012a,b) also showed the improved feed cost efficiency in groups receiving the PF diets.

During 1 to 24 d of age, the ADFI was decreased ($P \leq 0.05$) by multi-step PF in trail 1, but in trial 2, multi-step PF tended ($P = 0.09$) to decrease the ADFI. During 1 to 39 d of age, the ADFI was decreased ($P \leq 0.05$) by PF8 in trial 1, but there was not a significant difference ($P > 0.05$) between the Aviagen feeding program and PF13 in trial 2. Brewer *et al.* (2012b) investigated the effect of PF diets on three broiler strains and showed one strain had lower

Table 5. Effect of multi-step phase-feeding program on relative weight (g/100 g live body weight) of carcass, breast, thigh+drumstick and abdominal fat pad in broiler chickens on d 39

	Carcass[1]	Breast	Thigh+Drumstick	Abdominal fat pad
Trial 1				
Aviagen	62.0	22.6	19.9	1.67
PF8[2]	62.3	23.1	20.3	1.52
SEM[3] (n = 5)	0.30	0.81	0.26	0.168
P-value	0.46	0.71	0.31	0.53
Trial 2				
Aviagen	63.0	24.1	19.2	1.52
PF13[4]	64.3	25.1	20.4	1.43
SEM (n = 5)	0.82	0.91	0.75	0.175
P-value	0.29	0.50	0.25	0.73

[1]Without neck, leg, and skin. [2]Eight-step phase-feeding program. [3]Standard Error of the Mean. [4]Thirteen-step phase-feeding program

feed intake when received the PF diet. However, Warren and Emmert (2000), Pope and Emmert (2001), Pope *et al.* (2002, 2004) and Brewer *et al.* (2012a) did not show any reductions of feed intake by the PF diets.

The results of the RW of carcass, breast, thigh+drumstick and abdominal fat pad on d 39 are presented in Table 5. The multi-step PF programs did not affect ($P > 0.05$) the RW of carcass, breast, thigh+drumstick and abdominal fat pad. Broilers fed PF diets maintained a similar carcass and breast yield to those receiving the Aviagen feeding program, indicating that the PF approach as applied in the current study does not compromise carcass and breast yield. In agreement to our study, Warren and Emmert (2000), Pope and Emmert (2001), Pope *et al.* (2004) and Brewer *et al.* (2012a) did not find any improvement in the RW of carcass, breast, thigh + drumstick or abdominal fat pad by PF diet. However, Brewer *et al.* (2012b) investigated the effect of the PF diet on three strains of broiler chickens and found that the RW of breast was increased by PF diet just in one strain, without any effect on other parts of the carcass. In addition, Pope *et al.* (2002) reported that the PF approach increased the RW of carcass, without any effect on other parts of carcass.

Conclusion

Eight-step or thirteen-step phase feeding program improves feed conversion ratio compared to the current commercial three-step feeding program. Thirteen-step phase feeding program increases weight gain from 1 to 39 d of age.

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