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Research Article
Effects of High Fat Broiler Pre-starter Rations on Performance and Cost

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Abstract

Background: Addition of fat has been shown to improve performance of broilers, but can also be expensive. **Methodology:** An experiment was designed to determine if early addition of fat might lead to performance improvements that would be maintained to market weight. Forty nine days experiment was conducted to test the addition of 6 or 8% Yellow Grease (YG) to diets of broilers during the 0-10 or 0-14 day pre-starter period. Forty eight pens of birds were fed one of 6 treatments of 8 pens (33 chicks per pen) consisting of a control (least cost addition of YG), 6% YG or 8% YG, each fed to either 10 or 14 days. Diets consisted of commercial type corn-soy-distillers dried grains with solubles(DDGS)-meat meal base and were adjusted to maintain a consistent relationship between energy and crude protein as well as amino acids. Birds were weighed and diets changed at 10 or 14 days, 17 days and 35 days with completion of the trial at 49 days. **Results:** Feed conversion was significantly improved by the addition of fat during the treatment period, a result of numerically higher body weight and reduced feed intake, although neither was significant. Improved growth performance from the addition of fat during the treatment period did not result in improved performance at market, as no effects by dietary treatment were found at 49 days. **Conclusion:** These results suggest the addition of high levels of fat in the pre-starter ration does not improve growth performance at 49 days.

Key words: Broiler, fat, pre-starter, yellow grease, growth performance

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

The first 2 weeks of life make up 28% of a typical broiler's life, slaughtered at 49 days, but only accounts for about 8.5% of total feed consumption[1]. Lilburn[2] and Ebling *et al.*[3] agree that this separation gives nutritionists an opportunity to use more expensive ingredients to provide a higher plain of nutrition that could improve performance during the first two weeks and should be seen as an investment rather than a cost. At current prices of about \$220 and \$200 t^{-1} in the pre-starter and finisher rations, respectively, an 8% increase in the price of the pre-starter ration would have to occur to raise the total cost of feed/bird one cent[1,4]. This calculation would be assuming the increase in diet cost caused no improvements in feed efficiency and thus demonstrates the potential for cheaply improving the growth and efficiency of broilers.

Feed costs represent about 70% of the cost of poultry production[5]. As the cost of feed continues to increase, improved feed conversion and reduced mortality become more valuable[5-8]. For a broiler marketed at 49 days, about 50% of feed consumption occurs in the last 2 weeks resulting in about 50% of feed costs being incurred during this period[1]. As the broiler grows older and larger, maintenance requirements increase causing a decline in feed conversion and increased feed consumption. This high amount of feed consumption later in life causes improved feed conversion to be very important economically and mortality to be expensive since the bird has already consumed so much feed. Optimizing nutrition during the first two weeks, with a practical disregard for cost could improve gut health and ensure birds develop to their maximum genetic potential. Ferket[9] suggests under nutrition in the perinatal and immediate post-hatch nutrition are constraining development to support subsequent growth. With proper development and gut health during the immediate post-hatch period, when intense changes are occurring in the small intestine[10], we may be able to improve feed conversion and reduce mortality later in the life of the bird as well as improve the final Body Weight (BW) of the bird at marketing.

Increased nutrient density via the use of high fat rations is a promising method for achieving optimal nutrition in the young chick. Traditionally, the young chicks' ability to digest and absorb fats has been considered to be low[11-15]. These studies have caused a dogma in poultry nutrition that fats should not be used in the diets of young chicks, but this is no reason to avoid fats since the young chick is outfitted for fatty acid metabolism[2], digestion improves rapidly[16] and total absorption of fat and energy increases with increased dietary fat inclusion[17]. Fat, starch and amino acid digestibility are all lowest in the young chick during the 1st week and all improve with age[18-20]. The young chick also has a low capacity for feed consumption due to physical limitations. Utilization of a high nutrient density diet via the use of high dietary fat inclusion thus has the potential to increase total nutrient uptake in the young chick.

The primary objective of this experiment was to determine if high fat pre-starter rations could improve initial performance of chicks and if the observed increase would be maintained to market weight.

MATERIALS AND METHODS

General procedures: To determine if industry growth standards could be improved, an experiment was conducted using as hatched Cobb/Cobb birds obtained from a commercial hatchery. Birds were housed and maintained according to the University of Missouri standard operating procedures and the University of Missouri Animal Care and Use Guidelines. Standard US corn-soy-DDGS-animal byproduct diets were used with the exception of the changes in yellow grease addition.

Trial design: Forty eight pens of broilers with 33 birds/pen for a total of 1,584 birds were used in a 2×3 factorial design with 6 treatments and 8 replicate pens. Treatments included a low fat pre-starter diet, 6 or 8% added fat (yellow grease)×10 days and 14 days on diet. These diets were fed for either the 10 or 14 day period followed by industry standard diets through the remaining growout period with ration changes at 17 and 35 days. Each floor pen measured 4 feet wide and 8 feet deep and contained one metal feeder, one nipple waterer with 5 nipples each 6 inches apart, one heat lamp and new cedar shavings. Supplemental feed trays were used in each pen from 0 to 5 days to encourage acclimation to feed. Heat lamps were used during brood and removed at 14 days of age. Birds received continuous light throughout the trial.

Treatment descriptions: Three experimental diets were fed representing 6 treatments with time fed being the other variable. Experimental diets consisted of an industry standard control diet (C), 6% added fat (YG6) or 8% added fat (YG8) (Table 1). Fat used was Yellow Grease (YG) (15% max FFA) from Hahn and Phillips Grease Company in Marshall, MO. The control diet and post-experimental period diets (Table 2) were industry standard diets based on Cobb-Vantress[1] recommendations, formulated on a digestible amino acids basis and a minimum level of CP. Minimum constraints were

Table 1: Ingredient composition and nutrient profile of experimental diets fed to broilers to either 10 or 14 days of age

	Treatments		
Ingredient	C (%)	YG6 (%)	YG8 (%)
Corn	59.28	50.27	46.41
Soybean meal	27.01	31.17	32.94
Porkmeal	5.00	5.00	5.00
Corn DDGS	5.00	5.00	5.00
Yellow grease*	1.33	6.00	8.00
Dicalcium phosphate	0.59	0.72	0.77
Copper sulfate	0.00	0.00	0.00
Sodium chloride	0.32	0.32	0.32
Limestone	0.51	0.55	0.60
Choline chloride	0.02	0.01	0.00
Vitamin/mineral premix#$	0.18	0.18	0.18
DL-methionine	0.33	0.36	0.37
Lysine HCl	0.26	0.23	0.22
Threonine	0.15	0.15	0.15
Avatec	0.05	0.05	0.05
Nutrient			
ME (kcal kg^{-1})	3035.00	3209.00	3283.00
Crude protein	22.00	23.30	23.85
Calcium	0.90	0.95	0.98
Available phosphorus	0.45	0.48	0.49
Lysine	1.18	1.25	1.28
Methionine+cysteine	0.88	0.93	0.95
Threonine	0.77	0.82	0.84
Valine	0.80	0.85	0.87

*Yellow grease analysis: Total fatty acids: Minimum 90.0%, Moisture: Maximum 1.0%, Insoluble impurities: Maximum 0.5%, Unsaponifiable matter: Maximum 1.0%, Total MIU: Maximum 2.0%, Free fatty acids: Maximum 15.0%, #Vitamins provided per kilogram: Vitamin E 93.697 mg, B-12 18000 mcg, Thiamin 2.343 mg, Riboflavin 9.369 mg, Niacin 81.983 mg, Pyridoxine 5.857 mg, Biotin 205 mg, Folate 3.514 mg, $Minerals provided per kilogram: Mn 160.000 mg, Zn 150.000 mg, Fe 10,000 mg, Se 240 mg, Mg 20.000 mg

Table 2: Ingredient composition and nutrient profile of common diets fed to broilers in all treatments starting at either 11 or 15 days of age through 49 days of age

	Periods (%)		
Ingredient	11-17	18-35	36-49
Corn	63.79	65.46	67.95
Soybean meal	22.22	20.06	17.60
Porkmeal	5.00	5.00	5.00
Corn DDGS	5.00	5.00	5.00
Yellow grease*	1.88	2.77	2.74
Dicalcium phosphate	0.48	0.31	0.32
Copper sulfate	0.00	0.00	0.00
Sodium chloride	0.32	0.32	0.32
Limestone	0.44	0.33	0.34
Choline chloride	0.00	0.00	0.00
Vitamin/mineral premix#$	0.18	0.18	0.18
DL-methionine	0.28	0.24	0.22
Lysine HCL	0.24	0.18	0.20
Threonine	0.13	0.11	0.10
Avatec	0.05	0.05	0.05
Nutrient			
ME (kcal kg^{-1})	3110.00	3180.00	3200.00
Crude protein	20.00	19.00	18.00
Calcium	0.84	0.76	0.76
Available phosphorus	0.42	0.38	0.38
Lysine	1.05	0.95	0.90
Methionine+cysteine	0.80	0.74	0.70
Threonine	0.69	0.65	0.61
Valine	0.73	0.70	0.66

*Yellow grease analysis: Total fatty acids: Minimum 90.0%, Moisture: Maximum 1.0%, Insoluble impurities: Maximum 0.5%, Unsaponifiable matter: Maximum 1.0%, Total MIU: Maximum 2.0%, Free fatty acids: Maximum 15.0%, #Vitamins provided per kilogram: Vitamin E 93,697 mg, B-12 18000 mcg, Thiamin 2,343 mg, Riboflavin 9,369 mg, Niacin 81,983 mg, Pyridoxine 5,857 mg, Biotin 205 mg, Folate 3,514 mg, $Minerals provided per kilogram: Mn 160,000 mg, Zn 150,000 mg, Fe 10,000 mg, Se 240 mg, Mg 20,000 mg

placed on YG to force 6 or 8% fat addition. Energy was allowed to increase accordingly. Crude Protein (CP) and Amino Acids (AA) were increased to maintain a consistent CP and AA ratio to energy across all treatments. Fat addition and adjustment for CP and AA were done without regard to cost. All diets were formulated using least-cost formulation software and included an industry provided premix.

Measurements: Birds were weighed by pen at 0, 10, 14, 17, 35 and 49 days via electronic scale. Feed was weighed and placed in front of pens, a total quantity was recorded at that time and feed disappearance measured at 10 or 14, 17, 35 and 49 days. Mortality weights were recorded daily and used to adjust feed conversion. Feed intake, body weight gain, feed conversion and adjusted feed conversion were calculated for each period. At 49 days of age, 3 birds per pen (24 birds per treatment) of average weight for their pen, were selected for processing. On day 50 birds were processed to determine carcass and parts yield. Parts collected were pectoralis major and minor, thigh, leg, wing and fat pad.

Statistical analysis: The experiment was a complete randomized block design with the position of each block of pens in the barn being the blocking factor. Data was analyzed by analysis of variance (ANOVA) with a two-way design with the pen being the experimental unit throughout the study. All statements are based on the 0.05 level of significance. Mean separations were done as appropriate using the Tukey's least significant difference test.

RESULTS

Body weight was similar across treatments at 10 days of age (DOA), although Feed Intake (FI) of treatment Cx10 was significantly higher than all other treatments except Cx14 at 10 DOA (Table 3). From 0-10 days birds fed diet C did not consume significantly more than diets YG6 or YG8 (p-value = 0.128) but feed/gain and adjusted feed/gain were both significantly poorer in birds fed diet C than diets YG6 or YG8 (Table 3).

Table 3: Growth performance from 0-10 days of broilers fed control (C), 6% addition of YG (YG6) or 8% addition of YG (YG8) for either 10 days (x10) or 14 days (x14)

Treatments*	Livability (%)	Body weight (kg)	Feed intake (kg)	Feed/gain	Adjusted feed/gain
Cx10	0.975	0.269	0.258^{a}	1.115^{a}	1.105^{a}
Cx14	0.960	0.264	0.238^{ab}	1.114^{a}	1.099^{a}
YG6x10	0.977	0.269	0.227^{b}	1.026^{b}	1.029^{b}
YG6x14	0.981	0.269	0.230^{b}	1.025^{b}	1.018^{b}
YG8x10	0.970	0.275	0.233^{b}	1.011^{b}	1.014^{b}
YG8x14	0.978	0.270	0.229^{b}	1.010^{b}	1.011^{b}
Diet#					
C	0.958	0.259	0.240	1.114^{a}	1.120^{a}
YG6	0.979	0.266	0.229	1.025^{b}	1.020^{b}
YG8	0.964	0.266	0.225	1.026^{b}	1.009^{b}
Time$					
10 days	0.974	0.264	0.232	1.055	1.047
14 days	0.960	0.264	0.230	1.055	1.046
Pooled SE	0.028	0.014	0.013	0.024	0.018

$^{a-b}$Means within a column with no common superscripts differ significantly by Tukey method ($p<0.05$), *Data are means of 8 replicate pens initially containing 33 broilers per pen, #Data are means of 16 replicate pens initially containing 33 broilers per pen, $Data are means of 24 replicate pens initially containing 33 broilers per pen

Table 4: Cumulative growth performance from 0-14 days of broilers fed control (C), 6% addition of YG (YG6) or 8% addition of YG (YG8) for either 10 days (x10) or 14 days (x14)

Treatments*	Livability (%)	Body weight (kg)	Feed intake (kg)	Feed/gain	Adjusted feed/gain
Cx10	0.988	0.467^{ab}	0.529^{a}	1.267^{a}	1.233^{a}
Cx14	0.976	0.424^{d}	0.452^{c}	1.224^{ab}	1.197^{b}
YG6x10	0.970	0.449^{bc}	0.492^{b}	1.214^{b}	1.201^{b}
YG6x14	0.981	0.438^{cd}	0.438^{c}	1.140^{c}	1.138^{c}
YG8x10	0.970	0.474^{a}	0.513^{ab}	1.200^{b}	1.189^{b}
YG8x14	0.974	0.448^{bc}	0.442^{c}	1.103^{c}	1.093^{d}
Diet#					
C	0.959	0.441	0.494^{a}	1.245^{a,†}	1.223^{a,†}
YG6	0.975	0.447	0.472^{b}	1.151^{b,†}	1.170^{b,†}
YG8	0.972	0.456	0.477^{ab}	1.177^{b,†}	1.141^{c,†}
Time$					
10 days	0.970	0.460^{a}	0.513^{a}	1.227^{a,†}	1.211^{a,†}
14 days	0.968	0.436^{b}	0.448^{b}	1.156^{b,†}	1.145^{b,†}
Pooled SE	0.033	0.015	0.021	0.031	0.019

$^{a-d}$Means within a column with no common superscripts differ significantly by Tukey method ($p<0.05$), *Data are means of 8 replicate pens initially containing 33 broilers per pen, #Data are means of 16 replicate pens initially containing 33 broilers per pen, $Data are means of 24 replicate pens initially containing 33 broilers per pen, †Interaction within the column was also significant ($p<0.05$)

Table 5: Cumulative growth performance from 0-17 days of broilers fed control (C), 6% addition of YG (YG6) or 8% addition of YG (YG8) for either 10 days (x10) or 14 days (x14)

Treatments*	Livability (%)	Body weight (kg)	Feed intake (kg)	Feed/gain	Adjusted feed/gain
Cx10	0.939	0.618^{ab}	0.770^{a}	1.319^{a}	1.278^{a}
Cx14	0.934	0.591^{b}	0.696^{bc}	1.290^{a}	1.226^{bc}
YG6x10	0.939	0.603^{ab}	0.738^{abc}	1.293^{a}	1.254^{ab}
YG6x14	0.947	0.610^{ab}	0.689^{bc}	1.224^{b}	1.193^{cd}
YG8x10	0.935	0.625^{a}	0.741^{ab}	1.288^{a}	1.241^{ab}
YG8x14	0.944	0.604^{ab}	0.682^{c}	1.179^{b}	1.156^{d}
Diet#					
C	0.937	0.604	0.725	1.310^{a}	1.258^{a}
YG6	0.947	0.611	0.720	1.250^{b}	1.218^{b}
YG8	0.939	0.622	0.712	1.242^{b}	1.200^{b}
Time$					
10 days	0.938	0.606	0.749^{a}	1.304^{a}	1.258^{a}
14 days	0.945	0.618	0.689^{b}	1.231^{b}	1.192^{b}
Pooled SE	0.034	0.021	0.037	0.034	0.026

$^{a-d}$Means within a column with no common superscripts differ significantly by Tukey method ($p<0.05$), *Data are means of 8 replicate pens initially containing 33 broilers per pen, #Data are means of 16 replicate pens initially containing 33 broilers per pen, $Data are means of 24 replicate pens initially containing 33 broilers per pen

At 14 days, YG8x10 was significantly heavier than all other treatments except Cx10 while Cx14 was significantly lighter than all other treatments except YG6x14 (Table 4). From 10-14 days, birds fed a pre-starter ration to 10 DOA consumed and gained significantly more than birds fed a pre-starter ration to 14 DOA resulting in significantly poorer feed conversion of birds fed pre-starter to 10 days during the 10-14 days period (Table 5). Consequently, birds fed pre-starter to 10 days were found to have significantly increased cumulative BW, feed intake and feed/gain (Table 4). Cumulative feed consumption at 14 DOA was significantly higher in birds fed diet C than YG6 but not significantly greater than YG8 (Table 4). This resulted in significantly improved feed conversion as fat inclusion increased (Table 4). Interactive effects were found in treatments cumulative feed/gain and adjusted feed/gain at 14 DOA (Table 4) although only YG8x14 was significantly lower than all other treatments during the 10-14 day period (Table 5).

From 14-17 days, birds fed a pre-starter ration to 14 days gained significantly more weight than birds fed a pre-starter ration to 10 DOA despite similar feed intake causing significantly poorer feed conversion in birds fed pre-starter to 10 DOA (Table 6). Cumulative feed intake at 17 DOA was significantly increased in birds fed pre-starter to 10 days due to the difference found at 14 DOA resulting in significantly poorer feed conversion of birds fed pre-starter to 10 days (Table 7). Cumulative feed intake and BW at 17 DOA was similar when comparing diet or time fed pre-starter separately although feed conversion was significantly higher in birds fed diet C than YG6 or YG8 (Table 7).

There were no cumulative or period effects from time fed pre-starter or diet on BW or feed intake after 17 DOA (Table 8-11) although cumulative feed consumption of YG8x10 was significantly higher than YG6x14 at both 35 (Table 8) and 49 DOA (Table 9). At 49 DOA feed conversion of treatment Cx10 was significantly poorer than treatments Cx14,

Table 6: Cumulative growth performance from 0-35 days of broilers fed control (C), 6% addition of YG (YG6) or 8% addition of YG (YG8) for either 10 days (x10) or 14 days (x14)

Treatments*	Livability (%)	Body weight (kg)	Feed intake (kg)	Feed/gain	Adjusted feed/gain
Cx10	0.952	2.169^{ab}	3.253^{ab}	1.509	1.493
Cx14	0.939	2.216^{a}	3.248^{ab}	1.490	1.477
YG6x10	0.924	2.151^{ab}	3.218^{ab}	1.512	1.486
YG6x14	0.943	2.098^{b}	3.143^{b}	1.501	1.491
YG8x10	0.926	2.175^{ab}	3.271^{a}	1.507	1.493
YG8x14	0.935	2.127^{ab}	3.248^{ab}	1.486	1.476
Diet#					
C	0.933	2.193	3.262	1.500	1.490
YG6	0.934	2.158	3.195	1.508	1.486
YG8	0.931	2.179	3.221	1.514	1.491
Time$					
10 days	0.930	2.174	3.250	1.517	1.498
14 days	0.935	2.179	3.203	1.497	1.480
Pooled SE	0.027	0.067	0.074	0.024	0.027

$^{a-b}$Means within a column with no common superscripts differ significantly by Tukey method (p<0.05), *Data are means of 8 replicate pens initially containing 33 broilers per pen, #Data are means of 16 replicate pens initially containing 33 broilers per pen, $Data are means of 24 replicate pens initially containing 33 broilers per pen

Table 7: Cumulative growth performance from 0-49 days of broilers fed control (C), 6% addition of YG (YG6) or 8% addition of YG (YG8) for either 10 days (x10) or 14 days (x14)

Treatments*	Livability (%)	Body weight (kg)	Feed intake (kg)	Feed/gain	Adjusted feed/gain
Cx10	0.947	3.532	6.138^{ab}	1.757	1.730^{a}
Cx14	0.933	3.661	6.101^{ab}	1.689	1.671^{b}
YG6x10	0.917	3.574	6.017^{ab}	1.717	1.686^{b}
YG6x14	0.928	3.612	5.938^{b}	1.690	1.691^{ab}
YG8x10	0.913	3.646	6.169^{a}	1.720	1.686^{ab}
YG8x14	0.913	3.610	5.953^{ab}	1.718	1.6832^{b}
Diet#					
C	0.935	3.645	6.120	1.722	1.698
YG6	0.922	3.606	5.978	1.704	1.677
YG8	0.913	3.563	6.093	1.736	1.685
Time$					
10 days	0.926	3.587	6.086	1.730	1.699^{a}
14 days	0.921	3.623	6.041	1.711	1.674^{b}
Pooled SE	0.038	0.087	0.137	0.043	0.026

$^{a-b}$Means within a column with no common superscripts differ significantly by Tukey method (p<0.05), *Data are means of 8 replicate pens initially containing 33 broilers per pen, #Data are means of 16 replicate pens initially containing 33 broilers per pen, $Data are means of 24 replicate pens initially containing 33 broilers per pen

Table 8: Growth performance from 10-14 days of broilers fed control (C), 6% addition of YG (YG6) or 8% addition of YG (YG8) for either 10 days (x10) or 14 days (x14)

Treatments*	Livability (%)	Body weight (kg)	Feed intake (kg)	Feed/gain	Adjusted feed/gain
Cx10	0.988	0.196^{a}	0.278^{a}	1.392^{a}	1.373^{a}
Cx14	0.976	0.161^{b}	0.221^{b}	1.335^{a}	1.332^{a}
YG6x10	0.970	0.194^{a}	0.267^{a}	1.411^{a}	1.398^{a}
YG6x14	0.981	0.157^{b}	0.209^{b}	1.333^{a}	1.333^{a}
YG8x10	0.970	0.198^{a}	0.280^{a}	1.402^{a}	1.400^{a}
YG8x14	0.974	0.183^{a}	0.216^{b}	1.199^{b}	1.198^{b}
Diet#					
C	0.959	0.179^{b}	0.247	1.366^{a,†}	1.362^{a,†}
YG6	0.975	0.179^{b}	0.239	1.361^{a,†}	1.352^{a,†}
YG8	0.972	0.190^{a}	0.246	1.300^{b,†}	1.299^{b,†}
Time$					
10 days	0.970	0.196^{a}	0.273^{a}	1.402^{a,†}	1.394^{a,†}
14 days	0.968	0.169^{b}	0.215^{b}	1.282^{b,†}	1.281^{b,†}
Pooled SE	0.033	0.01352	0.01118	0.0517	0.0553

$^{a-b}$Means within a column with no common superscripts differ significantly by Tukey method (p<0.05), *Data are means of 8 replicate pens initially containing 33 broilers per pen, #Data are means of 16 replicate pens initially containing 33 broilers per pen, $Data are means of 24 replicate pens initially containing 33 broilers per pen, †Interaction within the column was also significant (p<0.05)

Table 9: Growth performance from 14-17 days of broilers fed control (C), 6% addition of YG (YG6) or 8% addition of YG (YG8) for either 10 days (x10) or 14 days (x14)

Treatments*	Livability (%)	Body weight (kg)	Feed intake (kg)	Feed/gain	Adjusted feed/gain
Cx10	0.939	0.152	0.218	1.560^{a}	1.395^{a}
Cx14	0.934	0.175	0.219	1.410^{c}	1.297^{b}
YG6x10	0.939	0.156	0.224	1.516^{ab}	1.373^{a}
YG6x14	0.947	0.173	0.226	1.429^{bc}	1.307^{b}
YG8x10	0.935	0.160	0.218	1.569^{a}	1.345^{ab}
YG8x14	0.944	0.175	0.208	1.425^{bc}	1.302^{b}
Diet#					
C	0.937	0.163	0.219	1.500	1.349
YG6	0.947	0.164	0.223	1.492	1.357
YG8	0.939	0.165	0.217	1.497	1.343
Time$					
10 days	0.938	.158^{b}	0.219	1.547^{a}	1.384^{a}
14 days	0.945	.170^{a}	0.221	1.446^{b}	1.316^{b}
Pooled SE	0.034	0.015	0.019	0.057	0.033

$^{a-c}$Means within a column with no common superscripts differ significantly by Tukey method (p<0.05), *Data are means of 8 replicate pens initially containing 33 broilers per pen, #Data are means of 16 replicate pens initially containing 33 broilers per pen, $Data are means of 24 replicate pens initially containing 33 broilers per pen

YG6x10 and YG8x14 (Table 9). Cumulative feed conversion at 49 DOA was also found to be significantly poorer in birds fed pre-starter to 10 days than 14 days (Table 9).

Although no significance was found between treatments at 49 DOA, treatment C was heaviest followed by YG6 or YG8, each about 40 g lighter than the previous (Table 9). Final BW at 49 DOA was heavier than expected at an average of 3.60 kg, 0.10 kg above the suggested 49 days b.wt., of 3.50 kg[1].

Under normal conditions with no extreme immune challenge, livability was unaffected throughout the trial.

At 50 days of age, three birds of average weight from each pen were slaughtered and parts yield measured. All treatments were similar in percentage of hot carcass, fat pad, major, minor and total breast, leg, thigh and wing (Table 12). Comparison of diet and time on pre-starter diet were also similar.

DISCUSSION

The primary objective of this study was to determine if high fat pre-starter rations could improve initial performance of chicks and if the observed increase in performance would be maintained to market weight. To do so, birds were fed a pre-starter ration of either a standard low fat diet (C), 6% added fat (YG6) or 8% added fat (YG8) (Table 1) for either 10 or 14 days. Yellow Grease (YG) was used in this study as it is typically the cheapest source of fat and cost is the recommended selection determinate[21].

Table 10: Growth performance from 17-35 days of broilers fed control (C), 6% addition of YG (YG6) or 8% addition of YG (YG8) for either 10 days (x10) or 14 days (x14)

Treatments*	Livability (%)	Body weight (kg)	Feed intake (kg)	Feed/gain	Adjusted feed/gain
Cx10	0.952	1.554[ab]	2.473	1.574	1.574
Cx14	0.939	1.625[a]	2.555	1.561	1.561
YG6x10	0.924	1.584[ab]	2.484	1.598	1.582
YG6x14	0.943	1.529[b]	2.460	1.602	1.602
YG8x10	0.926	1.570[ab]	2.499	1.589	1.601
YG8x14	0.935	1.523[b]	2.501	1.609	1.598
Diet#					
C	0.933	1.589	2.528	1.567[b]	1.567
YG6	0.934	1.547	2.472	1.594[ab]	1.586
YG8	0.931	1.557	2.500	1.599[a]	1.594
Time$					
10 days[3]	0.930	1.556	2.492	1.587	1.582
14 days[3]	0.935	1.572	2.508	1.587	1.583
Pooled SE	0.027	0.059	0.063	0.033	0.032

[a-b]Means within a column with no common superscripts differ significantly by Tukey method ($p<0.05$), *Data are means of 8 replicate pens initially containing 33 broilers per pen, #Data are means of 16 replicate pens initially containing 33 broilers per pen, $Data are means of 24 replicate pens initially containing 33 broilers per pen

Consistent with previous study[22-28], feed conversion was significantly improved by the addition of fat during the treatment period at 10 and 14 DOA as well as immediately following the treatment period at 17 DOA (Table 3, 4, 7). This effect was primarily caused by reduced feed intake in birds consuming additional fat as BW was similar across dietary treatments. The BW, cumulative feed intake and cumulative feed conversion were all similar across dietary treatments after 17 DOA (Table 8, 9).

Lilburn[2] and Ebling *et al.*[3] have suggested feeding a higher plain of nutrition during the first 2 weeks of life may better meet the needs of the broiler and improve performance at marketing. This theory is not supported by the present

Table 11: Growth performance from 35-49 days of broilers fed control (C), 6% addition of YG (YG6) or 8% addition of YG (YG8) for either 10 days (x10) or 14 days (x14)

Treatments*	Livability (%)	Body weight (kg)	Feed intake (kg)	Feed/gain	Adjusted feed/gain
Cx10	0.947	1.431	2.914	2.107	2.095
Cx14	0.933	1.438	2.848	1.997	1.974
YG6x10	0.917	1.422	2.824	1.969	1.976
YG6x14	0.928	1.473	2.813	1.974	1.975
YG8x10	0.913	1.394	2.835	2.065	2.011
YG8x14	0.913	1.376	2.870	2.022	1.980
Diet#					
C	0.935	1.434	2.881	2.052	1.996
YG6	0.922	1.448	2.806	1.970	1.958
YG8	0.913	1.385	2.823	2.104	2.011
Time$					
10 days	0.926	1.415	2.849	2.047	2.013
14 days	0.921	1.429	2.825	2.037	1.964
Pooled SE	0.038	0.119	0.099	0.082	0.097

*Data are means of 8 replicate pens initially containing 33 broilers per pen, #Data are means of 16 replicate pens initially containing 33 broilers per pen, $Data are means of 24 replicate pens initially containing 33 broilers per pen

Table 12: Processing yields of broilers at 50 days of age, after 12 h fasting, fed control (C), 6% addition of YG (YG6) or 8% addition of YG (YG8) for either 10 days (x10) or 14 days (x14)

Treatments*	Hot carcass†	Fat pad[ε]	Major breast[ε]	Minor breast[ε]	Total breast[ε]	Leg[ε]	Thigh[ε]	Wing[ε]
Cx10	71.39	2.33	26.11	5.36	31.08	15.29	18.64	11.57
Cx14	72.68	2.59	26.56	5.52	31.67	15.10	19.16	11.45
YG6x10	72.04	2.55	26.46	5.54	32.00	15.30	19.30	11.78
YG6x14	72.40	2.50	26.09	5.51	31.68	15.22	18.81	11.23
YG8x10	71.70	2.91	25.92	5.29	31.22	15.20	18.97	11.60
YG8x14	72.68	2.44	26.50	5.36	31.83	15.05	18.65	11.58
Diet#								
C	72.41	2.46	26.09	5.31	31.37	15.30	18.99	11.56
YG6	72.43	2.59	26.27	5.57	31.84	15.33	18.99	11.50
YG8	72.24	2.72	26.39	5.33	31.72	15.13	18.81	11.58
Time$								
10 days	72.17	2.64	26.08	5.37	31.43	15.30	18.93	11.68
14 days	72.56	2.54	26.42	5.44	31.86	15.21	18.93	11.41
Pooled SE	1.96	0.83	2.40	0.68	2.91	1.19	1.38	0.88

*Data are means of 24 carcasses per treatment, #Data are means of 48 carcasses per treatment, $Data are means of 72 carcasses per treatment, †Expressed as a percent of live weight, εExpressed as a percent of the hot carcass weight study conducted with broilers in a standard floor pen trial. Fat, starch and amino acid digestibility are all lowest in the young chick during the 1st week[18,19]. Inclusion of a high level of fat and thus a high plain of nutrition, did improve total nutrient retention as feed conversion was improved at 10, 14 and 17 DOA, but this effect was not apparent at market (Table 9). This improved feed conversion also suggests the use of fats in the diets of young chicks is advisable in agreement with Lilburn[2].

Although, BW was similar between dietary treatments at 10 and 14 DOA (Table 7), weight gain was significantly higher and feed conversion was significantly improved in birds consuming YG8 from 10-14 days (Table 5). In addition, weight gain and feed intake were both significantly higher in birds fed pre-starter to 10 DOA (Table 5). In Table 5, weight gain is significantly higher in birds fed pre-starter to 10 DOA and YG8x14 over Cx14 and YG6x14. This would appear to confirm the suggestions set by Cobb-Vantress[1] that a feed change should occur at 10 DOA as the bird appears to require a higher level of energy post 10 DOA. This may not be the case though as treatment YG8x14 feed conversion was significantly better at 14 DOA than all other treatments (Table 4, 5), suggesting the bird may still require a high level of energy and protein to 14 DOA. In addition, weight gain and feed conversion were significantly improved from 14-17 days in broilers fed pre-starter to 14 DOA compared to pre-starter to 10 DOA (Table 6). Consequently, at 17 DOA broilers fed pre-starter to 14 DOA had numerically heavier BW, significantly reduced cumulative feed intake and significantly improved cumulative feed conversion (Table 7). Although, no significant cumulative effects were found at 35 DOA, feed conversion was significantly improved in broilers fed pre-starter to 14 DOA compared to broilers fed pre-starter to 10 DOA (Table 9).

From the present study, we find the broiler gains more weight immediately following a feed change but improvement in feed conversion does not mirror the improvement in weight gain (Table 5, 6). Feeding pre-starter to 14 DOA rather than 10 DOA appears to be beneficial as cumulative feed conversion was significantly improved at 49 DOA (Table 9). Feeding a pre-starter ration for a longer period would likely be more beneficial to growth, but cost must be considered as a pre-starter ration is essentially a diet with a higher plain of nutrition and thus costs more.

Broilers are commonly fed a starter ration to 17 or 21 days[29]. According to the present study, feeding a pre-starter ration with a high plain of nutrition via the addition of high levels of fat to 14 DOA may improve cumulative feed conversion at market, thus reducing cost of gain. Maximizing the improvement in feed conversion will require further research to determine at what age a pre-starter, high plain of nutrition ration should be fed while reduced cost of gain will be highly dependent on ingredient cost and the level of nutrient inclusion in the pre-starter ration.

Today's broiler appears to have an outstanding ability to compensate for lack of BW gain and achieve flock uniformity. This is likely due to the remarkable improvements in broiler genetics[30,31] leading to a drive in the broiler to maximally consume feed and grow accordingly. In the current study, Cx14 was the lightest treatment at 17 DOA (Table 7), but was the heaviest at both 35 (Table 8) and 49 DOA (Table 9). At 49 DOA, BW was similar across all treatments with only 130 g (3.6% of average 49 day b.wt.) difference between the lightest and heaviest treatment (Table 9). Studies in how today's broiler adjusts and compensates to deficient or excess energy and protein may lead to a better understanding of how to improve growth through marketing or more cheaply feed the birds with early intervention strategies.

SIGNIFICANCE STATEMENT

- Additional fat in the pre-starter diet did not result in improved BW or improved feed conversion at market
- Feeding the pre-starter ration to 14 DOA rather than 10 DOA did result in improved feed conversion at 49 DOA, but further research should be conducted to determine the ideal plain of nutrition and time feeding the pre-starter ration
- Under normal conditions, the addition of high level of fats during the pre-starter phase only is not recommended
- In the current study, significant improvements in growth and feed conversion were not observed at market and inclusion of high levels of fat raised the pre-starter diet cost. No changes in body fat content were noted

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