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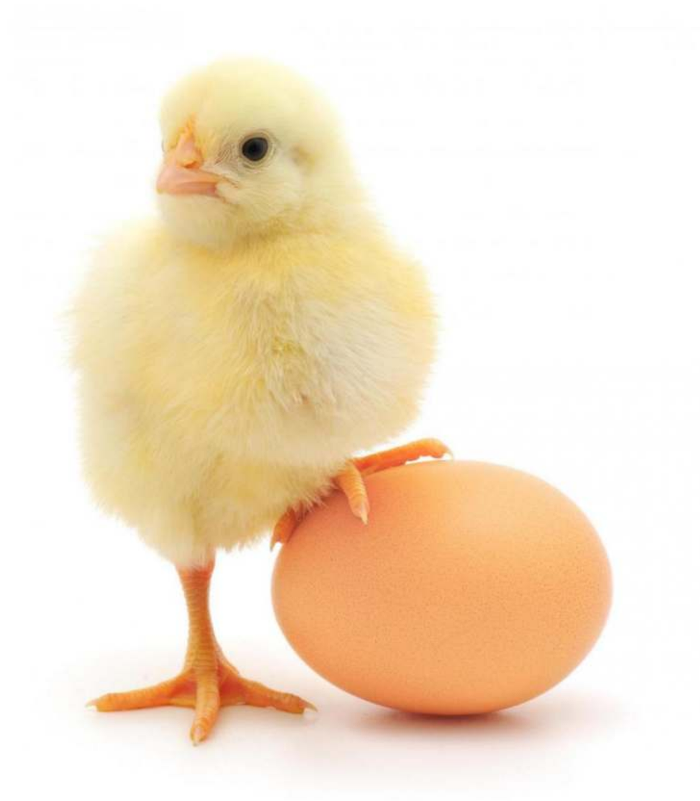

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Effect of Dietary Modifications Designed to Reduce Early Growth Rate on Live Performance and on Incidence and Severity of Ascites in Two Commercial Broiler Strains When Maintained Under Low Ventilation or Low Temperature Models[1]

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Abstract: Two studies were conducted in environmental chambers to evaluate different dietary modifications on the incidence or severity of ascites, leg disorders, and sudden death syndrome in males of two commercial broiler strains and their reciprocal crosses. A high energy-high nutrient density diet (HE) series served as the positive control. Two other diet series consisted of a high fiber (HF) diet fed 7 to 21 days of age, followed by the HE series, and a low energy-low nutrient density diet during the early growth phase, as suggested by a major breeder. All diets were pelleted. In one study, a low ventilation model was used while in the second study a low temperature model was used. However, due to limitations of the system we were unable to attain the desired low temperatures. In both studies, however, atmospheric levels of CO_2 and ammonia were greatly elevated. There were no differences in incidence or severity of ascites, leg disorders, or sudden death syndrome among broilers fed the different dietary regimes to 49 days of age. Broilers fed diets designed to reduce early growth rate were significantly lighter than those fed the HE diets at 21 days of age. At 49 days of age body weights were not always significantly different but quantitative weight differences were equal or greater than those observed at 21 days of age. It is possible that under environmental conditions more favorable to the development of ascites that dietary modification may prove beneficial. In these studies, however, live performance was reduced by the dietary modifications with no beneficial effects on reduction of ascites.

Key words: Broilers, ascites, sudden death syndrome, leg weakness, diet

Introduction

Earliest reports of the ascites syndrome were associated with high altitudes (Hall and Machicao, 1967; Maxwell *et al.*, 1986; Hernandez, 1987). More recently, it has become a severe problem in flocks reared at low altitudes (Julian *et al.*, 1987; Odum, 1993). Management factors associated with the development of ascites include inadequate house ventilation (Odum, 1993) or exposure to cold temperatures (Odum, 1993; Bendheim *et al.*, 1992; Julian *et al.*, 1989; Schlosberg *et al.*, 1992). The use of high energy or high nutrient density diets has been suggested to exacerbate ascites (Dale and Villacres, 1986; 1990) this may be influenced by the strain of bird used (Scheele *et al.*, 1991). A similar association of rate of gain with the development of sudden death syndrome (Guenter and Rotter, 1985; Steele and Edgar, 1982; Gardiner *et al.*, 1988; Julian and Bowes, 1987) and leg disorders (Hester *et al.*, 1989; Hulan *et al.*, 1980; Kestin *et al.*, 1992) has been proposed.

It has been suggested that a reduction in the rate of growth during the first few weeks of life can be effective in control of ascites (Dale, 1990) and sudden death syndrome (Bowes *et al.*, 1988; Yu and Robinson, 1992). However, this reduction in early growth should be achieved with little negative effect on the live production parameters. Although some research has indicated that feed restriction at an early age may alter early growth rates with no reduction in body weight at eight weeks of age (Plavnik and Hurwitz, 1985; Arce *et al.*, 1992) others have been unable to overcome the early growth retardation (Fontana *et al.*, 1992; Pinchasov and Jensen, 1989). The phenomenon of "compensatory gain" or "catch up gain" has been reviewed in detail by Yu and Robinson (1992). Based upon the hypothesis that ascites is associated with the rapid growth of the broiler chicken, restricting early growth rate through manipulation of the diet should lead to a reduction in ascites mortality. This has proved beneficial in some instances (Arce *et al.*, 1992; Moreno *et al.*, 1990; Bowes *et al.*, 1988) but not in others (Robinson *et al.*, 1992).

The objective of the present studies was to examine the use of different programs designed to alter early growth rate in broilers under environmental conditions designed to exacerbate the incidence of ascites. These programs included a low energy-low protein program

[1]Published with approval of the Director, Arkansas Agricultural Experiment Station, Fayetteville AR 72701. Mention of a trade name, proprietary product, or specific equipment does not constitute a guarantee or warranty by the University of Arkansas and does not imply its approval to the exclusion of other products that may be suitable.

Table 1: Composition (%) and calculated nutrient content of experimental diets

Ingredients	Starter Moderate Energy	Starter High Energy	Starter High fiber	Grower High Energy	Finisher High energy	Arbor Acres 0-14 d	Arbor Acres 14-21 d	Arbor Acres 21-35 d	Arbor Acres 35-49 d
Defatted rice bran	0.00	0.00	60.00	0.00	0.00	0.00	0.00	0.00	0.00
Yellow corn	62.62	51.33	23.62	55.46	62.01	60.10	56.25	61.90	68.32
Soybean meal (47% CP)	27.18	32.24	8.47	28.76	22.85	24.98	31.86	25.70	20.51
Poultry oil	2.00	7.94	2.00	7.61	7.27	1.00	3.83	4.70	3.68
Pro-Pak1	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Ground limestone	0.84	0.89	0.00	0.80	0.77	1.42	1.04	0.95	0.92
Dicalcium phosphate	1.08	1.26	0.00	1.14	0.96	1.06	0.98	0.72	0.60
Iodized salt	0.40	0.45	0.25	0.45	0.46	0.35	0.35	0.35	0.35
Vitamin premix[2]	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Trace mineral mix[3]	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
DL-Methionine (98%)	0.17	0.21	0.02	0.18	0.08	0.07	0.09	0.08	0.02
L-Lysine HCl (98%)	0.11	0.08	0.04	0.00	0.00	0.00	0.00	0.00	0.00
Ground rice hulls	0.00	0.00	0.00	0.00	0.00	5.42	0.00	0.00	0.00
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
AME, kcal/kg	3069.00	3300.00	2493.00	3322.00	3366.00	2805.00	3080.00	3190.00	3190.00
Crude protein, %	21.49	22.92	20.28	21.53	19.22	20.00	23.00	20.50	18.50
Calcium, %	0.91	0.98	1.50	0.91	0.84	0.95	0.95	0.85	0.80
Nonphytate P, %	0.46	0.50	0.47	0.47	0.43	0.47	0.47	0.41	0.38
Lysine, %	1.24	1.34	1.01	1.18	1.03	1.11	1.31	1.13	0.99
Methionine, %	0.55	0.61	0.42	0.56	0.44	0.45	0.50	0.47	0.38
TSAA, %	0.92	0.99	0.82	0.93	0.77	0.80	0.90	0.83	0.72

[1]H J. Baker & Bro., 595 Summer Street, Stamford, CT 06901-1407. [2]Provides per kg of diet: vitamin A (from vitamin A acetate) 7714 IU; cholecalciferol 2204 IU; vitamin E (from dl-alpha-tocopheryl acetate) 16.53 IU; vitamin B_{12} 0.013 mg; riboflavin 6.6 mg; niacin 39 mg; pantothenic acid 10 mg; menadione (from menadione dimethylpyrimidinol) 1.5 mg; folic acid 0.9 mg; choline 1040 mg; thiamin (from thiamin mononitrate) 1.54 mg; pyridoxine (from pyridoxine HCl) 2.76 mg; d-biotin 0.066 mg; ethoxyquin 125 mg; Se 0.1 mg. [3]Provides per kg of diet: Mn (from $MnSO_4•H_20$) 100 mg; Zn (from $ZnSO_4•7H_2O$) 100 mg; Fe (from $FeSO_4•7H_2O$) 50 mg; Cu (from $CuSO_4•5H_20$) 10 mg; I from $Ca(IO_3)_2•H_20$), 1 mg.

recommended by a major poultry breeding company and a high fiber-low energy program (Leeson *et al.*, 1991). These were compared to a high energy-high nutrient density program designed to exacerbate any potential problems with ascites or sudden death syndrome. The trials were carried out under conditions of low ventilation (Experiment 1) and low temperature (Experiment 2).

Materials and Methods

Experimental Diets: Three feeding programs were compared. The first program was considered as high energy (HE), consisting of feeding diets containing 1,500 kcal ME/kg for 0 to 21 days, 1,510 kcal ME/kg for 21 to 42 days, and 1,530 kcal ME/kg for 42 to 49 days of age. Diets were formulated to provide a minimum of 110% of the amino acids and protein levels recommended for male broilers (Thomas *et al.*, 1992), adjusted to the energy level of the diet. The second program was considered as a high fiber (HF) dilution program, based upon the recommendations of Leeson *et al.* (1991). This program consisted of feeding a moderate energy diet (1395 kcal ME/kg) for 0 to 7 days, followed by feeding a diet containing 60% defatted rice bran for 7 to 21 days of age; this diet was calculated to contain 1,133 kcal ME/kg with a minimum of 110% of the amino acid and protein levels recommended for male broilers (Thomas *et al.*, 1992), adjusted to the energy level of the diet. From 21 to 49 days of age the birds on this program were fed the high energy diets indicated above. The third program was that recommended by a major poultry breeder[2]. In this program (AA), a low energy (1,275 ME kcal/kg) diet was fed from 0 to 14 days of age, followed by progressively higher energy diets to market age. Composition of the diets is shown in Table 1. All diets were fed in pelleted form.

Experimental animals: Eggs from two commercial broiler strains (Ross x Ross[3], Cobb x Cobb[4]) and their reciprocal crosses (Ross x Cobb, Cobb x Ross) were obtained from local breeding flocks. Breeder flocks from which the eggs were obtained were of similar ages. The same breeder flocks were used for both experiments in this study. Chicks were hatched at the University of Arkansas hatchery and received no vaccinations. The chicks were feather-sexed and only the males used in the experiment.

[2] Arbor Acres Broiler Feeding and Management Guidelines, Arbor Acres Farms, Inc., Glastonbury CT 06033.
[3]Ross Poultry Breeders, Huntsville AL 35805. [4]Cobb-Vantress, Inc., Siloam Springs AR 72760.

Table 2: Weekly mean values (mean ± SD) for temperature, oxygen, carbon dioxide, and ammonia in environmental chambers (Experiment 1)

Day	Location	CarbonDioxide (%)	Oxygen (%)	Ammonia[1] (ppm)	Temperature (F)
7	Chamber	0.16 ± 0.05	20.9 ± 0.03	Nd	82.9 ± 2.42
	Ambient	0.20	20.8	Nd	73
14	Chamber	0.30 ± 0.04	20.8 ± 0.01	Nd	85.1 ± 2.31
	Ambient	0.20	20.8	Nd	74
21	Chamber	0.45 ± 0.06	20.5 ± 0.09	18.2 ± 9.4	85.8 ± 2.44
	Ambient	0.20	20.9	Nd	71
28	Chamber	0.33 ± 0.05	20.7 ± 0.05	30.5 ± 11.9	79.9 ± 2.57
	Ambient	0.20	20.9	Nd	58
35	Chamber	0.37 ± 0.05	20.7 ± 0.09	68.9 ± 18.9	84.8 ± 2.27
	Ambient	0.20	20.9	Nd	54
42	Chamber	0.28 ± 0.06	20.9 ± 0.04	41.0 ± 9.8	80.4 ± 2.27
	Ambient	0.20	20.9	Nd	55
49	Chamber	0.32 ± 0.04	20.9 ± 0.03	13.6 ± 3.0	74.3 ± 1.76
	Ambient	0.30	20.9	Nd	58

[1]Nd = not detected.

Table 3: Effect of different feeding programs on performance of male broilers maintained under low ventilation (Experiment 1)

Measurement	Feeding Program				
	Arbor Acres	High Energy	High Fiber	SEM	Prob > F
21 d Body weight, kg	0.741 b	0.780 a	0.599 c	0.01	0.0001
42-d Body weight, kg	2.328 ab	2.379 a	2.274 b	0.027	0.03
49-d Body weight, kg	2.807	2.873	2.808	0.037	0.36
0-21 d feed consumed, kg	0.981	0.977	0.976	0.014	0.95
0-42 d feed consumed, kg	3.898	3.881	3.870	0.038	0.86
0-49 d feed consumed, kg	5.135	5.043	5.080	0.057	0.53
0-21 d feed conversion (feed:gain)	1.325 b	1.255 c	1.636 a	0.014	0.001
0-42 d feed conversion (feed:gain)	1.676 ab	1.632 b	1.703 a	0.014	0.007
0-49 d feed conversion (feed:gain)	1.832 a	1.756 b	1.810 a	0.017	0.015
0-21 d calorie conversion (kcal/g gain)	3.923 b	4.140 a	4.221 a	0.056	0.003
0-42 d calorie conversion (kcal/g gain)	5.254 b	5.413 a	5.326 ab	0.047	0.076
0-49 d calorie conversion (kcal/g gain)	5.770	5.843	5.759	0.056	0.53
0-21 d mortality, %	0.83 b	3.96 a	2.71 ab	0.26	0.002
0-42 d mortality, %	2.29 b	5.83 a	6.04 a	0.27	0.005
0-49 d mortality, %	3.13 b	6.66 a	6.66 a	1.11	0.009
0-21 d culled, %	0.21	0.63	1.25	0.22	0.15
0-42 d culled, %	0.21 b	0.63 b	2.29 a	0.25	0.02
0-49 d culled, %	0.83 b	0.63 b	3.96 a	1.01	0.05
Ascites, % of total mortality	39.59	35.27	36.83	2.26	0.77
Skeletal, % of total mortality	31.04 ab	22.40 b	33.83 a	1.98	0.04
Other, % of total mortality	29.37 b	42.33 a	29.34 b	2.39	0.03

[abc]Means in row with common superscript do not differ significantly (P ≤ 0.05).

Housing and management: Twelve experimental chambers (120 ft^2) were utilized in this study; chambers were identical with regard to floor space, design, and equipment. Each chamber was subdivided into three sub-pens (40 ft^2) using dividers constructed of welded wire (1" x 2"). Each of the sub-pens contained a tube feeder and an automatic water fount. New rice hull litter was placed into the chambers. Between experiments, the chambers were cleaned, disinfected, and allowed to stand empty for 14 days.

Three chambers were assigned to each of four strains or strain crosses (Ross x Ross, Cobb x Cobb, Ross x Cobb, and Cobb x Ross). Forty male day-old chicks of the appropriate strain were placed in each sub-pen. The three experimental feeding programs were applied to each chamber in a randomized block design with sub-pen location (inner, middle, outer pen) as the block.

In the first experiment, a low ventilation model was used. Ventilation was provided to the birds via a port in the side of each chamber. Air flow rates were adjusted to provide for 0.1 cfm per bird from day 1 to 14, 0.2 cfm from day 14 to 28, 0.5 cfm from day 28 to 35, and 1.0 cfm per bird from 35 to 42 days of age. At this time, airflow rates were increased to 2 cfm per bird since the critical period for development of ascites was passed. Minimum room temperature rates were set beginning at 85 F for day 1 to 7 with a reduction of 5 F weekly to a minimum of 70 F; however, as a result of the reduced air flow, it was not

[5]ABL330, Radiometer America, Inc., Westlake OH 44145.

Table 4: Weekly mean values (mean ± SD) for temperature, oxygen, carbon dioxide, and ammonia in environmental chambers (Experiment 2)

Day	Location	CarbonDioxide (%)	Oxygen (%)	Ammonia[1] (ppm)	Temperature (F)
7	Chamber	0.29 ± 0.05	20.9 ± 0.05	Nd	83.2 ± 2.58
	Ambient	0.20	21.0	Nd	71
14	Chamber	0.33 ± 0.06	20.8 ± 0.04	Nd	81.4 ± 1.56
	Ambient	0.20	21.0	Nd	70
21	Chamber	0.32 ± 0.04	20.8 ± 0.06	23.8 ± 0.79	82.2 ± 1.89
	Ambient	0.20	21.0	Nd	62
28	Chamber	0.22 ± 0.04	21.0 ± 0.01	4.25 ± 0.9	71.5 ± 3.26
	Ambient	0.10	21.0	Nd	66
35	Chamber	0.22 ± 0.04	20.9 ± 0.01	8.8 ± 3.2	72.6 ± 1.67
	Ambient	0.20	21.0	Nd	64
42	Chamber	0.17 ± 0.06	20.7 ± 0.02	25.3 ± 5.9	75.4 ± 1.73
	Ambient	0.10	20.7	Nd	62
49	Chamber	0.23 ± 0.04	20.6 ± 0.04	19.1 ± 2.8	75.4 ± 1.78
	Ambient	0.20	20.7	Nd	64

[1]Nd = not detected.

possible to markedly reduce room temperature until after air flow rates increased. Incandescent lamps (one 60 W lamp per pen at 8 ft) were used to provide light from 0100 to 2400 daily.

In the second experiment, a combination of low ventilation rates and cold stress was attempted. From hatch to 3 wk, chicks were reared as previously described. From 3 wk through the duration of the trial, the ventilation rate was increased to 1 cfm per bird and an attempt was made to reduce the chamber temperature below the thermal comfort zone (55 F). However, the system used to cool the chambers was unable to overcome the heat generated by the birds and did not reach this level.

Measurements: Group body weights by sub-pen were taken at day-old and at weekly intervals. Feed allocations were made at the times specified above and quantity of feed determined. Birds that died or were removed from the pens (primarily as a result of leg disorders) were weighed and the weight used in calculation of feed utilization and calorie conversion. Dead birds were examined for presence of fluid in the abdomen and pericardium as an indication of ascites. Temperature was measured daily; atmospheric oxygen, ammonia and CO_2 were measured weekly per chamber. Atmospheric CO_2 and oxygen were measured[5] on sampled air drawn from a tube after all void air had been exchanged. Atmospheric ammonia was sampled by drawing air through Gastec analyzer tubes[6]. All temperature and air quality measurements were made at bird level. As a comparison, air quality measurements were also made inside the Poultry Environmental Laboratory in which the chambers were located. Chamber temperature and humidity were continually monitored and recorded daily at 1500 hr. At 49 days all birds in the second study were individually examined ante mortem for visual indications of ascites.

Statistical analysis: Data were subjected to statistical analysis using the General Linear Models (GLM) procedure of the SAS Institute (1988). Live performance data were analyzed as a randomized block design with pen means as the statistical unit. Blocks were sub-pens in chambers. Mortality data were transformed as $\sqrt{n+1}$; percentage data were transformed to arc sine before analysis. Natural numbers for these data are presented in the following tables. The statistical model included block, strain or strain cross, dietary treatment, and appropriate interactions. When significant treatment differences were found, means were separated using repeated t tests using probabilities generated by the LSMEANS option of the GLM procedure of SAS® software (SAS Institute, 1988). All statements of statistical significance are based upon $P < 0.05$.

Results and Discussion

Experiment 1

Chamber characterization: Weekly mean values for temperature, oxygen, carbon dioxide, and ammonia are shown in Table 2. Although atmospheric levels of oxygen in the environmental chambers did not change markedly during the study, the levels of CO_2 and ammonia increased markedly during the study as compared to ambient values. Ammonia levels peaked at 35 days and declined at 42 and 49 days of age as ventilation rates were increased. The chambers were unable to reach the lower minimum temperatures established for the study due to the high bird density and reduced airflow. At 42 and 49 days of age chamber temperatures declined as airflow rates were increased. There were no interactions of strain or strain cross and dietary treatments on any of the performance parameters evaluated; therefore discussion of the results will focus on main effects of dietary treatment. The effects of the three dietary feeding programs on performance under the low ventilation model are shown in Table 3.

[6] Gastec Corporation, 6431 Fukaya, Ayase City 252, Japan.

Table 5: Effect of different feeding programs on performance of male broilers maintained under low temperature (Experiment 2)

Measurement	Feeding Program				
	Arbor Acres	High Energy	High Fiber	SEM	Prob > F
21 d Body weight, kg	0.627 b	0.716 a	0.547 c	0.017	0.0001
42-d Body weight, kg	2.041 ab	2.161 a	2.001 b	0.040	0.03
49-d Body weight, kg	2.516 b	2.646 a	2.453 b	0.031	0.001
0-21 d feed consumed, kg	0.905 b	0.916 b	0.979 a	0.017	0.01
0-42 d feed consumed, kg	3.643	3.744	3.642	0.050	0.29
0-49 d feed consumed, kg	4.808	4.933	4.821	0.064	0.36
0-21 d feed conversion (feed:gain)	1.453 b	1.282 c	1.801 a	0.035	0.0001
0-42 d feed conversion (feed:gain)	1.788 ab	1.734 b	1.827 a	0.026	0.04
0-49 d feed conversion (feed:gain)	1.912 ab	1.866 b	1.966 a	0.024	0.02
0-21 d calorie conversion (kcal/g gain)	4.298 b	4.231 b	4.658 a	0.097	0.01
0-42 d calorie conversion (kcal/g gain)	5.606	5.750	5.698	0.081	0.47
0-49 d calorie conversion (kcal/g gain)	6.021	6.206	6.235	0.075	0.12
0-21 d mortality, %	1.04	1.46	2.29	0.28	0.60
0-42 d mortality, %	5.62	7.60	7.08	0.26	0.41
0-49 d mortality, %	6.88	8.65	8.96	0.24	0.32
0-21 d culled, %	0.00	0.63	0.42	0.15	0.20
0-42 d culled, %	0.63	1.25	1.25	0.26	0.65
0-49 d culled, %	0.63	1.25	1.25	0.26	0.65
Ascites, % of total mortality	70.58	65.90	54.00	8.01	0.58
Skeletal, % of total mortality	8.82	6.82	12.00	4.48	0.76
Other, % of total mortality	20.60	27.28	34.00	7.71	0.23
External Ascites score					
No visible abdominal fluid, %	60.87	62.65	61.22	0.04	0.91
Some visible abdominal fluid, %	38.90	35.74	36.60	0.03	0.72
Abdominal fluid present, %	0.23	1.61	2.18	0.03	0.19

[abc]Means in row with common superscript do not differ significantly ($P \leq 0.05$).

Body weight: At 21 days body weight of broilers fed either the AA or HF programs was significantly less than that of broilers fed the HE program; broilers fed the HF diet weighed significantly less than those fed the AA program. At 42 days there was no significant difference in body weight between those fed the HE and the AA program; birds on the HF program weighed significantly less than those on the HE program but not those on the AA program. At 49 days, there were no significant differences in body weight among those fed the different feeding programs.

These results would suggest that some "compensatory gain" occurred among broilers fed the AA and HF diets following the periods of early growth restriction. Analysis of weekly body weight gains (Fig. 1) depicts the early growth restriction attained on the AA and HF feeds; however, at no time after 21 days of age was weekly growth rate of birds on these diets significantly greater than that of birds on the HE diet program. This apparent incongruity between lack of an apparent "compensatory gain" and lack of significant difference in body weight at 49 days of age can be explained by the fact that quantitative differences in weight existed between birds on the AA or HF programs and those fed the HE at 21, 42, and 49 days of age; however, as a relative percentage of the body weight these differences declined. For example, birds fed the AA program weighed 39 g less at 21 days than those fed the HE program (a 5% reduction in weight) and differed significantly in body weight. At 49 days birds fed the AA program weighed 66 g less than those fed the HE program (a 2.29% reduction in weight) but this was not a statistically significant difference.

Feed consumption: There were no significant differences in feed consumed among broilers fed the different dietary programs. The modern broiler has been selected to eat at full capacity (Marks, 1979, 1980), and intake did not appear to be a limiting factor in this study. All diets were pelleted, alleviating some of the problems with differences in dietary bulk density.

Feed conversion: Significant differences in feed conversion (kg feed:kg gain) were observed at all ages. Broilers fed the HE program had significantly better feed conversion that those fed the HF program at all ages and significantly better than those fed the AA program at 21 and 49 d. Birds fed the AA program had significantly better feed conversion than those fed the HF diets at 21 d but there was no significant difference in feed conversion between broiler fed the AA or HF programs at 42 or 49 d.

Calorie conversion: As diets in the different programs varied markedly in calorie content, calorie conversion (kcal ME per g gain) is a more precise measure of the ability of the birds to utilize their diets than is feed conversion. At 21 days of age birds on the AA program had a significantly better calorie conversion than birds on the HE or HF program; at 42 days calorie conversion by birds fed the AA program was still significantly better than that of birds fed the HE program. At 49 days of age, however, there were no significant differences in calorie conversion among birds fed the different dietary programs.

Mortality and culls: Mortality and number of culls were lowest for birds fed the AA program. Mortality was similar for birds fed the HE and HF programs; however there were significantly more culled birds among those fed the HF program. Due to the composition of the defatted rice bran, the HF diets were high in both calcium and phytate phosphorus as compared to the other diets fed during the 0 to 21-day period; these high levels may have contributed to a greater incidence of leg abnormalities that resulted in increased numbers of cull birds.
Mortality attributed to ascites made up approximately 37% of the total mortality, and did not differ among the dietary treatments. Mortality attributed to skeletal problems was significantly higher for those fed the HF program as compared to those fed the HE program; mortality from skeletal problems for those fed the AA programs was intermediate between those fed the HE and HF programs.

Experiment 2

Chamber characterization: Weekly mean values for temperature, oxygen, carbon dioxide, and ammonia are shown in Table 4. Atmospheric levels of oxygen in the environmental chambers did not change markedly during the study; however, levels of CO_2 and ammonia increased during the study as compared to ambient values. Ammonia levels in this study were lower than those observed in the previous study as air flow rates were markedly higher; peak levels of 23.8 and 25.3 ppm ammonia were reached at 21 and 42 days of age, respectively. Temperature in the chambers was considerably higher than the desired temperature as the supply of cold air was not sufficient to overcome heat generated by the birds; therefore cold temperature stress was not encountered in this study.
There were no interactions of strain or strain cross and dietary treatment on any of the performance factors evaluated; therefore discussion of the results will focus on main effects of dietary treatment. The effects of the dietary feeding programs on performance under the low temperature model are shown in Table 5.

Body weight: At 21 and 49 days body weight of broilers fed the AA program was significantly less than that of broilers fed the HE program. Body weight of broilers fed the HF diet was significantly less than that of broilers fed the HE program at all ages examined, but did not differ

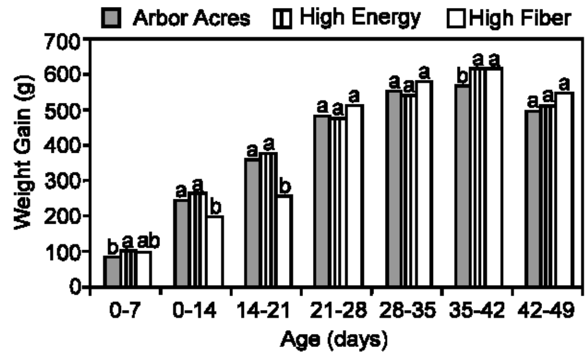

Fig. 1: Effect of different feeding programs on weekly weight gain of male broilers maintained under low ventilation model (Experiment 1)

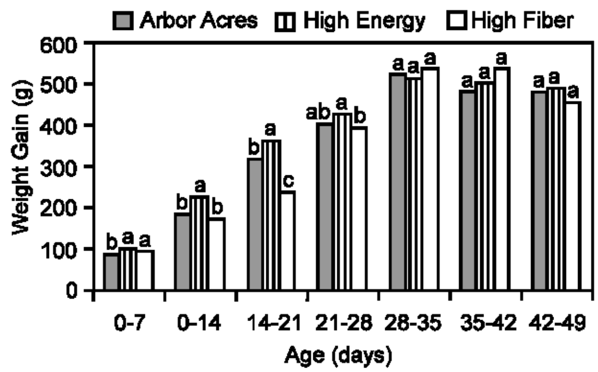

Fig. 2: Effect of different feeding programs on weekly weight gain of male broilers maintained under low ventilation model (Experiment 2)

significantly from that of those fed the AA program at 42 and 49 days of age. Analysis of weekly body weight gains (Fig. 2) indicates that at no time during the study was weekly gain of broilers fed the AA or HF diets significantly greater than that of broilers fed the HE diet; therefore the phenomenon of "compensatory gain" was not observed in this study. Quantitative differences in body weight between broiler fed the HE diet program and those feed either the AA or HF programs were equal or greater at 42 or 49 days than at 21 days, although a lesser percentage of difference in body weight.

Feed consumption: Birds fed the HF dietary program consumed significantly more feed during the first 21 days than those fed the HE or AA programs; there was no significant difference in feed consumption among dietary treatments at 42 or 49 days of age.

Feed conversion: As would be expected, feed conversion was numerically the lowest for broilers fed the HE program; however, except at 21 d of age there was no significant difference in feed conversion between broilers fed the AA and HE programs . Broilers grown on the HF program had significantly higher feed conversion than those fed the HE diets at all ages; they did not differ significantly from those fed the AA program at 42 or 49 days of age.

Calorie conversion: Calorie conversion at 21 days was significantly increased by the HF feeding program; at 42 and 49 days of age there were no significant differences in calorie conversion among the dietary treatments.

Mortality and culls: There were no significant differences in mortality or number of culls among the dietary treatments. The increase in percentage of culls observed on the HF program in the first study was not apparent in this study. A different lot of defatted rice bran was used in the second study; however, analysis of the product indicated similar values for calcium and total phosphorus as that used in the first study.

Mortality attributed to ascites was somewhat higher than in the previous study, accounting for approximately 63% of total mortality. However, there were no significant differences among the dietary treatments. There were no significant differences among dietary treatments for incidence of mortality due to skeletal problems.

Visible ascites score: At 49 days of age, approximately 62% of the birds had no visible indications of ascites, while approximately 37% displayed some visible abdominal fluid and approximately 1.3% had definite indications of abdominal fluid present. However, there were no significant differences among dietary treatments for percentage of birds within each of these categories, suggesting that dietary treatment had little effect on incidence or severity of ascites.

Results of these studies suggest that dietary factors have little effect upon incidence or severity of ascites in rapidly growing chickens. The HE diet regime used in these studies is probably as nutrient-dense as is likely to be encountered under practical conditions; however, incidence and severity of mortality on this dietary regime was no more than that encountered on regimes designed to delay early growth rate. This is in contrast to reports by Dale and Villacres (1990); however, it is possible that the environmental insults faced by broilers in the studies by Dale and Villacres may have resulted in a greater predisposition to the development of ascites.

One of the problems in attempting to conduct research on a problem such as ascites is being able to consistently reproduce the syndrome as it occurs under practical conditions. In these studies, total mortality was not exceptionally high in either trial, as compared to field averages reported by various agricultural reporting services. However, percentage of total mortality from ascites was quite variable, ranging from 35 to 40% in the first trial and 54 to 70% in the second trial. Although we were unable to attain the cold stress levels we were attempting to achieve, elevated levels of CO_2 and ammonia were attained. As environmental conditions were considerably worse in the first trial than in the second, trial differences in percentage of total mortality from ascites are difficult to associate with environmental conditions.

Birds used in these trials received no vaccination on day of hatch or at any subsequent time during the study. It is possible that the stress associated with routine hatchery vaccination for various respiratory diseases may predispose chicks to ascites, especially if atmospheric ammonia levels are high.

Conclusions: No differences were noted in incidence or severity of ascites, leg disorders, or sudden death syndrome between two popular commercial broiler strains and their reciprocal crosses. Under environmental conditions of increased atmospheric CO_2 and ammonia, broilers fed high energy-high nutrient density diets from day of hatch to 49 days of age had no greater incidence or severity of ascites, leg disorders, or sudden death syndrome than those fed a high fiber-low energy diet from 7 to 21 days of age or those fed a low energy-low nutrient density diet during the early growth phase. Feeding such diets to delay early gains resulted in a significant reduction in body weight at 21 days of age. Differences in body weight at 49 days of age were significant in one study but not in another; however quantitative differences in body weight at 49 days of age were equal or greater than those observed at 21 days of age; thus, "compensatory gains" were not attained in these trials.

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