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Relationship of Diet Composition to Survival Time of Chicks When Subjected to High Temperature.* (32518)

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Several factors influence survival time of poultry during heat stress. It has been reported that heat tolerance is controlled by inheritance(1-3), and that genetic selection is effective in decreasing or increasing the survival times of birds(2). Laying hens developed in an area of high temperatures were more tolerant of high temperatures than those developed in cooler areas and those developed in cooler areas were more tolerant of cool weather(3). It has also been found that temperature and relative humidity affect the heat tolerance ability of poultry(4).

There are relatively few reports in regard to the effect of nutrition on heat tolerance. Most of the research has been concerned with increasing the feed efficiency, egg production and/or growth during the summer months. Elevated temperature depressed growth and feed consumption, and the incorporation of fat into the diet improved growth and feed consumption(5). Mortality was shown to be appreciably greater in groups of chickens receiving diets moderately high in protein than it was in groups receiving standard diets or diets low in protein(6).

It is an accepted fact that the chicken eats to meet its energy requirement. There has been, however, much controversy as to whether calories from fat, carbohydrate and protein are equal. It has been reported that calories from fat and carbohydrates are equal (7). When protein, fat or carbohydrate was fed alone, the basal metabolism was raised over the intake of calories received from the individual feedstuffs, with protein giving the greatest increase(8). All specific dynamic effects were reported(9) to be greatly modified when a food mixture rather than a single foodstuff was fed. It has also been reported (10) that the iso-caloric substitution of corn oil for 0, 5, 10 and 15% glucose and animal fat resulted in a reduced heat increment at 90°F as the level of corn oil was increased. However, increasing the energy or protein content of the diet did not restore growth rate of chicks when the temperature was increased from 70 to 95°F(11).

This study was designed to determine the relationship of dietary protein and energy levels to the heat tolerance of five-week old Single Comb White Leghorn chicks.

Methods. Experiment 1. Birds used in Trials 1 and 2 were the F_3 generation of the lines selected for high and low tolerance to high temperature(2). These birds were designated as hi-line and lo-line birds, respectively.

At one day of age the chicks were wing-banded for identification and equal numbers of hi-line and lo-line chicks were randomized into floor brooding pens with 20 chicks per pen. The chicks were not dubbed, debeaked, wingclipped or vaccinated. Each pen contained peanut hulls as litter, one automatic water fount, one tube-type feeder and one infra-red bulb as a heat source.

The diets (Table I) used were corn-soybean type containing 2026 Calories of productive energy per kilogram of diet. Adjustments were made by varying the corn, soybean meal and inert filler (sand) to keep the diets isonitrogeneous and iso-caloric as animal fat was added. Feed and water were available *ad libitum*.

Survival time, at 40.8°C, of the 5-week old chicks was measured in a heat chamber as described by Wilson *et al*(2).

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TABLE I. Composition of Diets.

Ingredients	Diets 1	2	3	4
	(%)			
Yellow corn	56.40	46.85	26.00	17.00
Soybean meal (50%)	34.20	47.50	38.60	51.50
Ground limestone	.68	1.07	.43	.82
Defluorinated phosphate	1.30	.77	1.68	1.15
Microingredients*	.90	.90	.90	.90
Iodized salt	.50	.50	.50	.50
Animal fat	.00	.00	12.00	12.00
Inert filler (sand)	3.62	.00	17.47	13.73
Alfalfa meal (17%)	2.50	2.50	2.50	2.50
Protein	22.0	28.0	22.0	28.0

* Supplied per kg of feed: 6,600 I.U. vit. A, 2,200 I.C.U. vit. D_3, 11 mg menadione sodium bisulfite, 4.4 mg riboflavin, 13.2 mg calcium pantothenate, 39.6 mg niacin, 500 mg choline chloride, 22 μg vit. B_{12}, 125 mg ethoxyquin, 20 mg iron, 2 mg copper, 200 μg cobalt, 1.1 mg iodine, 100 μg zinc, and 175 mg manganese.

Eight chicks from each diet were randomly selected for each run, with equal numbers from each sex, dietary protein level, dietary fat level and genetic line. The chicks were then placed in a welded wire tray with 35 individual (6 × 6 × 4 inch) compartments. Each tray contained 32 birds per run. While in the chamber, the chicks were observed constantly and survival time recorded to the nearest minute from the time they were placed in the chamber. Birds not dead after the 120-minute exposure period were recorded as having a 120-minute survival time. Neither feed nor water was available in the chamber, and the chicks were placed in the cabinet within 30 minutes after being selected.

Trials 1 and 2 were identical, except that feed efficiency was measured in Trial 2. Therefore, the data were combined and analyzed as one experiment. Analysis of variance techniques(12) were used to analyze the data.

Results and discussion, Experiment 1. The chicks which received the diets containing the 12% added animal fat had significantly shorter survival times, regardless of the dietary protein level (Table II). No explanation can be given for the lowered survival time due to the added fat. However, it did not appear to be related to feed intake or feed efficiency, since there was no apparent difference in these in Trial 2. The finding that protein did not affect heat tolerance agrees with a previous report(13).

Differences between hi-lines and lo-lines were significant, with hi-lines surviving an average of 86.5 minutes, and the lo-lines 62.9 minutes. This was in agreement with a recent report from this laboratory(2). The line × diet interaction was not significant, which indicates that neither line was more responsive to the addition of fat to the diet.

In Trial 1 there was a significant difference due to sex (71.1 *vs* 79.2 min) and in Trial 2 survival times were numerically different with the same trend (72.0 *vs* 75.9 min). The difference in survival time due to sex does not agree with other reports(2,14). It does agree with one report where such a difference was found(4). The sex difference in this experiment may have resulted from the difference in body weight, hormone levels or metabolic rates. There were no significant interactions with sex.

Methods, Experiment 2. Two hundred and fifty Single Comb White Leghorn cockerels were randomized at one day of age into floor brooding pens and grown under the same conditions as the chicks in the previous experiment. The diets were formulated to contain 22% protein and 3, 6, or 12% animal fat. The various levels of animal fat in the diets were obtained by mixing appropriate parts of the control diet, which contained 22% protein and no supplemental fat, with the correct amount of the 12% animal fat diet. In 3 diets, corn oil was substituted for animal fat, resulting in a total of 7 experimental diets. Survival time of chicks was measured at 5 weeks of age using procedures identical to those in Experiment 1.

Results and discussion, Experiment 2. The

TABLE II. Survival Time of Chicks Fed 4 Different Diets.

Diets	Protein (%)	Fat (%)	Survival time (min)* Trial 1	Trial 2	Avg
1	22.0	0	81.05[a]	82.35[a]	81.70[a]
2	28.0	0	76.85[a]	83.02[a]	79.94[a]
3	22.0	12	68.00[b]	67.09[b]	67.55[b]
4	28.0	12	69.98[b]	68.44[b]	69.21[b]

* Means with different superscripts are significantly different according to Duncan's multiple range test.

effect of diet on survival time of chicks was not significant. However, the survival times were 72.8 and 68.0 minutes for the control and fat-fed birds, respectively. The significant run × diet interaction apparently caused the main effect of diet to be obscured.

The chicks used in Experiment 2 were a commercial strain not previously selected for heat tolerance. Therefore, the variation in this population was considerably greater than that of the selected population used in Experiment 1.

Differences between runs and run × diet interaction were both significant. This was attributed to the greater individual variation in the chicks used.

Results from these two experiments indicated that it was of utmost importance to know the previous breeding program of the experimental birds. Since the background of the chicks used in Experiment 1 was known, it was possible to explain why they were less variable than the chicks in Experiment 2.

Summary. Two experiments were conducted to test the effect of diet composition on heat tolerance. The addition of 12% animal fat to the diet significantly reduced the survival time of chicks when they were exposed to 40.8 ± 0.3°C and 75 ± 5% relative humidity. The level of protein in the diets had no effect. The birds used had been previously selected for either a high or low tolerance to heat. In Experiment 2, the differences between runs and the run × diet interaction were both highly significant. The interaction obscured the main effect of diet which was not significant. This population which was unselected with regard to heat tolerance had such great variation that large numbers of birds would be required to test effects of diet on heat tolerance.

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Effect of Hypocapnia and Respiratory Alkalosis on Cardiac Contractility.* (32519)

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The effect of hypocapnia on cardiac performance remains open to question. Studies on isolated muscle by Vaughan Williams(1) and others(2,3) suggested that a reduction in P_{CO_2} is accompanied by an increase in myocardial contractility. This finding has been supported by data from unanesthetized human studies(4) and the dog heart-lung preparation(5). Recently, Little and Smith(6) and Theye and coworkers(7) have presented evidence that the drop in arterial P_{CO_2} that accompanies hyperventilation in anesthetized dogs or man is associated with a reduction in cardiac performance. Other investigators

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