Hematocrit Values in Weight-Selected and Relaxed Lines of White Rock Chickens

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ABSTRACT Hematocrits (PCV) were measured at 29 and 106 d of age (PCV1 and PCV2, respectively) in male and female White Plymouth Rocks. Four lines were used, two of which had undergone 40 generations of divergent selection for 8-wk BW (HWS, LWS), and two respective sublines (HWR, LWR), in which selection had been relaxed for five generations. At both ages, males and females did not differ for PCV in lines HWR, LWR, and LWS. For line HWS there was an age by sex interaction that resulted from an age effect for males but not for females, and from a sex effect at each age. At both ages, PCV was higher for the HW than the LW lines. Initially, there was no difference between the selected and their respective relaxed lines, but by 106 d, HWR chickens had a higher PCV than HWS chickens. In lines HWR and LWR, PCV increased with age. There was a negative correlation in HWS males for PCV1 with 28 and 56 d BW. The HWR males also had a negative correlation for PCV1 with BW at 28 d, but not between PCV2 and BW. The correlation for PCV1 with PCV2 was high and positive for HWR males and females.

(Key words: hematocrit, body weight, broiler)

INTRODUCTION

Meat-type chickens have been intensely selected for rapid growth, high meat yield, and superior feed conversion, causing changes in other physiological parameters. Often, the high yielding meat lines experience metabolic stress in the form of hypoxemia, resulting from high demands for blood oxygen by a rapidly developing tissue mass. In response to such metabolic demands, broilers often have higher values for packed cell volume or hematocrits (PCV).

Washburn and Siegel (1963), Lubritz and McPherson (1994), and Silversides et al. (1997) reported that hematocrits differed among populations, with those selected for high body weight, rapid protein accretion, or superior feed efficiency having higher values than birds selected for low weight or unselected controls. Also, it was found that PCV could be modified by direct selection (Washburn, 1967; Shlosberg et al., 1996), or as a correlated response to selection for traits that cause metabolic stress: high juvenile body weight, rapid growth, high feed efficiency, high meat yield, or response to cold stress (Washburn and Siegel, 1963; Lubritz and McPherson, 1994; Shlosberg et al., 1996). Also, Shlosberg et al. (1996) noted that extremes in PCV had possible deleterious effects on mortality.

The purpose of the present experiment was to measure PCV in lines of White Rock chickens divergently selected for juvenile body weight and in sublines in which selection had been relaxed.

MATERIALS AND METHODS

Stocks, Husbandry, and Traits Measured

White Plymouth Rocks in the S40 generation of divergent selection for 8-wk BW (high weight select = HWS, low weight select = LWS) and two lines in which selection had been relaxed for five generations (high weight relaxed = HWR, low weight relaxed = LWR) (Liu et al., 1995; Dunnington and Siegel, 1996) were used for this experiment.

Eggs from age-contemporary parents of the four lines were incubated together. At hatch, chicks were wing-banded, vaccinated for Marek’s disease, and brooded by line in an eight floor-pen unit. Chicks were fed a mash diet containing 20% CP and 2,685 kcal ME/kg to 56 d of age. Thereafter, the diet contained 14% CP and 2,827 kcal ME/kg. These diets were the same formulation used through-

Abbreviation Key: HWR and LWR = sublines of HWS and LWS, respectively, where selection was relaxed for five generations; HWS = line selected 40 generations for high 8-wk body weight; LWS = line selected 40 generations for low 8-wk body weight; PCV = hematocrits.
out selection. The LW chicks consumed feed *ad libitum*, whereas HW chicks were placed on a restricted feeding regime commencing at 57 d of age. At that age, chicks were transferred to growout pens in another building. Individual BW were obtained at 28 and 56 d of age. At 29 and 106 d of age, duplicate samples of blood (PCV1 and PCV2, respectively) were collected from the left brachial vein into heparinized microhematocrit tubes. For PCV1, 40 chicks per line were selected at random. Sample sizes for PCV2 were 35, 36, 38, and 42 for lines HWS, LWR, HWR, and LWS, respectively. Samples were centrifuged, and the results read using the Damon® Micro-capillary Reader.2

**Statistical Analyses**

Means of the duplicate PCV samples were used for analysis. Body weights were transformed to common logarithms and PCV to arc sine square roots prior to preliminary ANOVA with line, sex, and age as main effects, along with all of the interactions among them. When line effects were significant, comparisons of multiple means were made using Duncan’s multiple range test. Product-moment correlations between PCV and BW were calculated for males and for females within each line. Analyses were performed using SAS® procedures (SAS Institute, 1985), with significance considered as *P* ≤ 0.05.

**RESULTS AND DISCUSSION**

The line by age by sex interaction for PCV was significant; therefore, the effects of age, sex, and the interaction between them were tested separately for each line. The PCV (Table 1) of high weight line chickens were higher than for the low weight line chickens, which is in agreement with results of Washburn and Siegel (1963). Among these lines, it has been found that the high weight lines reach maturity at an earlier age than birds of the low weight lines (Liu et al., 1995). Onset of sexual maturity would tend to increase PCV due to the positive effect of androgens (Washburn and Siegel, 1963). These results were also consistent with those reported by Scheele et al. (1991) and Lubritz et al. (1995), in that the more feed-efficient and faster growing lines displayed higher PCV. In such chickens, rapid protein accretion and body growth increased physiological demands for oxygen, causing the body to increase the concentration of red blood cells. Although this trend existed at 106 d, at this age PCV were higher for HWR than HWS chickens (Table 1). This difference between HWR and HWS chickens may be because sexual maturity and development are delayed in the selected lines as compared to their respective relaxed lines (Dunnington and Siegel, 1996). This reasoning was consistent with an age effect for HWR and LWR, and HWS males. The LWS chickens did not exhibit any change in PCV throughout the experiment, which was expected because their sexual maturity is greatly delayed due to anorexia (Zelenka et al., 1988, Dunnington and Siegel, 1996).

Coefficients of variation for PCV were higher in the LW than HW lines, which may be due, in part, to the more varied states of well-being among LW and the degree of anorexia in individuals (Dunnington and Siegel, 1996). In addition, as an indirect response to selection for high 8-wk BW, PCV may exhibit less variation in HWS and HWR as demands for oxygen would dictate a narrower range of values.

Significant negative correlations (Table 2) existed between PCV1 and 28 and 56 d BW for HWS males, and between PCV1 and 28 d BW for HWR males. All other correlations between PCV and BW were not significant. Demands for resources in intensely selected lines may at times be in conflict, creating negative correlations between traits because individuals cannot simultaneously satisfy all demands (Dunnington and Siegel, 1996). Also, noting the established relationship between low feed conversion ratios, rapid protein accretion, and high PCV (Scheele et al., 1991; Lubritz et al., 1995), it is feasible that males with heavier juvenile BW were going through a metabolic period during which feed efficiency or growth of muscle mass were diminished due to allocation of resources, a metabolic state that less developed females and smaller males had not yet reached.

Both sexes of HWR showed a high positive correlation between PCV1 and PCV2 (Table 2). This association in which individuals with higher PCV at 29 d would also have the higher PCV at 106 d was not evident for the other lines. The correlation among HWR may be linked to maturity, as HWR chickens reach sexual maturity earlier than those of the other three lines studied here, and to genetic status of the line with respect to selection intensity and overall fitness. It has

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<th>Table 1. Mean hematocrits ± SEM at 29 and 106 d of age</th>
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2a,bMeans ± SEM within a column with no common superscript differ significantly (*P* ≤ 0.05). *P* ≤ 0.05, **P** ≤ 0.01 when comparing adjacent means.

1HWS = high weight selected line, LWS = low weight selected line, HWR = high weight relaxed line, LWR = low weight relaxed line.

2The interaction between sex and age was significant for HWS.
also been suggested that when lines are subjected to intense selection pressures, physiological parameters may be reset (Dunnington and Siegel, 1996). The two HW lines, under intense selection for high body weight for many generations, would need PCV levels at a higher concentration to accommodate oxygen demands. It is possible that chickens of the relaxed line, without continued selection pressure, became more stabilized than HWS at the new level, with a more uniform rate of change in PCV. It follows that PCV is closely associated with onset of sexual maturity and rate of development within a line.

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REFERENCES


