HEMATOLOGICAL PARAMETERS AND ORGAN WEIGHTS IN CHICKENS OF TWO STRAINS

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SUMMARY

Various hematological parameters, organ weights and water content in two different strains of chickens (Shaver and New Hampshire) were studied in 10 males and 10 females from each strain at different ages. Shaver animals usually showed higher hematocrit and hemoglobin values than the New Hampshire, while no strain differences were observed for plasma iron. The absolute weights of liver, spleen, kidneys, heart and feathers were usually lower in the Shaver, but relative weights tended to reduce the differences and feathers presented maximum values in the Shaver at all ages. A decrease of absolute and relative weights in the spleen during laying was noticed. The water content for a given organ was similar in both strains at all ages except for feathers which showed a decrease with age. The above cited differences between the two strains may be related to their different relative metabolism, as the Shaver have more active behavior and smaller size.

RESUMEN

Se estudiaron varios parámetros hemáticos, pesos de los órganos y su contenido en agua en dos razas de pollos (Shaver y New Hampshire), en diez machos y diez hembras

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de cada raza a diferentes edades. Los animales de raza Shaver normalmente presentaron valores más elevados para el hematocrito y la hemoglobina que los de raza New Hampshire, mientras que no se detectaron diferencias para el hierro plasmático. Los pesos absolutos de hígado, bazo, riñones, corazón y las plumas fueron generalmente más bajos en los pollos Shaver, pero los pesos relativos tenían tendencia a igualarse y las plumas presentaban valores máximos en los animales de raza Shaver a todas las edades. El descenso de los pesos absolutos y relativos del bazo durante la puesta fue remarcable. El contenido en agua para un órgano determinado fue igual en las dos razas a todas las edades, excepto para las plumas, las cuales presentaron un descenso con la edad. Las diferencias arriba citadas entre las dos razas pueden estar relacionadas con un diferente metabolismo relativo, ya que los pollos de raza Shaver son más activos y tienen menor talla.

INTRODUCTION

Mammals, especially from laboratories, are most often used in experimental physiology and variations in their development, organ weights and hematological values, have been often observed [2, 8, 26, 27]. However, comparatively few studies have been done on birds.

In birds, organ weights have been shown to change because of factors such as genetic variations [20, 21], environmental conditions [3, 4, 10] and age [5, 15, 30]. At the same time, the hematological parameters of growing animals [5, 10, 13, 16, 17] and those in the laying state [1, 13, 19, 25], have also been analyzed, usually, however in isolated observations.

We therefore thought it of interest to study some hematological parameters and both absolute and relative weights of organs in males and females from 4 to 18 weeks, and females until the laying period (24 weeks), in two different strains of chickens: the Shaver, and the New Hampshire because of their different growth rate and laying frequency [14].

MATERIALS AND METHODS

One-day-old Shaver and New Hampshire chickens, of both sexes, were purchased from a commercial breeder and then reared in our laboratory. The chicks were raised at temperatures of 33-35 °C, during the first 2 weeks after hatching and then at 21-22 °C until sacrificed. Growing chickens and laying females of both strains were fed at specific life periods with "Hens" ® (Barcelona-Spain) all-mash adapted feed (Table 1).

When the animals reached 8 weeks they were individually housed in galvanized batteries and given free access to water and food. Animal quarters were artificially illuminated for 12 hours a day.

At the beginning of the study, chickens were weighed and 2 ml. of blood were withdrawn from the radial vein with an heparinized syringe after being anesthetized with an intramuscular injection of chloral hydrate (0,3 mg/kg body weight). The hematocrit was determined using a microcentrifuge, the hemoglobin concentration by Drabkin's reagent [7] and the plasma iron by the method described by the International Comittee for Standardization in Hematology [11].

In order to sacrifice and to eliminate tissue blood, the chickens were perfused through the jugular vein with heparinized 154 mM NaCl fed at a rate of 5-10 ml/min, using a Gilson pump. Liver, spleen, kidneys, heart and feathers were removed; the

organs were washed in NaCl 0.9%, dried on filter paper and the weight was immediately determined. Aliquots of 0.5-1 g were dried during 2 days at 80 °C in order to calculate the water content of the organs and tissues removed.

All studies were performed on groups of 10 chickens for each strain and sex at the ages of 4, 8, 13, 18 weeks (the females were in a prelaying state), as well as on 24-week-old females (laying females), at which time, Shaver and New Hampshire females reached 86% and 75% of egg production respectively [14]. All animals had fasted for 18 hours prior to sacrifice.

In order to study the influences of strain and age on the variables analyzed, the data was evaluated by the two-way analysis of variance with four or five levels per age. When the age effect was statistically significant, the levels were pairwise compared with a multiple comparison method [18]. The calculation were processed on a P4V program in a BMDP statistical packet [6].

TABLE 1
Formula feeds for starting, growing, finishing and laying chickens.

	Starting 0-2 wk	Growing 2-5 wk	Finishing 5 wk-end	Laying
Ingredients (%)				
Ground yellow corn	37.75	50.88	62.82	49.77
Soybean meal (48% protein)	32.15	23.00	24.00	12.50
Wheat bran	1.00	3.00	1.00	3.00
Meat scraps (50% protein)	4.00	4.00	---	4.00
Denydrated alfalfa meal	1.00	3.00	1.00	2.00
Corn gluten meal (60% protein)	---	---	6.00	---
Sorghum	20.00	10.00	---	15.00
Vegetable oil	1.00	4.00	1.00	6.00
Animal fat	1.30	0.50	1.00	0.50
Mineral mixture	0.20	0.20	0.20	0.20
Salt	---	0.38	0.38	0.23
Dicalcium phosphate	1.60	0.93	1.80	0.10
Calcite flour	---	0.11	0.80	6.70
Calculated composition				
Protein, %	23.00	20.90	20.50	16.20
Crude fibre, %	3.50	5.00	2.70	4.00
Fat, %	4.50	3.50	3.00	3.50
Calcium, %	0.93	0.90	0.92	3.10
Phosphorus, %	0.79	0.69	0.62	0.48
Total salt, %	0.18	0.56	0.46	0.40
Potassium, %	0.94	0.86	0.69	0.66
Sodium, %	0.19	0.25	0.24	0.17
Vitamin A, I.U./Kg	9000.00	7500.00	8000.00	5000.00
Vitamin D, I.U./Kg	2000.00	1500.00	1500.00	1000.00
Iron, mg/Kg	155.00	155.00	155.00	155.00
Cooper, mg/Kg	12.00	12.00	12.00	12.00
Manganese, mg/Kg	75.00	75.00	60.00	70.00
Zinc, mg/Kg	110.00	50.00	100.00	60.00
Iodine, mg/Kg	0.80	0.80	0.80	0.40
Niacin, mg/kg	25.00	50.00	50.00	25.00
Panthotenic acid, mg/Kg	20.00	20.00	10.00	12.00
Metabolizable energy, cal/g	3000.00	2800.00	3100.00	2830.00

The gross composition of the different feeds were obtained from the comercial suppliers (Hens).

RESULTS

Body weights (Figure 1) of males and females were similar within strain until 8 weeks of age. Throughout subsequent observation periods, the weight of males exceeded that of females. The New Hampshire chickens showed a more rapid growth than the Shaver after 8 weeks. Shaver females reached 1.5 kg. at 24 weeks, while at the same age New Hampshire birds weighed 2.7 kg.

Hematological values

Our results showed a tendency for the hematocrit values to increase (Table 2) in male chickens aged 4-18 weeks, which was much less pronounced in Shaver females of the same age, while the hematocrit of New Hampshire females did not show any important variations during the same period of time. Egg laying resulted in a slight decrease of the hematocrit. Strain differences were noted between males, but were not evident in females.

TABLE 2
Hematological parameters (hematocrit, hemoglobin and plasma iron) in Shaver and in New Hampshire chickens.

		MALES		FEMALES	
	weeks	Shaver	New Hampshire	Shaver	New Hampshire
Hematocrit %	4	28.8 ± 0.76^{a*}	23.0 ± 2.01^{a}	27.5 ± 1.39^{a}	30.7 ± 0.97^{a}
	8	28.8 ± 0.76^{a**}	24.6 ± 1.16^{a}	30.5 ± 1.73^{ab}	29.3 ± 2.09^{a}
	13	29.7 ± 1.54^{a}	30.2 ± 2.26^{b}	33.0 ± 1.01^{b}	28.8 ± 1.80^{a}
	18	38.4 ± 2.30^{b*}	31.0 ± 2.56^{b}	31.0 ± 1.41^{ab}	28.7 ± 0.82^{a}
	24	---	---	27.7 ± 0.98^{a}	26.1 ± 0.91^{a}
Hemoglobin g/100 ml	4	9.1 ± 0.32^{a***}	7.0 ± 0.28^{a}	8.1 ± 0.37^{a}	8.6 ± 0.26^{b}
	8	11.8 ± 0.62^{b***}	7.4 ± 0.61^{ab}	9.9 ± 0.82^{a**}	6.3 ± 0.39^{a}
	13	10.6 ± 0.94^{ab*}	8.1 ± 0.79^{ab}	11.1 ± 1.62^{a*}	8.1 ± 0.43^{b}
	18	10.6 ± 0.25^{b*}	8.8 ± 0.54^{b}	9.7 ± 0.64^{a}	9.2 ± 0.54^{b}
	24	---	---	9.4 ± 0.85^{a}	9.1 ± 0.68^{b}
Plasma iron μg/100 ml	4	168 ± 12.1^{b}	196 ± 15.8^{b}	122 ± 17.2^{ab}	155 ± 9.1^{b}
	8	141 ± 12.1^{b}	196 ± 15.8^{b}	116 ± 5.4^{b}	132 ± 17.6^{ab}
	13	107 ± 9.5^{a}	118 ± 10.2^{a}	102 ± 3.1^{a}	113 ± 11.9^{a}
	18	139 ± 11.9^{b}	128 ± 8.9^{a}	185 ± 31.1^{b}	132 ± 6.8^{ab}
	24	---	---	384 ± 30.9^{c}	386 ± 36.0^{c}

Mean value ± standard error of 10 birds. Comparison within age between birds of the same sex: * $P < 0.05$ ** $P < 0.01$ *** $P < 0.001$.
Age influence: Values in the same column not sharing a common superscript are significantly differente ($P < 0.05$).

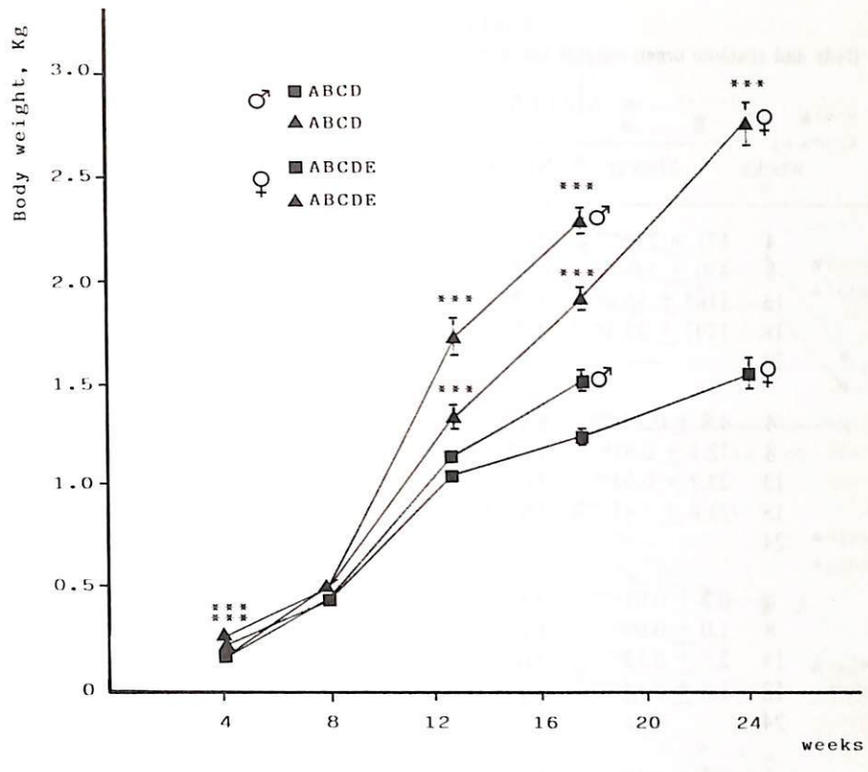

Figure 1.-Average body weights in Shaver (■) and in New Hampshire (▲) chickens. Mean value ± standar error of 10 birds. Comparison within age between birds of the same sex: * $P < 0.05$ ** $P < 0.01$ *** $P < 0.001$.

The hemoglobin values (Table 2) were usually lowest at 4 weeks and the maximum concentration (11.8 mg/100 ml) was observed in Shaver males at 8 weeks. Values were higher in Shaver strain and strain differences were significant between males at all ages. In females, however significant values were only found at 8 ($P \leq 0.01$) and 13 ($P < 0.05$) weeks of age. During the egg laying period hemoglobin concentrations remained similar to the values shown just prior to this period.

Plasma iron (Table 2) decreased with age in both strains and sexes only to increase at 18 weeks in males, while in females, this rise reached values of 385 μg of Fe/100 ml at the beginning of the laying period. Values were higher in 4-week-old males than in females at the same age ($P < 0.05$) and no strain differences were noticed.

Organ and tissue weights

A progresive increase of absolute weights of liver, kidneys, heart and feathers was observed (Table 3).

TABLE 3

Body and absolute organ weights (g) in Shaver and in New Hampshire chickens

		MALES		FEMALES	
	weeks	Shaver	New Hampshire	Shaver	New Hampshire
Body	4	171 ± 2.8^{a***}	235 ± 9.9^{a}	172 ± 4.9^{a***}	216 ± 7.7^{a}
	8	470 ± 7.6^{b}	482 ± 11.9^{b}	447 ± 8.5^{b*}	483 ± 13.9^{b}
	13	1165 ± 16.6^{c***}	1728 ± 105.9^{c}	1071 ± 14.3^{c***}	1347 ± 35.0^{c}
	18	1497 ± 35.5^{d***}	2535 ± 50.7^{d}	1236 ± 29.1^{d***}	1913 ± 33.4^{d}
	24	---	---	1526 ± 50.8^{e***}	2733 ± 90.9^{e}
Liver	4	4.8 ± 0.20^{a***}	8.8 ± 0.43^{a}	7.5 ± 0.50^{a}	7.9 ± 0.32^{a}
	8	12.7 ± 0.61^{b}	13.2 ± 0.75^{b}	12.8 ± 0.75^{b}	12.2 ± 0.38^{b}
	13	23.7 ± 0.94^{c**}	31.8 ± 2.06^{c}	21.7 ± 1.01^{c***}	29.4 ± 0.95^{c}
	18	23.8 ± 1.41^{c***}	38.6 ± 2.27^{d}	26.2 ± 1.08^{c***}	37.3 ± 2.16^{d}
	24	---	---	36.6 ± 2.58^{d}	40.4 ± 2.56^{d}
Spleen	4	0.3 ± 0.01^{a***}	0.6 ± 0.05^{a}	0.4 ± 0.05^{a}	0.5 ± 0.05^{a}
	8	1.0 ± 0.09^{b}	1.1 ± 0.08^{b}	0.8 ± 0.04^{b}	1.1 ± 0.16^{b}
	13	2.5 ± 0.12^{d*}	3.6 ± 0.39^{c}	2.0 ± 0.14^{c*}	2.7 ± 0.18^{c}
	18	1.8 ± 0.14^{c***}	5.1 ± 0.24^{d}	2.2 ± 0.14^{c***}	4.4 ± 0.40^{d}
	24	---	---	1.1 ± 0.08^{b***}	2.9 ± 0.24^{c}
Kidneys	4	1.8 ± 0.07^{a}	1.5 ± 0.25^{a}	1.8 ± 0.08^{a***}	1.2 ± 0.03^{a}
	8	4.0 ± 0.03^{b}	4.0 ± 0.10^{b}	4.1 ± 0.14^{b}	3.9 ± 0.09^{b}
	13	6.9 ± 0.11^{c*}	8.5 ± 0.71^{c}	7.3 ± 0.43^{c**}	9.0 ± 0.16^{c}
	18	7.3 ± 0.41^{c***}	13.9 ± 0.59^{d}	7.8 ± 0.23^{c***}	10.3 ± 0.42^{d}
	24	---	---	11.2 ± 0.53^{d**}	15.3 ± 0.87^{e}
Heart	4	1.2 ± 0.04^{a***}	1.6 ± 0.07^{a}	1.2 ± 0.06^{a*}	1.4 ± 0.07^{a}
	8	2.4 ± 0.06^{b*}	2.9 ± 0.16^{b}	2.5 ± 0.08^{b**}	3.0 ± 0.12^{b}
	13	5.6 ± 0.19^{c**}	7.9 ± 0.53^{c}	4.7 ± 0.19^{c***}	6.5 ± 0.26^{c}
	18	6.7 ± 0.33^{d***}	11.7 ± 0.46^{d}	5.3 ± 0.15^{d***}	9.0 ± 0.37^{d}
	24	---	---	6.1 ± 0.18^{e***}	9.5 ± 0.57^{d}
Feathers	4	11 ± 0.4^{a}	10 ± 0.6^{a}	9 ± 0.4^{a}	11 ± 0.6^{a}
	8	33 ± 0.8^{b***}	27 ± 0.9^{b}	38 ± 1.7^{b**}	30 ± 1.4^{b}
	13	98 ± 11.0^{c}	104 ± 10.7^{c}	98 ± 2.3^{c}	105 ± 7.2^{c}
	18	123 ± 4.8^{c***}	188 ± 8.5^{d}	117 ± 3.0^{d}	126 ± 3.6^{d}
	24	---	---	112 ± 5.2^{d**}	138 ± 4.8^{d}

Mean value ± standard error of 10 birds.
Comparison within age between birds of the same sex: * $P < 0.05$ ** $P < 0.01$ *** $P < 0.001$.
Age influence: Values in the same column not sharing a common superscript are significantly different ($P < 0.05$).

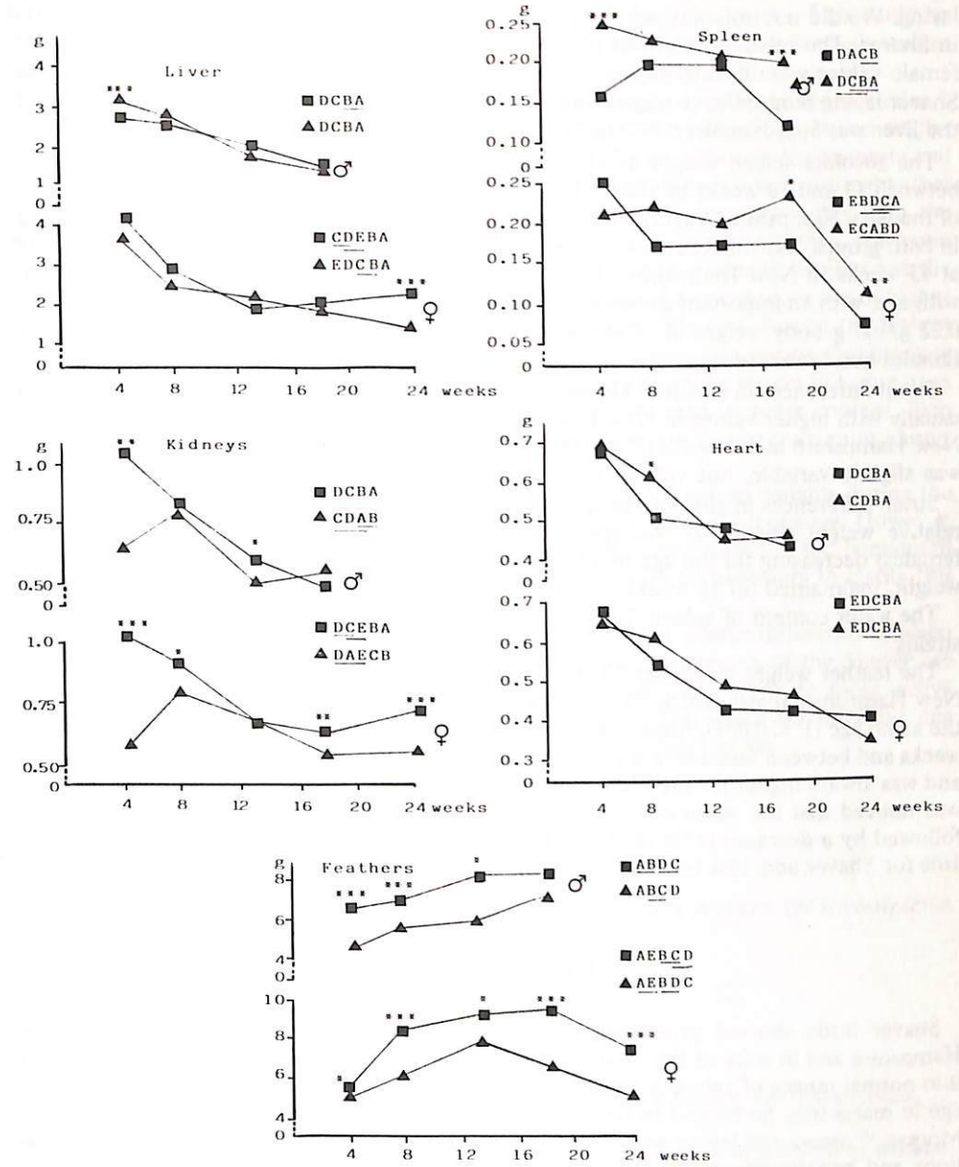

Figure 2.- Relative weight of organs of Shaver (■) and New Hampshire (▲) chickens. Mean value of 10 birds. Comparison within age between birds of the same sex: * $P < 0.05$ ** $P < 0.01$ *** $P < 0.001$.
Age influence: Groups not underlined are statistically different ($P < 0.05$). (A, B, C, D and E are equivalent to 4, 8, 13, 18 and 24 weeks respectively).

The liver and spleen of the New Hampshire had greater weights than the Shaver, especially at 13 and 18 weeks, but these differences disappeared in the liver during laying. We did not note any sex differences for the liver except at 4 weeks ($P < 0.001$) in Shaver. The relative weight of the liver (Figure 2) had a tendency to decrease and female values were usually higher in both strains; but it was interesting to note that Shaver laying females have higher values than New Hampshire. The water contents of the liver was approximately 70% in both strains and sexes.

The absolute spleen weight decreased at 18 weeks in Shaver males and was similar between 13 and 18 weeks in Shaver females, while it was still increasing in both sexes of the New Hampshire. Nevertheless, a significant decrease was observed during laying in both groups. Sex differences were noticeable at all ages in Shaver ($P < 0.01$) but only at 13 weeks in New Hampshire ($P < 0.05$). The relative weigth (Figure 2) oscillated with age, with an important decrease at laying such that the New Hampshire went from 0.22 g/100 g body weight at 18 weeks to 0.11 g/100 g body weight at laying. Shaver females had lower values.

Strain differences in absolute kidney weights were observed at 4, 13, 18 and 24 weeks usually with higher values in New Hampshire. Sex differences were noticeable only in New Hampshire at 18 weeks ($P < 0.001$). The relative weight of this organ (Figure 2) was slightly variable, but values for a given sex were usually greater in the Shaver.

Strain differences in absolute heart weights were observed at all ages. The maximum relative weight (Figure 2) was reached at 4 weeks (0.65 g/100 g body weight for females) decreasing till the age of 13 weeks with an average value of 0.5 g/100 g body weight, maintained till 18 weeks.

The water content of spleen, kidneys and heart was between 75-80% for all ages and strains.

The feather weight increased till the age of 18 weeks reaching the value of 188 g in New Hampshire males which differed statistically to the values observed in females of the same age ($P < 0.001$). Strain differences were observed between males of 8 and 18 weeks and between females of 8 and 24 weeks. The relative weight (Figure 2) increased and was always higher for the Shaver of both sexes and decreased at laying (P 0.05). It was noticed that the water content remained approximately 35% from 4 to 13 weeks followed by a decrease (25% at 18 weeks) while during the laying period values were 16% for Shaver and 10% for the New Hampshire.

DISCUSSION

Shaver birds showed greater hematocrit and hemoglobin values than the New Hampshire and in spite of the existence of some small variations with age, they all fell into normal ranges of values [1, 5, 13, 14, 15, 19, 25, 28]. The increase of the hematocrit with age in males may be related to their androgen levels [29]. Ramsay and Campbell [25] and Morgan [19] associated laying with a significant decrease of the hemoglobin concentrations and hematocrit and the same was observed in quails [9]. Pregnant rats with an equivalent extra iron demand and hypervolemia, also presented a reduction in hematocrit [26]. In our results, however, no statistical differences were observed in hemoglobin values, also reported by Sturkie [29]. The time-delay of blood sampling from the onset of laying, could explain these different results. As has been seen by Planas [22], the plasma iron concentration showed some variations with age in all animals, the lowest values were detected at 13 weeks. Laying, however, requires a mobilization of iron stores with the concomitant increase of plasma iron levels [12, 19, 23, 24, 25].

Both chicken strains presented their more intensive growth period between 8 and 13 weeks, which agrees with data given by Wittenberger et al. [30] on tetralinear hybrid Studler-Cornish chicks and by Matsuzawa [15] on White Leghorn chicks. This could be related to the "critical period" of the ontogenesis of domestic fowl. Similar body weight patterns have been observed in rats [27] with an inflexion point at 10-12 weeks.

According to literature, absolute and relative organ weights differ between strains [4, 15, 28, 30] which is confirmed in the present paper. The growth rate of Shaver was similar to that reported by Matsuzawa [15] on White Leghorn chicks, although the absolute and relative weights of most of the organs from our birds were lower. It was noticeable that the New Hampshire had higher growth rates and absolute organ weights than the Shaver, but New Hampshire had lower kidney and feather relative weights. The same happened when comparing the liver and heart of these two strains to broilers [4] at the ages of 4 and 8 weeks. In laying hens, liver weight increased as a consequence of higher synthesis (hepatic vitellogenesis) and so the laying strain (Shaver) showed the highest relative values. In mammals, increased energetic needs during pregnancy, also produce a rise in liver and small intestine weights [26]. The relative plumage weight in laying hens decreased significantly in both strains because of a reduction in water content. Skin weight in rats also decreased during pregnancy and lactation due to maximum energy drainage affecting the subcutaneous adipose tissue [26].

No data was found on significant decrease in the relative spleen weights during the laying period, or any equivalent phenomenum during mammal pregnancy. However, some explanation could be taken from the relationship seen between the hematocrit and the onset of the laying process. Further studies would be necessary to clarify this observation.

In the hematological and anatomical parameters analyzed, a large difference between these two strains was evident. The high hematological parameters of the Shaver are coincident to a foreseeable higher relative metabolism, due to their more active behavior and smaller size. Moreover, the adaptation of this strain for intensive egg production could also be a result of these high energy requirements.

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INDUCCION Y SINCRONIZACION DE CELOS DURANTE EL ANESTRO ESTACIONARIO EN LA OVEJA RIPOLLESA MEJORADA, MEDIANTE ESPONJAS VAGINALES (FGA) Y PMSG INYECTABLE

HEAT INDUCTION AND SINCHRONIZATION DURING SEASONAL ANOESTRUS OF THE IMPROVED RIPOLLESA SHEEP BY USING VAGINAL SPONGES (FGA) AND PMSG INJECTABLE

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Palabras clave: anoestro, sincronización celo, oveja, esponjas vaginales (FGA).
Key words: Anoestrus, heat sinchronization, sheep, vaginal sponges.

RESUMEN

En el presente trabajo se realiza una evaluación y estudio de los resultados obtenidos con un tratamiento hormonal de inducción y sincronización de celos mediante esponjas vaginales, impregnadas de acetato de fluorogestona (FGA) e inoculación posterior de PMSG, durante el anestro estacionario en la raza ovina Ripollesa Mejorada.

El 97% de las ovejas manifestaron celo a las cuarenta y ocho horas de finalizar el tratamiento, momento en que se inició la cubrición, mediante monta dirigida y posteriormente monta libre.

La duración media de la gestación fue de 147,53 días, oscilando entre 144 y 152 días. La fertilidad obtenida es del 73%, mientras que la prolificidad era del 190%.

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