

Effect of sex reversal on muscle development of chicken

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One characteristic of poultry is a sex dimorphism on body weight to the benefit of males which influences the weight of muscles. It seems that the post-hatching differences observed between males and females in muscle characteristics are determined during embryonic myogenesis (Henry and Burke, 1999). By injecting Fadrozole (a nonsteroidal aromatase inhibitor enzyme allowing the conversion of androgens into oestrogens) *in ovo*, before the 5th day of incubation, it is possible to reverse the sex of genetically determined female embryos (Burke and Henry, 1999). In chicken and turkey, this treatment had no effect on body weight and breast weight of reversed females (Burke and Henry, 1999). The aim of this study was to evaluate the effect of sex reversal on development and typology of muscle fibres in *Pectoralis major* and *Sartorius* (breast and thigh muscles respectively) of chicken.

Mature female chickens from a laying type (Isabrown) were inseminated with pooled semen samples. A total of 380 eggs were collected and incubated under standard conditions. On day 4 of incubation, 190 eggs were injected with Fadrozole (1 mg diluted in 0.1 ml phosphate buffered saline = PBS). The remaining 190 eggs received PBS alone as previously described by Vaillant et al. (2003). At hatching, chicks were phenotypically and genetically sexed according to Vaillant et al. (2003). All birds were reared in floor pens up to 16 weeks of age and then placed in individual battery cages up to 28 weeks of age. At 28 weeks of age, the chicks were weighed and sacrificed using a lethal dose of pentobarbital (1 ml/kg). Their gonads were removed and analysed by histology (Vaillant et al., 2003). *Pectoralis major* (fast twitch breast muscle with a glycolytic metabolism) and *Sartorius* (fast twitch thigh muscle with an oxydo-glycolytic metabolism) were excised and weighed. One sample of each muscle was frozen in isopentane cooled with liquid nitrogen and stored at -80°C for histochemical analysis. Then, the typology of fibres was realised as previously described by Baéza et al. (1999). Data were compared using analysis of variance.

On birds sacrificed at 28 weeks of age, the gonad observation showed that the *in ovo* treatment with Fadrozole of genetically determined females induced a more or less complete sex reversion (Vaillant et al., 2003). The sex reversion had no effect on body weight at 28 weeks of age, neither on the development of *P. major* (Table), confirming the observations of Burke and Henry (1999). By contrast, the weight of *Sartorius* and its percentage to body weight were significantly increased and the reversed females had intermediate average values between control males and females.

Despite an important sex effect on body weight (+ 1041 g, Table) and breast weight (+ 65.6 g), to the benefit of males, the cross-sectional areas (CSA) of muscle fibres in *P. major* of males and females were equivalent (Table). The difference in muscle weight could be induced by a higher fibre number and/or length in males. In *P. major* muscle, the sex reversion had no effect on the typology neither on the CSA of muscle fibres. By contrast, in *Sartorius* muscle, the percentage of type IIa oxydo-glycolytic fibres was higher in males and reversed females than in control females to the detriment of type IIb glycolytic fibres (Table). The percentages of type I oxydative fibres were equal in the three groups of birds. In *Sartorius* muscle, the reversed females exhibited a higher fibre CSA than the control females: + 31, 42 and 45 % for type I, IIa and IIb fibres respectively but it never reached the CSA of fibres measured in *Sartorius* muscle of males. This fibre size increase could explain the increase of *Sartorius* weight (+ 44 %) observed in reversed females.

Table Effect of sex reversal on body and muscle development of chicken and on the typology and size of fibres in Pectoralis major and Sartorius (breast and thigh muscles respectively)

Criteria	Control females	Control males	Reversed females
Body weight at 28 weeks of age (g)	3519 ± 251 b	4557 ± 236 a	3361 ± 316 b
Sartorius weight (g)	10.19 ± 0.95 c	23.06 ± 2.76 a	14.70 ± 2.51 b
% Sartorius / body weight	0.29 ± 0.02 b	0.51 ± 0.05 a	0.44 ± 0.07 a
<i>P. major</i> weight (g)	193.18 ± 26.21 b	258.78 ± 21.11 a	186.45 ± 24.88 b
% <i>P. major</i> / body weight	5.48 ± 0.33 b	5.68 ± 0.36 a	5.40 ± 0.32 b
Sartorius: % I	15 ± 5 a	17 ± 6 a	15 ± 4 a
CSA I (µm ²)	1777 ± 392 b	2623 ± 520 a	2333 ± 468 ab
% IIa	50 ± 5 b	58 ± 7 ab	60 ± 6 a
CSA IIa (µm ²)	1694 ± 290 b	2860 ± 494 a	2399 ± 353 ab
% IIb	35 ± 8 a	26 ± 10 b	25 ± 5 b
CSA IIb (µm ²)	2728 ± 367 b	4371 ± 743 a	3955 ± 850 a
<i>P. major</i> : CSA IIb (µm ²)	4025 ± 834 a	4047 ± 686 a	3805 ± 662 a

a, b, c: significant difference with $P < 0.05$ - CSA = cross-sectional area - I = slow-twitch oxydative fibres- IIa and IIb = fast-twitch oxydolytic and glycolytic fibres respectively

The *in ovo* treatment with Fadrozole of genetically identified females induced a sex reversion and modified the growth and typology of fibres in muscles such as *Sartorius* the development of which begins early during the embryonic period. The growth and typology of muscles developing after hatching, such as *P. major*, were not affected.

References

- BAEZA, E., G. MARCHE, N. WACRENIER** (1999) Effet du sexe et de l'âge sur la croissance musculaire du canard de Barbarie. *3èmes Journées de la Recherche Avicole*, St Malo, 23-25/3/99: 391-394.
- BURKE, W.H., M.H. HENRY** (1999) Gonadal development and growth of chickens and turkeys hatched from eggs injected with an aromatase inhibitor. *Poultry Science*, **78**: 1019-1033.
- HENRY, M.H., W.H. BURKE** (1999) The effects of *in ovo* administration of testosterone and an antiandrogen on growth of chick embryos and embryonic muscle characteristics. *Poultry Science*, **78**: 1006-1013.
- VAILLANT, S., D. GUÉMENE, M. DORIZZI, C. PIEAU, N. RICHARD-MERCIER, J.P. BRILLARD** (2003) Degree of sex reversal as related to plasma steroid levels in genetic female chickens (*Gallus domesticus*) treated with Fadrozole. *Molecular Reproduction and Development*, **65**: 420-428.