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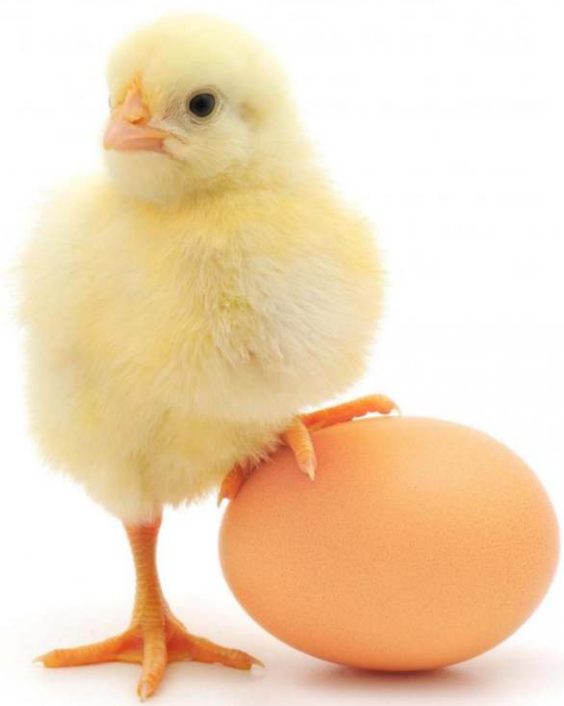

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Performance, Breast Morphological and Carcass Traits in the Ardennaise Chicken Breed

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Abstract: The aim of this study was to quantify performance, breast morphological and carcass traits in Belgium's most ancient chicken breed: the Ardennaise. Evaluation during growing showed at 84 days of age light as-hatched mean live Body Weights (BW) (1115g ± 221), fairly high Feed Conversion Ratio (FCR) (5.09 ± 0.4) and Liveability (LIV) (92.55% ± 4.6). At 85 days, male and female *in vivo* breast measurements such as Keel Angle (KA) (67.74-71.82^0), Thoracic Circumference (TC) (25.61-28.05 cm), Keel Length (KL) (10.32-11.26 cm) and muscle thickness (TM) (10.70-12.11mm), with associated BW, were all greater in males and significantly different between sexes ($p<0.001$), except for Chest Width (CW) (4.62-5.35 cm). However, there was no sexual dimorphism for all yield traits. Yields of Eviscerated Carcass (EC) varied from 57.54-59.28%, Thighs and Drumsticks (TD) from 19.37-19.80%, Breast Meat (BM) from 11.02-11.62% and Wings (WI) from 8.67-8.82%. All *in vivo* measurements, carcass and portions data were lower than those reported mostly for broilers, except similar KA degrees and slightly higher WI. Finally, most of traits studied in the Ardennaise chicken were moderate when compared to those obtained by broilers.

Key words: Ardennaise chicken breed, breast morphology, carcass, performance

INTRODUCTION

Promoting the use of endangered traditional chicken breeds remains a *sine qua non* condition for their survival and is necessary to insure long-term conservation of global genetic diversity in poultry. These breeds, generally colour-feathered, have a slow growth and a limited number of eggs but may present interesting meat quality attributes and adaptation to current management systems. Meat-type quality poultry are preferred in some parts of the world in which meat flavour, meat texture and appearance such as plumage or skin colour, are the main attributes justifying consumer's choice. Beside, some production systems such as Chinese *Three Yellow (3Y)*, French *Label Rouge* and Belgian *Label de Qualité Wallon* impose the exclusive use of slow-growing breeds and remain good examples of quality chickens (Yang and Jiang, 2005). In Belgium, these are generally obtained from a two-way cross between a slow-growing male and a more efficient female, for hybrid vigour and obvious economic reasons. For example, the result of a cross between the Ardennaise chicken male and a commercial female has led to supply a slow-growing meat-type chicken (Coqard Colombus®) to niche markets. As Belgium's most ancient chicken breed, the Ardennaise originates from the French-Belgian Ardennes region and would be a direct descent of the French Gauloise as described by La Perre de Roo in 1880 (Brandt and Willems, 1985). The breed exists today in 13 different varieties. With a total population of less than 700 individuals the Ardennaise like most of Belgian poultry breeds, would be endangered or under a critical status (Larivière and Leroy, 2005 2007). This urges more initiatives to maintain the species gene pool. Proposed strategies aiming at conserving this diversity include evaluation of genetic resources. Presumed genotypes from main phenotypic traits have been studied in Belgian chicken breeds (Larivière and Leroy, 2006) but very little information has been published on their performance under modern production systems (Larivière *et al.*, 2007). The purpose of this study is to quantify performance, breast morphological and carcass traits in the Ardennaise chicken breed.

MATERIALS AND METHODS

Subjects, husbandry and feeding: In experiment 1, performance was studied up to 84 days and chickens from the same flock were used in experiment 2 for evaluating breast morphological and carcass traits at 85 days. Day-old chicks were obtained from an Ardennaise chicken breed nucleus flock (about 10 males and 100 females), unselected for production traits. As-hatched birds were vaccinated by injection against Marek's Disease and were fed an *ad libitum* typical "Label" mash diet (lower energy and protein than commercial broiler diets, genetically modified organism-free and no coccidiostats) (Table 1) with continuous supply of water. Diets were mainly composed of soybean, wheat and corn.

Performance traits: Three hundred and ten Ardennaise chicks were hatched, dispatched and reared in six closed pens, each measuring 1.4 m x 1.5 m x 2 m (width x depth x height), with floor litter (wood-shavings),

Table 1: Composition proportions (%) of the diets fed to the Ardennaise chicken

	Diets	
Ingredients	Starter	Grower
Wheat	27.04	21.46
Wheat + enzymes	10.0	10.0
Soybean meal	31.92	27.13
Corn	25.0	35.0
Chalk	0.50	0.72
Soybean oil	2.23	2.70
DL-Methionine	0.19	0.16
L-Lysine HCL	0.10	0.14
Dicalcium phosphate	1.92	1.63
Vitamin mix	0.01	0.05
Mineral mix	1.00	1.00
Essential oils	0.1	0.0
Laboratory analysis		
Dry matter (g/kg)	25.89	25.26
Ash (g/kg)	56.09	53.64
Fat (g/kg)	43.06-90.0	49.64-70.0
Crude fiber (g/kg)	872.24	872.72
Crude protein (g/kg)	220.0	200.0
ME (kcal/kg)	2937.25	3034.42

waterer (10 nipple drinkers) and one feeder (metal hopper). The starter diet was given during the first 14 days and the grower diet from 15-84 days of age. The light schedule followed standard broiler recommendations (Aviagen, 2002) from day-old till end of experiment with 23 h light and 1 h dark. Illumination was provided by fluorescent lamps and light intensity, measured at floor levels in all pens with a digital luxmeter (Mavolux-Digital, Gossen-Metrawatt GmbH, Germany), varied from 8.96-31.0 lux. The ambient spot brooding temperature at 5 cm above litter in center of pen, from 84 days data, varied from a minimum of 16.1°C to a maximum of 35.4°C. Birds were weighed weekly from day-old to 21 days with a small digital scale (Phillips HR 2395 model, The Netherlands) and with a larger hanging scale (Salter Brecknell, 235-6S model, U.K.) at further ages. Stocking densities were maximum 28.76 kg/m^2 at end of the growing period. As-hatched Body Weight (BW), amount of food consumed and mortality was recorded per pen on a weekly basis from day-old to 84 days of age to determine Average Daily Gain (ADG), cumulative Feed Conversion Ratio (FCR) and Liveability (LIV).

Breast morphological and carcass traits: At six weeks of age, each bird was individually identified with a wing-band (Hauptner GmbH, Herberholz, Germany) designed for tracing carcass at slaughter. Considering breast meat as the most valuable part in chicken, *in vivo* measurements using morphological or ultrasound methods were performed at 85 days of age. These indicators appeared to be useful in predicting breast muscle weight in slow-growing chickens (Larivière *et al.*, 2007). A number of 105 females and 111 males, randomly taken, were estimated for Thoracic Circumference (TC) with a flexible tape, Chest Width (CW) and Keel Length (KL) with a caliper, Keel Angle (KA) with a protractor and live BW with a hanging scale. Thickness of Breast Muscle (TM) was determined on 24 chickens randomly chosen (10 males and 14 females), by sonography with a Pie Medical 100 ultrasound apparatus (Pie Medical Equipment B.V., Maastricht, The Netherlands), using a scanner of 5 MHZ positioned perpendicularly to the cranial end of the keel. The observed site was an optimal point for measuring muscle thickness in broilers (König *et al.*, 1997). Three images per bird were visualized on a video screen, recorded on a hard-disk and then transferred on software (Echo Image Viewer, Maastricht, The Netherlands) to measure the thickness of muscle. A number of 40 chickens randomly chosen (22 males and 18 females) were then removed to assess carcass yields. Birds were deprived of food 12 h prior to investigations, weighed and slaughtered. Total breast muscles (*Pectoralis major* and *Pectoralis minor*) and other parts were dissected and weighed following a described methodology (Marché, 1995). Eviscerated Carcass Yield (EC) was without neck, abdominal fat and giblets, Breast Meat Yield (BM) was estimated without skin with bone removed, Thighs and Drumsticks Yield (TD) and Wings Yield (WI), as whole with skin and bone. Each portion was presented as a percentage of live BW.

Statistical analysis: Data were processed using the statistical software package SAS, version 9.1 (SAS, Institute Inc., Cary NC). In the first experiment, a General Linear Model (GLM) procedure was used to analyze the effect of age, pen and their interaction on BW, ADG, FCR and LIV. The effects of sex, pen and their interaction on KA, TC, KL, CW, TM, EC, TD, BM, WI and associated BW, were considered in the second experiment. Regression of these traits on age and corresponding coefficient of determination were calculated.

RESULTS AND DISCUSSION

Performance traits: In this experiment, effect of age, pen and their interaction were all very significant ($p \leq 0.0001$) on BW, ADG, FCR and LIV. All consecutive BW in the Ardennaise was significantly different (except between 0 and 7 days). Final live as-hatched BW at 84 days (Table 2) was five times lighter (1115g < 5521g) than results obtained in an experiment using broiler chicks of a popular commercial strain (Ross 308) at the same age and broiler diets in intensive conditions (Havenstein *et al.*, 2003). In the same way, a review on production performances of seven French traditional breeds showed live BW up to 2.5 times heavier than the Ardennaise (725-1473 g > 592 g) at 56 days of age (Tixier-Boichard *et al.*, 2006). ADG in the Ardennaise was also five times slower (13.27 g/day < 65.73 g/day) and

Table 2: Number of birds (N) and mean values (± SD) for Body Weight (BW), Average Daily Gain (ADG), Feed Conversion Ratio (FCR) and Liveability (LIV) in the Ardennaise chicken from day-old to 84 days of age

Age (days)	N	BW (g)	ADG (g/day)	FCR (g:g)	LIV (%)
day-old	310	35.4 (± 3)	.	.	100.0
7	305	48.6 (± 6)	6.94 (± 0.9)	1.16 (± 0.1)	98.31 (± 1.1)
14	299	92.9 (± 17)	6.64 (± 1.2)	2.24 (± 0.4)	96.69 (± 1.9)
21	298	145 (± 27)	6.89 (± 1.3)	3.19 (± 0.6)	96.35 (± 1.9)
28	298	193 (± 41)	6.89 (±1.5)	3.43 (± 0.4)	96.13 (± 2.1)
35	296	263 (± 55)	7.52 (± 1.6)	3.48 (± 0.4)	95.53 (± 2.3)
42	292	349 (± 80)	8.30 (± 1.9)	3.66 (± 0.2)	94.18 (± 3.4)
49	289	468 (± 109)	9.54 (± 2.2)	4.19 (± 0.6)	93.32 (± 4.0)
56	289	592 (± 133)	10.57 (± 2.4)	4.21 (± 0.4)	93.32 (± 4.0)
63	287	702 (± 149)	11.14 (± 2.4)	4.41 (± 0.4)	92.85 (± 4.4)
70	287	847 (± 168)	12.10 (± 2.4)	4.64 (± 0.4)	92.85 (± 4.4)
77	286	971 (± 195)	12.61 (± 2.5)	4.96 (± 0.5)	92.55 (± 4.6)
84	286	1115 (± 221)	13.27 (± 2.6)	5.09 (± 0.4)	92.55 (± 4.6)

Table 3: Breast morphological and ultrasound measurements, carcass and portions yields of male and female Ardennaise chickens, with corresponding mean body weights and their standard deviations (± SD) per sex at 85 days of age

		Morphological measurements					Ultrasound measurements		Carcass and portions yields			
Sex	BW (g)	KA (°)	TC (cm)	KL (cm)	CW (cm)	BW (g)	TM (mm)	BW (g)	EC (%)	TD (%)	BM (%)	WI (%)
Males	1239 ±185	71.82 ±5.3	28.05 ±1.2	11.26 ±0.9	5.35 ±4.1	1125 ±138	12.11 ±1.0	1119 ±147	57.54 ±5.0	19.80 ±1.8	11.02 ±1.3	8.67 ±0.9
n		111					14		22			
Females	957 ±140)	67,74 ±9.2	25.61 ±3.4	10.32 ±1.2	4.62 ±0.6	899 ±87	10.70 ±0.6	888 ±108	59.28 ±3.0	19.37 ±1.2	11.62 ±1.1	8.82 ±0.3
n		105					10		18			
F-test	****	****	****	****	N.S.	****	N.S.	****	N.S.	*	N.S.	N.S.

BW: body weight; KA: keel angle; TC: thoracic circumference; KL: keel length; CW: chest width; TM: thickness of muscle; EC: eviscerated carcass yield; TD: thighs and drumsticks yield; BM: breast meat yield; WI: wings yield.
Significant different means (*0.01≤ p≤0.05; **0.001≤ p≤0.01; ***0.0001≤ p≤0.001; ****P≤0.0001).

varied greatly, increasing linearly from 28-84 days (b = 290.6; R^2 = 60.9%). FCR was twice as much higher (5.09 > 2.72) than broilers and increased linearly by 0.15 per day of age up to 21 days (b = 0.05; R^2 = 99.85%), reaching a plateau thereafter with a value of 0.04 per day of age. FCR in other slow-growing breeds (Tixier-Boichard *et al*., 2006) at 56 days and 84 days of age (3.59 and 5.71) were close to those obtained by the Ardennaise (4.21 and 5.09).

In the Ardennaise, mortality rates reached 0.77% per week (LIV of 92.55% at 84 days), decreasing by 0.1% per day (R^2 = 83.41%), Generally, mortality rates during rearing can reach up to 0.14% per week in pullets (Guerder *et al*., 1998), 0.25% per week in slow growing genotypes (Prin and Koehl, 1998) and 1.19% per week in broilers raised up to 84 days of age (Havenstein, 2003). This is in good correspondence with positive relationships found between body weight and mortality (Gardiner *et al*., 1988). Metabolic problems (ascites, sudden death syndrome) or skeletal disorders (tibial dyschondroplasia) inducing higher mortality in fast growing lines (Rauw *et al*., 1998), were not observed in the Ardennaise. As a result of improved broiler performance, genetic selection has also decreased the adaptive immune response (Cheema *et al*., 2003), increasing susceptibility to diseases such as Marek's Disease (Han and Smyth, 1972) or to commonly encountered infections, where mortality rates were greater than those of slow-growing chickens (Yunis *et al*., 2000).

Breast morphological and carcass traits: Differences in carcass anatomy and morphology were demonstrated with longer carcass and keel bone in slow growing lines, while assessing breast meat weight with *in vivo* methods (Rémignon *et al*., 2000). Variance of analysis in our experiment showed a significant effect of sex (Table 3) on KA, KL, TC, associated BW (p≤0.0001) and TD (p≤0.05). Pen effect varied greatly with KA, KL, TC, EC, TD, BM, WI and associated BW (p≤0.0001). KA and BM differed significantly with sex and pen interaction (p ≤0.05). *In vivo* breast measurements (morphological and ultrasound) and corresponding BW were greater in males, except for chest width. TC, KL and CW values were smaller in the Ardennaise than in broiler males and females (25.61-28.05 < 28.60-29.40 cm, 10.32-11.26 < 12.57-12.98 cm and 4.62-5.35 < 7.32-7.48 cm) (Griffin *et al*., 2005). Similarly, ultrasonic TM was up to twice shallower in the Ardennaise than in broilers (10.70-12.11 mm < 14.0-24.0 mm) (Komender and Grashorn, 1990). KA values in the Ardennaise (67.74-71.82°) were similar to those measured in broilers

(70.80-70.90°) (Ricard and Rouvier, 1970) and above those in three naked neck genotypes (61.80-63.90°) (Bordas *et al.*, 1978). Using the average of both sexes at 85 days, yield performances of the Ardennaise were lower for EC (58.41 < 76.1%), BM (11.32 < 22.20%), TD (19.58 < 31.0%) but greater for WI (8.75 > 7.65%), than those reported for Ross 308 broiler (Havenstein *et al.*, 2003). Effect of genetic origin on carcass and meat yields at same age has been demonstrated with higher values in slow growing lines (Ricard and Rouvier, 1970). Yet carcass and breast meat yields evaluated in five slow-growing genotypes were inferior to those of a fast-growing chicken (Grashorn and Clostermann, 2002). This discrepancy can be attributed to selection efforts that have improved these traits in both broilers and slow-growing chickens throughout the years.

Conclusion: Producing a traditional chicken breed for market remains a challenge at both economical and technical levels. With light live body weight, fairly high feed conversion value but low mortality rates, the Ardennaise has moderate performance. Although morphological and ultrasound breast measurements were greater in males and despite significant difference in associated body weight between males and females, eviscerated carcass and other portions yields did not vary greatly between sexes. However, none of the experiments included a control with broilers on the same diet and conditions for comparisons. Performance and carcass traits of the results from the cross between the Ardennaise and other female chicken strains to produce a more productive chicken for market should also be further investigated.

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