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Evaluation of the Production Performances of an Endangered Local Poultry Breed, the Famennoise

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Abstract: The Famennoise is a Belgian poultry breed which is greatly endangered. Like most of the local breeds in this situation, the Famennoise remains largely unknown and is representative of the continuous loss of genetic diversity that is threatening the future of animal production. From preliminary results, egg production traits in this breed showed valuable economic assets. The present study is, thus, aimed at assessing its production performances with the prospect that it might be conserved for future valorization. Egg production as well as growth traits were estimated. Both aspects showed exploitable performances. In absence of past selection for these traits, eggs presented a mean weight of 55.43 ± 3.03 g, so being in the middle class of marketable eggs, a yolk to albumen ratio of 50.7 ± 5.02 %, an eggshell resistance (maximal force of breakage of 36.03 ± 3.3 N) equal to commercial strains and superior to already valorized local breeds. In broilers, a mean weight 980.67 ±16.62 g was reached at 8 weeks, 1815.90 ± 36.55 g at week 12 and 2191.90 ± 48.31 g at week 15. The Famennoise is, therefore, suggested for use as a dual-purpose breed with a good potential of selection for both productions. It could further serve in crosses for improvement of commercial strains. In conclusion, it appears to be highly urgent to screen endangered local poultry breeds for economically exploitable traits which would motivate conservation programs of biodiversity, before this extraordinary scientific and economic potential get irremediably lost.

Key words: Biodiversity, local breed, famennoise, growth, egg quality, Belgium

INTRODUCTION

The present extraordinary wealth of poultry breeds is the result of about four thousands years of selection for morphological and productive traits (Granevitze *et al.* 2007). However, in all domestic species, as a result of intensification of animal productions, a few highly specialized breeds have been privileged and exploited world-wide leading to a global threat to biodiversity. In poultry, production systems have become largely industrial, resulting in a great improvement of their productivity and economic efficiency (Beaumont *et al.*, 2004). This intensive industrialization has made the problem of genetic diversity loss particularly acute in poultry. A few hybrid strains are indeed exploited across the world, with a decreasing number of companies controlling the global market. According to the Commission for Genetic Resources of the Food and Agriculture Organization of the United Nations (FAO), at least one domestic breed have become extinct every month in the last seven years, a tremendous genetic potential being irremediably lost (FAO report, 2007). Nevertheless, as in the rest of Europe, a great biodiversity still remains in Belgium, which is, however, characterized by a critically endangered status of 96 % of local poultry breeds (less than 100 females and 5 males) (Larivière and Leroy, 2005). Because of these small population sizes, local breeds will survive only if the responsibility for their preservation is rapidly taken (Spalona *et al.*, 2007).

Paradoxically, parallel to this continuous loss of biodiversity, the consumers' expectations have evolved to an important demand for terroir products, for environment and animal-friendly production systems and for an enhanced food safety (Lamine, 2005). Local breeds, adapted to less industrial production systems, can fulfil this threefold expectation, offering the more flavorous products which the modern consumers are looking for (Sarter, 2004).

This growing demand can be considered as an opportunity for the launching of extensive conservation programs of local breeds, which find in this new context their economical justification. In France, some good illustration of such an economically-driven conservation program in poultry can be found, as several local breeds, among which the Bresse, have been conserved with the prospect of commercial exploitation under "quality labels" of controlled origin (Tixier-Boichard *et al.*, 2006a,b), which the Bresse breed had since 1957 (Beaumont *et al.*, 2004). Spain and Poland are also good examples of countries where several local breeds, known for the high quality of their eggs or meat, are actually protected from extinction (Francesch *et al.*, 1997; Anita, 2002). In Belgium, such an approach also exists. By using the Ardennaise in commercial crosses for high quality slow-growing broiler production, this endangered local breed has also been saved from extinction. The Famennoise is another Belgian poultry breed which is at the moment endangered. Like most of endangered local breeds, the Famennoise remains largely unknown and is representative of the continuous loss of genetic diversity that is threatening the future of animal production. From preliminary results, egg production traits in this breed showed valuable economic assets. It has, thus, been chosen as the focus of the present work. Phenotypically, it is quite close to the Ardennaise, from which it must, however, be differentiated by its dark brown eyes. It is further characterized by its white plumage, its red face, and its slightly bluish beak, as described by Brandt and Willems (1970). The same authors give for this breed a mean annual egg production of 140-170 eggs, with a mean egg weight of 60 g. The adult rooster weighs 3 kg and the adult hen 2.5 kg, while young males and females are about 2.5 and 2 kg, respectively (Thewis, 2007). The meat of this slow growing breed is known for its delicate flavour and is highly appreciated by a few connoisseurs. In 2005, Larivière and Leroy (2005) reported that only 98 individuals (19 roosters and 79 hens) were still kept by fanciers. The breed was, therefore, at the time almost extinct. However, since then, a selection program was initiated by Professor Thewis, from the Agronomy College of Gembloux and is presently implemented at the Experimentation Centre of Malagne-la-Galloromaine in Rochefort. This program allowed the production of broilers weighing 2.3 kg at 110 days, with a ready-to-cook weight of 1.5 kg (Thewis, 2007).

In this context, the present study aims at establishing production performances of the Famennoise in the prospect of its conservation and future valorization.

MATERIALS AND METHODS

Egg quality: Eggs were freshly collected from laying hens aged 52 weeks, that were bred at the Experimentation Center of Malagne-la-Galloromaine in Rochefort. Hundred and one eggs were collected, numbered and stored at 6°C until the day following collection, when measurement were taken.

Eighty eggs were studied at the Veterinary Faculty of the University of Liege (Food Science Laboratory) where the following parameters were measured: length, width (electronic sliding caliper, 0.1 mm accuracy), total egg weight, albumen weight, yolk weight, eggshell weight (electronic balance, 10^{-2} g accuracy) and albumen pH (Consort, P514). Egg shape index could then be calculated as defined as the ratio between length and width multiplied by 100 (Parmar *et al.*, 2006; Monira *et al.*, 2003). Egg constituents weight were used in the form of their percentage of total egg weight. The ratio of yolk and albumen was also calculated (Y:A ratio).

Twenty one eggs were studied at the Catholic University of Leuven at the Egg Quality and Incubation Research Group. Maximal breaking force (F_{max}, in Newton) was determined by the static compression method (De Ketelaere *et al.*, 2002) using a universal tensile and compression test machine (UTS test system GmBH., Ulm, Germany) shown in Fig. 1 (De Ketelaere *et al.*, 2002). Eggs were placed horizontally between two steel plates squeezing them at a speed of 10 mm/min. F_{max} was the force at which egg breaking occurred.

The shell thickness was measured at three different random points in the equatorial shell zone using an electronic micrometer (accuracy 0.1 mm). The calculated average was used as a trait. Tyler and Geake (1964) indeed reported the eggshell thickness to be slightly thinner but more stable in the equatorial shell zone compared to other shell zones.

Famennoise broiler production

Animals: At the Experimentation Center of Malagne-la-Galloromaine (Rochefort), 59 chicks from eggs layed by 54 weeks old hens were followed. These were bred on a sawdust litter in a ventilated building. The animals were divided in four groups, three of them containing 15 animals and a fourth group containing 14 animals.

Feeding and prophylaxis: Animals were fed *ad libitum* with a starter mix until the age of 14 days (energy: 2870 Kcal/kg, density: 0.732 kg/l) and then passed to a tradition poultry mix (energy: 2950 kcal/kg, density: 0.723 kg/l) which was given *ad libitum* until slaughter. Between day 14 and 21, both food types were mixed to respect a food transition phase. Both mixes contained wheat, corn, soy, soy oil, methionine, lysine, vitamins and BHT ethoxyquine antioxydant. Their compositions are listed in Table 1.

Controls and measures: Animals were weighted individually once a week until week 15. Sexing was achieved at 8 weeks by observation of the comb. During the eight first weeks an electronic balance (accuracy 0.1 g, maximum weight 2 kg) was used. A balance with an accuracy of 1 g and a maximum weight of 5 kg was then used until week 15.

The feed conversion index was determined for each group from the total calculated ingested food and total live weight. Daily Weight Gain (DWG) was calculated by dividing the week gain by seven. Mortality was recorded.

Statistical analysis: Descriptive statistical analysis (arithmetic mean, maximum and minimum values, standard error) was achieved for each of the studied traits. Effect of sex and group on growth was then assessed through an analysis of variance, using the SAS software (general linear model, Statistical Analysis Software, 2000). Means of live weights at each age, as well as standard errors, were calculated for each sex.

Growth curve parameters were estimated, according to the following Gompertz equation:

$$Y = Ae^{-Be^{-Kt}}$$

where Y = weight of broiler (g) ; A = asymptotic weight ; B = integrating constant; K = growth speed factor (maturation factor) (Hurwitz *et al.*, 1997; Mignon-Grasteau and Beaumont, 2000). These parameters were estimated through a non-linear regression procedure using the Marquardt method (SAS Software, Proc nlin).

Table 1: Composition of feed mixes

Ingredients	Broiler Starter mix	"Tradition" Broiler mix
Soy oil cake	32	30
Wheat	37	31
Corn	25	33
Soy oil	2.3	2.0
Calcium phosphate	1.5	1.8
Minerals [1]	1.1	1.0
Calcium carbonate	1.08	1.2
Methionine	0.02	0.2

[1]: Vitamin A 13.500 UI/kg, Vitamin D3 3.000 UI/kg, Vitamin E 25 mg/kg, Copper (copper sulfate) 15 mg/kg

Table 2: Fammennoise Egg composition and resistance traits

	N	Mean	Maximum	Minimum	Std dev
Albumen Ph	80	8.86	9.20	8.57	0.20
Egg weight (g)	80	55.43	62.41	49.50	3.03
Albumen weight (g)	80	32.47	38.19	28.23	2.21
Yolk weight (g)	80	16.42	20.70	14.11	1.40
Shell weight (g)	80	6.54	8.00	5.40	0.49
PC albumen (%)	80	58.56	62.75	53.18	2.02
PC yolk (%)	80	29.63	34.66	26.35	1.91
PC eggshell (%)	80	11.82	13.57	9.90	0.79
Y:A ratio (%)	80	50.70	65.00	43.00	5.02
Length (mm)	80	55.5	59.5	52.5	1.6
Width (mm)	80	42.4	44.1	40.1	1.1
Form index (%)	80	76.49	82.71	68.47	2.87
Fmax (N)	21	36.03	41.72	30.01	3.30
Shell thickness (mm × 10^{-2})	21	32.95	36.90	29.00	2.16

RESULTS AND DISCUSSION

Egg quality: Egg total weight, length, width and form index, components (albumen, yolk and eggshell) weight and percentage, Y:A ratio, albumen pH, maximum breaking force and eggshell thickness are presented in Table 2.

The average albumen pH was 8.86 ± 0.20. This value is close to that reported by Silversides and Villeneuve (1994) (8.83) and by Merat *et al.* (1983) (8.85-8.91), for different poultry breeds. However, it is higher than values recorded in commercial hybrid strain (Silversides and Scott, 2001) (8.42-8.44). Breeding conditions, rather than a genetic effect, is probably to incriminate here. In industrial egg production, eggs are collected sooner after laying compared to our study where eggs could stay for some hours on the litter before collecting, which could speed up albumen liquefaction and pH modifications.

Mean egg weight was 55.43 ± 3.03 g, which corresponds to the middle category (53-63 g) of eggs commercialized in Europe (Sauveur, 1995). This egg weight is actually superior to those of different European local breeds, as the Bresse (54.2 g), the Gasconne (54 g) or the Grey Gauloise (51.7 g) (Tixier-Boichard *et al.*, 2006a). More importantly, it is far superior to those of the Egyptian breed, the Fayoumi (42.8 g) (Tixier-Boichard *et al.,* 2006b), the latter breed being extensively used in crosses with commercial hybrids aiming at egg quality improvement but presenting the disadvantage of a low egg weight.

Albumen, yolk and eggshell percentages were 58.56 ± 2.02 , 29.63 ± 1.91 and 11.82 ± 0.79 %, respectively. Average Y:A ratio was 50.70 ± 5.02 %. This value is intermediate between those presented by Fayoumi eggs (64 %) and commercial hybrid strains (42.3 %) (Merat *et al.*, 1983; Tixier-Boichard *et al.*, 2006b). It is here important to mention that the Fayoumi breed has undergone an important selection effort to improve this trait, which is not the case for the Famennoise breed.

In a general way, Y:A ratio is higher in local breeds, as also shown in a study comparing the Korean Native Chicken (KNC) and a Commercial Egg-type Chicken (CEC), the first showing a very high ratio of 55 % and the latter a weak ratio of 38 % (Suk and Park, 2001). Among local breeds, regarding Y:A ratio, the Famennoise can be classified as a middle class breed, as ratios as weak as 43.5-44.1% are reported for the Mandarah breed (Bordas *et al.*, 1994). This generally superior Y:A ratio in local breeds is a result of the strong correlation existing between egg weight and albumen percentage (Bougon *et al.*, 1981 ; Romanoff and Romanoff, 1949; Suk and Park, 2001). Commercial hybrids being bred for egg weight trait, this is accompanied by a fall in Y:A ratio. It is worth noting that this intensive selection history of commercial strains gives a general advance for this trait as well as for the yolk or albumen weight and eggshell thickness (Benabdeljelil and Merat, 1995; Hocking *et al.*, 2003). As already mentioned, the Fayoumi breed is largely used for crosses with commercial strain to improve Y:A ratio. In such crosses, Y:A ratio in the improving breed should be considered along with egg weight in an attempt not to decrease the latter trait.

Mean maximum breaking force (Fmax) of Famennoise eggs was 36.03 ± 3.30 N. This is superior to the reported value for the Fayoumi (35.00 N) and very close to the commercial Isa-Brown breed (36.70 N) (Tixier-Boichard *et al.,* 2006b). Other commercial strains, the Lohmann, the Bovan and the Hisex presented in another study Fmax values of 35, 32 and 38 N, respectively (De Ketelaere *et al.*, 2002). Again, this value is obtained in the Famennoise in absence of selection programs for this trait contrary to commercial strains.

Eggshell thickness was 32.95 ± 2.16×10^{-2} mm. This value is lower than that in commercial strains. Such a difference between local and commercial breeds is commonly reported (Suk and Park, 2001; Offiong *et al.*, 2006).

Famennoise broiler production: Global mortality was 15.25 % (9 animals). This value is far higher than that reported by Sauveur (1997) for the Label Rouge chicken (2.5 %) and the standard chicken (5.1 %). As no necropsy could be done, the cause for this high mortality rate is still unknown to the authors. The mortality was distributed as follows: 1 animal at weeks 3 and 12, 2 animals at weeks 5 and 7 and 3 animals at week 4.

Growth: Mean weights evolution is presented in Fig. 2. Mean weight at hatching was 38.30 ± 0.41 g, which is higher that recorded by the Organic Broiler Production in Denmark (35 g) (Pedersen *et al.*, 2003) and close to that recorded by Marguerie (2002) in different groups of the Gournay breed (34.75-41.18 g).
At week 8, the mean weight reached 980.67 ±16.62 g, 1815.90 ± 36.55 g at week 12 and 2191.90 ± 48.31 g at week 15. The weight at 12 weeks is here lower both than those reported for the Organic Broiler Production in Denmark (2167 g) and for the Label Rouge broiler (2170 g) (Pedersen *et al.*, 2003; Sauveur, 1997). However, at 14 weeks, the Famennoise broiler reaches a weight of 2124.6 g, which is superior to the Bresse broiler (1859 g), sold as a quality label product as could be the Famennoise (Tixier-Boichard *et al.*, 2006a). At 8 weeks, the Famennoise broiler also showed to have a higher weight than French breeds as the Gournay (763 g) or the Gasconne (725 g) (Tixier-Boichard *et al.*, 2006a). These growth performances of the Famennoise broiler are thus to consider as good in the context of quality label broiler production.
The difference between males and females was very significant ($p < 0.0001$) (Table 4). At week 8, males weighted 1042.88 ± 23.62 g versus 866.67 ± 31.98 g for females. Both weights are inferior to those presented in the Grey Gauloise breed (1184 g for males, 959 g for females at 8 weeks) and the Géline de Touraine (1302 g for males, 1069 g for females at 8 weeks), but higher than the Black Gauloise (950 g for males and 774 g for females) (Tixier-Boichard *et al.*, 2006a). In comparison to the closely related Belgian breed, the Ardennaise, the growth in the Famennoise showed to be clearly superior as the latter reached 1729.24 ± 23.62 g and 1321.39 ± 31.98 g at 11 weeks, for males and females respectively, versus corresponding values of 1148.06 g and 913.05 g in the former after two generations of selection for growth (Larivière *et al.*, 2006; Larivière and Leroy, 2006).
The mean Daily Weight Gain for the three breeding period from 0-2 weeks, 2-12 weeks and 12-15 weeks are 2.53 g, 24.89 g and 17.90 g, respectively (Table 3). As presented in Fig. 3, DWG starts at 1.91 g during the first week and increases to reach a maximum of 33.38 g at the seventh week. It decreases then to 25.6 g at week 8 but increases again to 32.94 g at the 12th week. A dramatic diminution is finally observed between week 12 and 15, DWG being of 9.64 g at that time. Such an evolution is classical for DWG (Pedersen *et al.*, 2003). As for live weights, a difference is observed between males and females between week 8 and 14, values becoming similar in both sex at week 15.

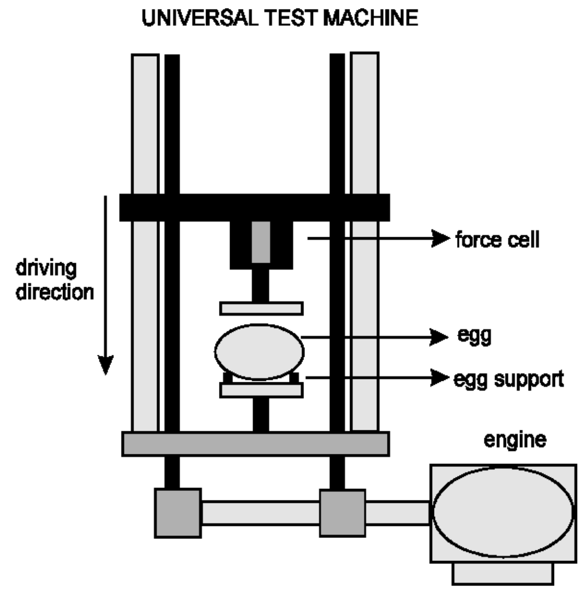

Fig. 1: Universal Tensile System used for measurement of the maximum breaking force Source: De Ketelaere *et al.* (2002).

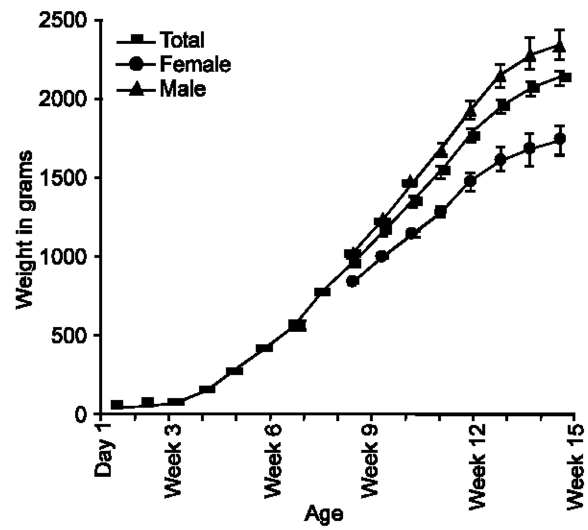

Fig. 2: Famennoise broiler growth curve from week1-week 15

Table 3: Feed conversion index, DWG and mortality

	0-2 weeks	2-12 weeks	12-15 weeks	0-12 weeks	0-15 weeks
IC	1.91	3.56	7.14	3.52	4.07
DWG	2.53	24.89	17.90	21.16	20.51
mortality	0	9 individuals	0	9 individuals	0

Table 4: Growth curve parameters of the Famennoise broiler

Parameters	Total population	Female	Male
A	2965.8	2245.1	3086.3
B	5.2292	5.5423	6.7681
K	0.0278	0.0311	0.0323

Feed conversion: At periods 0-2 weeks, 2-12 weeks and 12-15 weeks, the Feed Conversion index was 1.91, 3.56 and 7.14 respectively (Table 4). As shown in Fig. 4, Feed Conversion Index (FCI) progresses from 0.98 at the first week to 4.35 at the 13^{th} week. Beyond this age, FCI rises dramatically to 14.85 at week 15. Global FCI at 15 weeks was 4.07, while it was 3.51 at 12 weeks and 3.52 at 13 weeks (Table 4). Given that the Famennoise broilers reached a weight of 2 kg at 13 weeks, there is no need to prolong growth beyond this age, thus keeping an economically reasonable feed conversion efficiency. It is worth noting that this FC index is far lower than those presented at 12 weeks by other terroir broiler as the Gasconne (6.58) or the Bresse (4.59) (Tixier-Boichard *et al.*, 2006a). However, it is still much higher than values recommended for the French commercial quality Label Rouge broiler, which presents an FC index of 2.17 and 2.24 at 12 and 13 weeks, respectively (Sauveur, 1997).

Gompertz curve parameters: Parameters calculated for the growth curve of Famennoise broilers are presented in Table 4. The estimated formula was

$$Y = 2.966e^{-5.229e\ -0.0278t}$$

where y is the live weight and t the age in weeks. Parameters values were different in males and females, the formulas by sexe being

$$Y = 3.086e^{-6.7681e\ -0.0311t}$$

and

$$Y = 2.245e^{-5.5423e\ -0.0311t}$$

for males and females respectively. Such a difference is also described in the literature (Mignon-Grasteau and Beaumont, 2000; Pedersen *et al.*, 2003; Gous *et al.*, 1999). Indeed, Barbato and Vasilatos-Younken (1991) showed sex to explain 5-10 % of whole variability in growth. In all species for which males are heavier than females, as in poultry, asumptotic weight (A) are expected to be lower and maturation speed (K) higher in females (Barbato, 1991; Mignon-Grasteau and

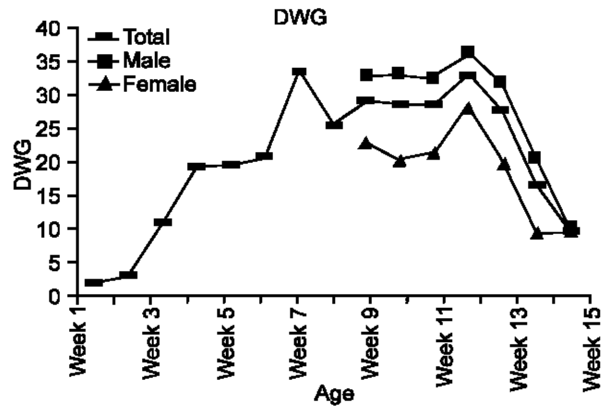

Fig. 3 : Daily weight gain of Famennoise broilers from week 1-week 15

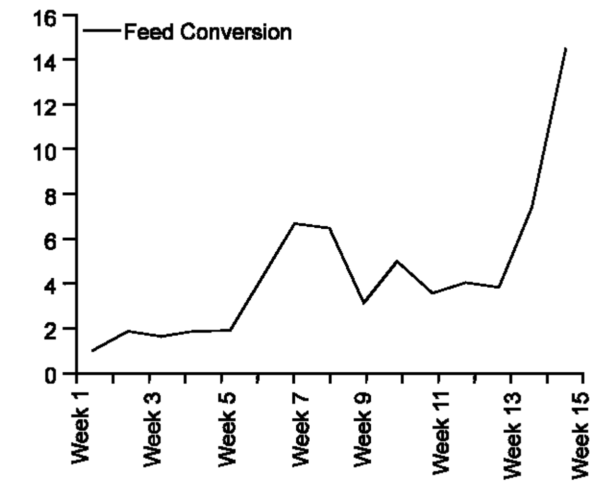

Fig. 4: Feed conversion index evolution in Famennoise broilers

Beaumont, 2000). In our study, however, maturation speed is higher in males (Table 4). This could result from selection on growth traits, such a selection being known to cause an increase of this parameter more efficiently in males compared to females (Gous *et al.*, 1999). Contradictory results can nevertheless be found in literature (Barbato, 1991; Hancock *et al.*, 1995).

Conclusion: The present study constitutes a first for the Famennoise breed. The evaluation of egg production and growth performances lead to the identification of different assets for its further valorization, so insuring its conservation.

First, produced eggs proved to have appreciable qualities, such as its good Y:A ratio and a very good eggshell resistance. The first parameter is important in that yolk contains much of proteins and lipids of the egg. This parameter is thus the most significantly linked to egg dry matter efficiency, which is economically important in regard with the different utilizations of eggs in pharmaceutical, food-processing or cosmetic industries (Hartmann and Wilhemson, 2001; Hartmann *et al.*, 2003ab; Harms and Hussein, 1993; Abanikannda *et al.*, 2007; Grunder *et al.*, 1991). Eggshell resistance to shocks is not less economically primordial as it determines the ability of eggs to withstand transportation from producers to consumers (Mertens *et al.*, 2006). Important losses, from 6-8% of total egg production, are indeed to put down to eggshell fragility (Washburn, 1982). Such a fragility being common in eggs layed by local breed, the present observation is of great importance.

Regarding growth performances, these showed to be very good. Although it cannot be compared to quality label broilers as the French Label Rouge, which has been bred for growth since many years, it advantageously compares with other terroir products, such as the Bresse chicken, which is exploited as a controlled origin product for more than 50 years. Its white plumage constitutes another asset as it leaves a spotless carcass after plucking, contrary to black feathered poultries, for which some reluctance of the consumer is to fear.

As the Famennoise is renowned for the delicate taste of its meat, a first valorization way would be the production of quality terroir poultry meat, under an official quality label. Selection procedures for growth could thus be implemented in this prospect, improving its already good performances.

Regarding egg production, its valuable assets could be exploited through crosses with industrial strains to produce hybrids, showing better Y:A ratio, without the strong negative effect on egg weight or eggshell resistance that is observed with the largely used Fayoumi breed in such improvement crosses. Moreover, as its eggs show middle class weight, a direct commercialization can be envisaged. The Famennoise could be regarded as a valuable dual-purpose terroir poultry, perfectly corresponding to the present trend in consumers' wish for authenticity, quality as well as for animal and environment respect.

Beyond the specific case of the Famennoise, the present study aims at highlighting the urgent need of biodiversity conservation, which in the case of poultry could be economically motivated and as such, is hoped to be efficient. Thus, it is here proposed to broaden the present approach to the great variety of local breeds that still exists in Belgium and Europe. The quite simple protocol allows indeed this to be extensively applied with minimal costs. Genetic variability is a true treasure that must be protected. Much traits of economic interest that are waiting to be promoted are disappearing every day.

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