Improving the Final Liveweight and Growing Ability of TETRA-H a Dual Purpose Chicken Type by Using a New Experimental Sire Line

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Summary

Our study was carried out with the pure, crossed and reciprocal crossed offspring of TETRA-H hybrid, a coloured slow-growing broiler genotype which was developed in the 1980's by Bábolna TETRA Ltd. In this project the potential of a new, improved sire line was also investigated. Experiments were carried out in the Poultry Test Station of the Kaposvár University in 2008 - 2010. In the first stage, growing ability of TETRA-H and a commercial genotype (standard control=Shaver Redbro) had been compared. In stages two and three the LL line, which was previously used as sire line, the newly selected sire Line EE, and the offspring came from the combination of those lines have been centrally tested. A total number of 6453 birds were used. The following traits were investigated: live weight, body composition evaluated by CT, carcass yield, meat quality, etc. The positive impact of the newly developed sire line (EE) in their offspring was confirmed. Lower slaughter weight of the F_1 offspring has improved by 10.1-10.8%, making the newly developed hybrid highly competitive on the market. Furthermore, the crossing method was incompetent (LL♂xEE♀ or EE♂xLL♀) in the birds live weight and growing ability.

Key words

slow growing broiler, pure lines and crossed offspring, liveweight, body composition, meat quality

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Aim

Following the idea and structure of French Label Rouge, free range and organic poultry systems are increasing in Hungary. This fact is due to pressure coming from both animal welfare organizations and special marketing needs. A genetic construction, which is competent for this purpose, is a three-line hybrid TETRA-H, which was developed in the early 1980's by the TETRA Poultry Breeding Company. Thanks for its calm temperament and balanced production it was capable of replacing the traditional free-range poultry breeds. However, out of its dual purpose characteristics, egg production of these birds is still dominant (Forgács, 2009).

The aim of this four year research project was to increase the final liveweight of this popular hybrid by using a new experimental sire line, which develop meat yield and create a suitable genotype for organic and free-range keeping systems in Hungary. The new sire line that expected to improve F_1 offspring have been selected by TETRA Breeding Company in a vigorous selection program within their Golden Plymouth pedigree stock. Birds in the EE line should have significantly higher final liveweight, uniform red plumage, and black tail feathers. Further on these traits, retention of excellent meat proportions (breast and leg ratio) and viability was aimed.

Definition and comparison of meat producing ability of TETRA–H, and a standard control (*Shaver Redbro*) was undertaken. Performance of the current (LL) and the new, experimental sire line (EE) have been centrally tested. Similar comparative study of fast growing (ROSS) and slow growing (Rhode Island Red, Barred Plymouth) meat type chickens was recently made by Sarica et al. (2010).

Material and methods

Environment

This experiment was conducted in the Poultry Test Station of the Kaposvár University, Faculty of Animal Science. Day-old birds were randomly allocated to 18 hatches (9.2 m^2 basic area), reared in a closed building up to 12 weeks of age, and separated by sex and genotype. Lighting program was 23L:1D. All birds were given *ad libitum* access to commercial diet (starter 0-10 d, growing 11-24 d, finisher from 25th d) and water from self-drinkers.

Experimental design

Experimental units in all three experiments were groups of 110 males and 129 females (m+f = 239). Two-factorial randomized blocked design was used.

Experiment 1: The first trial comprised of two genotypes TETRA-H and Shaver Redbro, with three replications (2x3=6 groups x 239 chicks=1436 birds). Meat producing ability and genetic capacity of the two genotypes were determined and compared.

Experiment 2: Secondly, the genetic ability and the performance of the original sire line (LL) and the new, experimental sire line (EE) were tested and compared both in pure lines and in their reciprocal crossed offspring (LL x EE). This trial comprised of three genotypes (LL, LE, EE) with four replications (3x4 =12 groups x 239 = 2868 birds).

Experiment 3: Next, in experiment 3, we tested and compared the performance of the two pure lines (LL and EE) and their crossed offspring (EE x LL). This trial comprised of three genotypes (LL, EL, EE) with three replications (3x3 =9 groups x 239 = 2151 birds). This construction will be the newly improved TETRA-H.

The following traits were measured during the three experiments: weekly liveweight, body composition (breast and leg ratio, muscle and fat tissue development) by computer tomography, slaughter parameters, and meat quality. Data collected from birds (week seven, 10) were analyzed by ANOVA using the GLM Model of SAS software (SAS 9.1). For all analysis, $P<0.05$ was considered significant.

Body composition traits and carcass yield

Examinations were undertaken at the Institute of Diagnostic Imaging and Radiation Oncology of the Kaposvár University, between four and 10 weeks of age. The CT measurements consisted of overlapping 8 mm thick slices covering the whole body (Siemens Somatom Emotion 6 multislice). Using the images obtained so called muscle and fat indices were calculated by determining the ratio of number of pixels with X-ray density values of muscle or fat to the number of pixels with density values of muscle, water and fat, i.e. the range between -200 to +200 on the Hounsfield-scale:

Muscle index = $\sum$ (+20)-(+200) / $\sum$ (-200)-(-200) x 100

Fat index = $\sum$ (-200)-(-20) / $\sum$ (-200)-(+200) x 100

Chickens for the CT examination (n=20 of each gender) were chosen randomly at four weeks of age. They were tagged and measured individually before the process. Moreover, 20 males and 20 females of each genotype were slaughtered and commercially processed at the age of 10 weeks. Carcass yields were calculated and compared.

Meat quality

A total of 120 samples were taken from the left whole leg of each genotype and sex after chilling carcasses at the Processing Plant for three hours. At 24 hours post-mortem, legs were deboned and taken into parts (bone, muscle, skin). Individual weights were measured and muscle pH24 was determined.

Results and discussion

Liveweight and growing ability

Experiment 1

In the first trial, two different slow growing broiler genotypes were compared. Results are shown in Table 1. The difference between the two evaluated genotypes was 28–29% at 10 weeks of age. Shaver Redbro chicks were significantly ($P<0.05$) heavier than Tetra-H birds by 1000 and 700 grams on average in males and females, respectively.

Experiment 2 and 3

Experiment 2 and 3 that compared and evaluated the pure lines and their crossings led to the following results (Table 2). EE birds had higher liveweight than LL or EL birds in both sexes ($P<0.05$). Crossed females (LE and EL) reached different ($P<0.05$) weight at 70 d. In contrast, liveweight was not different

Table 1. Liveweights of different broiler genotypes in different age groups

Genotype	Sex	Liveweight (*g*)		
		Week 7	Week 10	Week 12
Shaver Redbro	Male	2305 [a]	3504 [a]	3930 [a]
	Female	1947 [b]	2695 [b]	2930 [b]
Tetra H	Male	1628 [c]	2518 [b]	2902 [b]
	Female	1292 [d]	1907 [c]	2215 [c]

a-d Means within the column lacking a common superscript differ (P < 0.05)

(P>0.05) between EL and LE males. Growing ability of crossed birds, LE and EL have emerged the average performance of the pure lines, but failed to reach it by 4.5 and 5.1%, respectively.

Body composition traits and carcass yield

Development of the muscle tissue was continuously increasing in the LL and EL lines up to the 8th week of age, while its ratio in the body was decreasing in the EE birds during the whole experimental period in trial 3 (Figure 1). The ratio of fatty tissues in the body was continuously increasing in cocks from EL and EE genotypes till the 10th week of age (Figure 2). In contrast, the same parameter reached a lower level in EL pullets.

It was concluded that EE birds, although, had better growing ability, and were more prone to developing fatty tissues. This trait was observed in its crossed offspring pullets more than in its cocks, similar to previous studies (Milisits et al., 2010). The ratio of muscle and fat tissue values of the crossed birds (EL) lied between the pure lines between the 4-10 weeks of age.

Crossed birds reached the highest carcass yield at 10 weeks of age, exceeding the performance of the new sire line. Neither, grillfertig weight (g), nor carcass yield (%) were different (P>0.05) between EL and LE lines.

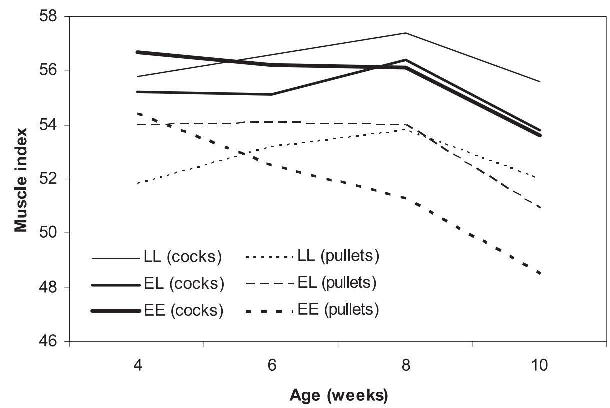

Figure 1. Changes in the muscle index of LL, EL, and EE genotypes between 4 and 10 weeks of age

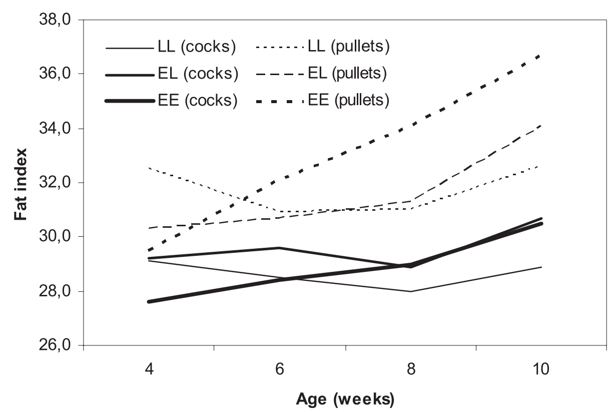

Figure 2. Changes in the fat index of LL, EL, and EE genotypes between 4 and 10 weeks of age

Table 2. Liveweights of pure and crossed lines of Tetra-H in different age groups

Live weights (g)	Genotype							
	LL		EL (Trial 3)		LE (Trial 2)		EE	
	Male	Female	Male	Female	Male	Female	Male	Female
17 days	431[d]	388[e]	526[c]	485[d]	488[bc]	452[d]	552[a]	510[b]
70 days	2662[d]	2000[f]	3149[b]	2425[d]	3154[b]	2372[e]	3923[a]	2987[c]
Percentage heterosis %			5.1		4.5			

a-f: Means within the row lacking a common superscript differ (P < 0.05)

Table 3. Live weights and some slaughtering traits of genotypes

Traits	Genotype												P
	LL			LE			EE			EL			
	M	F	M+F	M	F	M+F	M	F	M+F	M	F	M+F	
Liveweight (g)	2662	2000	2331[c]	3154	2372	2763[b]	3923	2987	3455[a]	3149	2425	2787[b]	*
Grillfertig weight (g)	1753	1282	1517[c]	2120	1569	1844[b]	2629	1941	2285[a]	2100	1612	1856[b]	*
Carcass yield (%)	65.9	64.1	65.0[c]	67.3	66.1	66.7[b]	66.7	64.9	65.8[a]	66.6	66.4	66.5[b]	*

a-c Means within the row lacking a common superscript differ (P < 0.05); * P<0.05, M=male, F=female

Table 4. Impact of genotype and age on meat pH and leg parts ratios

Lines		Week 7							Week 10						
		pH24	Bone [g]		Muscle [g]		Skin [g]		pH24	Bone [g]		Muscle [g]		Skin [g]	
LL♂	Mean	6.47	47.13	b	125.52	bc	26.24	abc	6.27	83.25	b	193.05	bc	38.86	ab
	SD	0.12	4.60		9.02		3.84		0.17	11.08		20.82		7.49	
LL♀	Mean	6.38	42.49	ab	98.94	a	18.52	a	6.26	53.85	a	130.64	a	29.89	a
	SD	0.13	5.58		11.73		4.69		0.21	4.81		7.29		4.09	
LE♂	Mean	6.27	58.94	c	143.52	c	22.22	ab	6.25	87.05	b	240.33	c	46.47	bc
	SD	0.21	4.11		8.49		4.16		0.14	10.97		41.68		4.07	
LE♀	Mean	6.36	33.81	a	113.14	ab	20.47	a	6.09	59.31	a	161.33	ab	34.70	a
	SD	0.13	3.40		9.09		2.51		0.12	6.15		17.44		7.45	
EE♂	Mean	6.38	57.97	c	191.69	d	30.42	c	6.07	91.65	b	294.87	d	57.73	c
	SD	0.19	9.46		17.39		6.70		0.25	15.36		43.02		7.18	
EE♀	Mean	6.44	41.81	ab	149.69	c	28.44	bc	6.17	63.71	a	211.77	c	48.64	bc
	SD	0.12	2.65		13.88		3.40		0.14	6.65		23.59		6.37	

a-d Means within the column lacking a common superscript differ ($P < 0.05$)

Meat quality

In this experiment both sexes and lines were compared (Table 4). The most important part: the weight of the leg muscle was the highest in cocks from the EE line, and the lowest in the LL line on both evaluated weeks. Bone ratio of LE males and females was the highest at seven weeks of age, whereas EE males developed the heaviest bones by the 10th week.

Heritability of meat quality traits in slow growing population are h^2=0.27-0.48 on average, except for cooking loss and shear force for which has very low heritability value (h^2=0.04 and 0.16). Meanwhile, meat colour and pH have a relatively good heritability (h^2=0.45-0.48)from which pH appears to be a key factor in selection, as it is strongly related to meat colour, water holding capacity and texture (Chabault et al., 2010).

Conclusions

Positive genetic impact of the new experimental sire line on its crossed offspring was confirmed by several methods. The crossing method (LE or EL) had no significant effect on birds growing ability. Liveweight of chickens from the two different crossing methods (LE and EL) were not different (P>0.05).

In conclusion, the new breeding program of Tetra-H is successful and will certainly create a new competitor on the dual purpose chicken market in Europe.

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