Broiler carcass and meat quality as affected by egg yolk content determined by means of Computer Tomography

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Abstract- **Computer tomography (CT) was used to select eggs with Low (L; 21.0±0.88 %), Medium (M; 24.5±0.1 5 %) and High (H; 28.3±0.98 %) yolk content with the purpose to check the effectiveness of this egg selection technique in improving broiler carcass and meat traits of two genotypes: dual purpose, LL (Tetra-H hybrid; Bábolna TETRA Kft.) and meat type, EE (hybrid of Plymouth rock breed origin). All chicks were slaughtered at 11 wk of age. Carcass yield, leg components and rheological traits, and breast main fatty acid (FA) groups were analyzed. All traits of LL birds weren't influenced by the egg yolk content. On the contrary, it significantly affected broiler carcass traits of EE genotype: birds belonging to L group, compared to H and M groups, showed higher slaughter weight (SW; 3.6 *vs* 3.4 *vs* 3.3 kg; P<0.05) and grill-ready weight (2.4 *vs* 2.3 *vs* 2.2 kg; P<0.05), respectively. The abdominal fat incidence significantly increased as yolk content increased (0.77 *vs* 1.00 *vs* 1.33 %; P<0.05). Birds belonging to the L group exhibited the highest leg weight (840 *vs* 754 *vs* 793 g for L, M and H groups, respectively; P<0.05) and thawing losses (2.22 *vs* 1.46 *vs* 1.67 % for L, M and H groups, respectively; P<0.001). No effect of yolk content on main FA groups was found in the 2 genotypes. EE males exhibited best SW, carcass yield, WHC, tibia strength, PUFA contents and lower dissectible fat of legs than EE females (P<0.05). On LL males only SW and tibia strength were higher than on females (P<0.01). Bird selection according to the yolk content was effective only on EE genotype: chickens whose belonged to eggs with L yolk content were heavier and leaner but were characterized by a reduced meat WHC.**

Keywords- **Computed Tomography, egg yolk content, meat quality.**

I. INTRODUCTION

Computed Tomography (CT) is a diagnostic tool that uses images obtained by X-ray scans which allows to reproduce sections of the animal's body and subsequently, using a specific software, tridimensional elaborations of it. CT was used by [1] to determine the surface of the egg yolk on the cross sectional images which were obtained by scans and it resulted in a 69.3-74.1% accuracy of prediction; for this reason CT represents an effective pre-hatching and non-invasive tool that allows repeated and detailed body component observations.

Egg weight and composition change among strains [2], and albumen, representing the primary source of water, is the main determinant of hatchling success and chicks size, whereas yolk, as a nutritional supplement, may influence neonatal quality even if it seems not able to affect tissue formation during incubation [3]. It was also demonstrated that eggs with different chemical composition also presented different electrical conductivity [4].

The aim of this study was to test the effectiveness of yolk content selection method by CT in improving broiler carcass and meat quality in breeding selection programs.

II. MATERIALS AND METHODS

Two genotypes were considered in the present study: Bábolna Tetra-H (LL), a dual purpose hybrid that can be kept extensively and that is characterized by low growth rate, and a new meat-type broiler which originates from the Golden Plymouth (EE). The future purpose is to use the Golden Plymouth as a paternal line in improving Tetra-H live weight and meat traits.

The experimental design considered a total of 3500 eggs per genotype which were first analyzed by CT and then, based on three different yolk (Y) contents, the 30% of them was selected and classified as Low (L; 21.0±0.88 %), Medium (M; 24.5±0.15 %) and High (H; 28.3±0.98 %) yolk content groups.

Eggs were incubated and, after hatching, chicks (130 males and 130 females for each Y group) were marked and reared with *ad-libitum* feeding up to slaughter at 11 weeks of age.

Carcass traits were measured and 15 thighs and breasts per group (n=360) underwent physicochemical analysis which considered rheological traits and proximate composition [5], whereas breast Fatty Acid (FA) profile was analyzed by Gas Chromatography (automated apparatus CE 8000 Top, Thermoquest, Milan, Italy) after Folch extraction [6]. Transmethylation was carried out using a mixture of methanol, benzene and sulphuric acid (75:25:4).

ANOVA tested effects of yolk content, sex and their interaction [7].

III. RESULTS

Yolk (Y) content influenced slaughter weight (SW) of EE animals and birds belonging to the L group exhibited the highest SW (3.6, 3.3 and 3.4 kg for L, M and H yolk group respectively; $P<0.05$); consequently, L group of EE genotype showed significantly ($P<0.05$) higher grill-ready weight (Table 1).

In our study, an inverse and significant trend ($P<0.05$) was exhibited by the abdominal fat content of EE chicks where L and H groups presented the lowest (0.77 % SW) and the highest values (1.33 % SW), respectively. Y content didn't affect neither the SW nor the carcass yields (CY) of LL genotype (Table 2). In the present study sex effect influenced almost all yield parameters on both genotypes (Tables 1 and 2), with the exception of the abdominal fat content.

As expected, males presented higher SW and CY than females ($P<0.01$). Statistically significant differences due to the sex effect were evident also for leg components (Tables 3 and 4): on both genotypes; legs of male chickens were heavier with higher tibia strength but characterized by lower meat/bone ratio than females (4.32 *vs* 4.92 and 3.93 *vs* 4.22, for EE and LL genotypes, respectively).

EE Birds of L yolk group were characterized by significantly higher thawing losses than M and H groups (2.22 *vs* 1.46 and 1.67%, respectively; $P<0.001$). FA profile didn't show differences related to the Y content (Tables 5 and 6).

Only the sex effect was evident on breasts of EE birds: males breast contained more PUFA (21.2 *vs* 19.5% total FA), n-6 (20.3 *vs* 18.7% total FA) and n-3 FA (0.55 *vs* 0.49% total FA) than females ($P<0.05$; Table 5).

IV. DISCUSSION

Results obtained on EE genotype SW and showed in Table 1 supported those reported in the study of [1] which compared slaughter characteristics of ROSS-308 meat-type chicks hatched from eggs with different composition and measured by Total Body Electrical Conductivity (TOBEC).

For what concerns the significance that was evidenced in Tables 3 and 4 results confirmed whose demonstrated in many research works on different animal species where sex effect was found to be responsible for great differences in terms of body composition, yields and carcass fatness [8] [9] [10] [11].

V. CONCLUSIONS

Yolk content selection method was effective on SW and on some carcass traits on EE genotype only; these findings suggest that it may be a valid selection tool to improve carcass performances of meat-type chickens.

Table 1. Effect of yolk content and sex on slaughter yields of EE genotype

	Yolk (Y)			Sex (S)		Significance		RSD$^{(1)}$
	L	M	H	M	F	Y	S	
N. birds	24	26	29	39	40			
Slaughter weight (SW), kg	3.6^{b}	3.3^{a}	3.4^{ab}	4.0	3.0	0.0310	<0.0001	0.4
Grill ready weight, kg	2.4^{b}	2.2^{a}	2.3^{ab}	2.7	1.9	0.0125	<0.0001	0.3
Grill ready yield, % SW	66.8	66.2	66.3	67.3	65.5	ns	0.0041	2.7
Legs, % SW	23.0	22.7	23.0	23.7	22.0	ns	<0.0001	1.3
Abdominal fat, % SW	0.77^{a}	1.00^{ab}	1.33^{b}	0.90	1.17	0.0369	ns	0.78

$^{(1)}$Residual Standard Deviation

Table 2. Effect of yolk content and sex on slaughter yields of LL genotype

	Yolk (Y)			Sex (S)		Significance		RSD$^{(1)}$
	L	M	H	M	F	Y	S	
N. birds	29	30	29	43	45			
Slaughter weight (SW), kg	2.7	2.6	2.7	3108	2204	ns	<0.0001	0.3
Grill ready weight, kg	1.8	1.7	1.7	2.1	1.4	ns	<0.0001	0.2
Grill ready yield, % SW	66.2	64.6	65.3	65.9	64.9	ns	ns	3.3
Legs, % SW	22.9	22.7	22.8	23.4	22.1	ns	<0.0001	1.3
Abdominal fat, % SW	1.36	1.37	1.13	1.16	1.41	ns	ns	0.65

$^{(1)}$Residual Standard Deviation

Table 3. Effect of yolk content and sex on leg components and rheological traits of EE genotype

	Yolk (Y)			Sex (S)		Significance		RSD$^{(1)}$
	L	M	H	M	F	Y	S	
N. birds	23	26	27	38	38			
Leg weight (LW), g	839.8^{b}	754.4^{a}	792.5^{ab}	942.8	648.3	0.0263	<0.0001	109.0
Thawing losses, %	2.22^{B}	1.46^{A}	1.67^{A}	1.58	1.99	<0.0001	0.0015	0.54
Skin, % LW	10.7	11.1	11.6	10.7	11.5	ns	ns	2.1
Meat, % LW	71.0	69.6	69.3	69.7	70.2	ns	ns	2.7
Bones, % LW	14.8	15.6	15.7	16.4	14.4	ns	<0.0001	1.8
Dissectible fat, % LW	3.43	3.60	3.36	3.18	3.75	ns	0.0113	0.94
Meat/bone ratio	4.83	4.54	4.89	4.32	4.92	ns	<0.0001	0.58
Tibia strength, kg	36.8	34.6	36.3	42.0	29.8	ns	<0.0001	10.1

$^{(1)}$Residual Standard Deviation

Table 4. Effect of yolk content and sex on leg components and rheological traits of LL genotype

	Yolk (Y)			Sex (S)		Significance			RSD$^{(1)}$
	L	M	H	M	F	Y	S	Y*S	
N. birds	29	30	29	42	46				
Leg weight (LW), g	611.7	598.7	612.0	727.9	487.0	ns	<0.0001	ns	65.5
Thawing losses, %	2.33	1.97	2.13	2.02	2.27	ns	ns	ns	0.64
Skin, % LW	10.9	11.1	11.5	10.8	11.6	ns	ns	ns	2.3
Meat, % LW	69.3	68.8	68.7	68.9	69.0	ns	ns	0.0476	2.0
Bones, % LW	17.2	17.4	17.0	17.8	16.6	ns	0.0139	ns	2.2
Dissectible fat, % LW	2.52	2.58	2.74	2.51	2.71	ns	ns	ns	0.86
Meat/bone ratio	4.09	4.00	4.13	3.93	4.22	ns	0.0158	ns	0.55
Tibia strength, kg	29.7	28.2	28.7	32.2	25.6	ns	0.0004	0.0162	8.4

$^{(1)}$Residual Standard Deviation

Table 5. Effect of yolk content and sex on breast main fatty acid groups, EE genotype

	Yolk (Y)			Sex (S)		Significance		RSD[(1)]
	L	M	H	M	F	Y	S	
N. birds	24	26	26	37	40			
SFA	35.0	35.8	34.9	34.8	35.7	ns	ns	1.6
MUFA	40.9	39.3	41.0	40.1	40.8	ns	ns	0.5
PUFA	20.2	20.6	20.3	21.2	19.5	ns	0.0318	2.2
n-6	19.4	19.7	19.5	20.3	18.7	ns	0.0333	2.1
n-3	0.53	0.52	0.51	0.55	0.49	ns	0.0367	0.07
n-6/n-3	37.1	38.2	38.8	37.5	38.5	ns	ns	3.4

[(1)]Residual Standard Deviation

Table 6. Effect of yolk content and sex on breast main fatty acid groups, EE genotype

	Yolk (Y)			Sex(S)		Significance		RSD[(1)]
	L	M	H	M	F	Y	S	
N. birds	27	30	27	40	44			
SFA	35.2	35.7	35.6	35.5	35.5	ns	ns	1.4
MUFA	38.9	37.3	38.3	37.7	38.6	ns	ns	2.1
PUFA	21.5	22.0	21.4	22.0	21.2	ns	ns	1.4
n-6	20.6	21.0	20.5	21.1	20.4	ns	ns	1.3
n-3	0.53	0.52	0.52	0.52	0.52	ns	ns	0.05
n-6/n-3	39.5	40.8	3.9	41.1	39.1	ns	ns	3.0

[(1)]Residual Standard Deviation

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