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Does the incidence of egg yolk influence the meat quality and fatty acid profile of broilers of two chicken genotypes?

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Abstract: The present experiment studied the effects of egg composition (egg yolk content; Y) of two different chicken genotypes (selected by computed tomography; CT) on hatched chick growth performance, slaughter traits, and meat quality. Three thousand five hundred eggs per genotype were scanned by CT. Then, for each genotype, eggs were selected according to their Y content: low (21.0 ± 0.88 – 350 eggs), medium (24.5 ± 0.15– 350 eggs) and high (28.3 ± 0.98 – 350 eggs). The remaining eggs were excluded from the study. At 11 weeks of age, 15 chickens per group were slaughtered, carcasses were dissected and breast and legs were excised and dedicated to meat quality evaluations. Many parameters were influenced in the meat-type (EE) chickens, including slaughter, breast and leg weights, and abdominal fat content, whereas only the breast incidence on slaughter weight was affected in Tetra-H hybrid. In neither genotype were the meat traits affected by Y content. Two exceptions were represented by leg thawing loss, higher in low Y group compared to medium and high Y group, and by tibia length, longer in high Y content group than in the medium one, both for EE chickens. Similar findings were observed for the meat fatty acid (FA) profile, as only some single FA were influenced by Y content, however, apparently without a specific physiological meaning. The present work demonstrated that the Y content, measured by CT, allowed to select high-quality meat-type animals characterised by the best productive performances in terms of growth rate, live weight, slaughter weight, breast and thigh weights, and with lower abdominal fat content. These findings would bring positive advantages to hatcheries in terms of chick quality and also to farmers in terms of economic revenues: They would rear robust animals that would guarantee a higher probability of survival in the first rearing period and would be characterised by a high slaughter weight at the end of the productive cycle.

Keywords: carcass traits; computed tomography; genotype; performance; poultry; proximate composition

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Newly hatched chick weight and health are very important parameters concerning the meat production system: heavier chicks are indicated for intensive farming focused on meat production, because this will guarantee small health problems and low mortality during the first weeks of rearing. Actually, hatcheries do not have a system that allows selecting eggs that will provide chicks with the best productive potential and this may negatively impact also on farmers. In fact, they are penalised because they rear chicks for days, weeks, or for the entire productive cycle, even if a part of those animals do not produce as expected, thus worsening the conversion index which is at the basis of their payment system. Therefore, a hatchery non-destructive selection method could allow farmers to reduce feed and disposal costs, chick waste and finally improve animal welfare.

Chick quality has been associated with some intrinsic physical characteristics such as egg weight (Schmidt et al. 2009), chick weight (Tahir et al. 2011), chick length (Willemsen et al. 2008), or extrinsic parameters like egg storage time (Reijrink et al. 2010) or position in the incubator (Elibol and Brake 2008). It was demonstrated that embryo weight is not correlated with egg weight during the first half of the incubation period, whereas the correlation progressively increases in the second half and reaches the maximum value at the time of hatching (Wilson 1991). Heavy eggs are known to have a greater proportion of albumen and less yolk than small eggs (Harms and Hussein 1993; Vieira and Moran 1998) and it was also found that the increase of egg and albumen weights often lead to lower hatchability (Miyoshi et al. 1996). It is known that embryo mass is influenced by the uptake of moisture and fat from the yolk and, more specifically, embryo and liver dry matter (DM) percentages are associated with different fatty acid (FA) fractions in yolk lipids. Finkler et al. (1998) studied the influence of some "egg factors" such as size, composition, albumen and yolk content on the size and body composition of near-term embryo hatchability, offspring fitness and weight in birds, but little research has been focused on slaughter characteristics of hatched chicks and adult chickens compared to egg composition.

Actually, a reliable, non-invasive and accurate prediction method to estimate egg composition is still being evaluated: X-ray absorptiometry was successfully used for determining the *in vivo* body composition of chickens (Mitchell et al. 1997; Swennen et al. 2004). Computer-assisted image analysis showed good conformity with egg composition (Kuchida et al. 1999) and total body electrical conductivity (TOBEC) was used in experiments with many species by different authors (Williams et al. 1997; Latshaw and Bishop 2001; Milisits et al. 2005, 2010) with positive results. Finally, computed tomography (CT) was positively evaluated in measuring the body composition of rabbits (Romvari et al. 1998), turkeys (Brenoe and Kolstad 2000) and broiler chickens between 4 and 18 weeks of age (Andrassy-Baka et al. 2003); CT was also applied to predict the egg yolk content (Y) with an accuracy of 69.3–74.1% (Milisits et al. 2009) and, more recently, for measuring the lean meat percentage of pig cuts (Daumas and Monziols 2011). For the good results which have been obtained in different species, CT could represent a useful and accurate method with the perspective of being involved in future studies.

Moreover, a demonstrated relationship of egg components with chicken performance traits and meat composition could also allow an anticipated hatchery selection that could improve business efficiency, without breaking eggs and avoiding costs connected with weak and less productive animal rearing. Given the above, the present experiment was aimed at studying the effects of egg composition, in this case the Y, of two different chicken genotypes (selected by the CT method) on hatched chick growth and then, after the rearing period, on chicken performance and slaughter traits, and meat characteristics, including rheological traits, proximate composition, cholesterol content and FA profile.

MATERIAL AND METHODS

Genotypes and rearing conditions

Research work was focused on two different genotypes: a red-feathered dual-purpose hybrid, well adapted to extensive production, which is called Tetra-H Bábolna Ltd. (LL) and a meat-type chicken which is evaluated as a parental line to improve Tetra-H meat productivity. The meat-type genotype (EE) originates from the Buff Plymouth and New Hampshire breeds, but the exact parental lines of this breed are kept secret by the production company.

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Computed tomography (CT)

This technique is commonly used in the medical field and it is a diagnostic system that uses images obtained by X-ray; it allows reproducing cross-sectional images (slices) of the patient's body and their three-dimensional elaborations. Data are then elaborated using specific software in order to create images that reproduce the body composition. In this study CT was applied to eggs as anon-destructive tool to determine their composition based on the Y, before hatching; yolk content was determined by measuring the surface of the egg yolk on the cross-sectional images that were obtained by CT and it resulted in a 69.3–74.1% accuracy of prediction (Milisits et al. 2009). Observations by CT were carried out at the Institute of Diagnostic Imaging and Radiation Oncology of the Institute of Animal Science, Hungarian University of Agriculture and Life Sciences (Kaposvár, Hungary) by the Siemens Somatom Emotion 6 scanner (Siemens Healthcare GmbH, Erlangen,Germany).

Experimental design

The *in vivo* trial was carried out at the Institute of Animal Science, Hungarian University of Agriculture and Life Sciences (Kaposvár, Hungary). Three thousand five hundred eggs per genotype were scanned by CT. Then, for each genotype, eggs were selected according to their Y content: low (21.0 ± 0.88 – 350 eggs), medium (24.5 ± 0.15 – 350 eggs) and high (28.3 ± 0.98 – 350 eggs). The remaining eggs were excluded from the study. Selected eggs were incubated, thereafter hatched chicks were semi-intensively reared in collective pens of 9.2 m^2 where they had free access to water; maintenance and growth requirements were supplied by three commercial feeds that were administered *ad libitum* for the whole cycle until slaughter (Table 1). At 11 weeks of age, 15 animals per group were randomly selected and sacrificed following the animal welfare legislation. Their average body weight was about 2.7 kg for LL genotype and 3.6 kg for the meat type genotype. Breast and one thigh for each animal were excised to carry out physicochemical analyses at the LabCNX laboratory of the Department of Animal Medicine, Production and Health (Agripolis, Legnaro, Italy). There, breast and leg meat were freeze-dried and subjected to the following analyses: pproximate composition, following the AOAC (2012) methods (no. 934.01, 2001.11, 967.05 for dry matter, crude protein and ash, respectively) and the EC (1998) protocol (ether extract), cholesterol content (Casiraghi et al. 1994) and breast FA profile (Dalle Zotte et al. 2016) were determined.

Table 1. Chemical composition (%; as fed) of the chicken diets

Parameter	Starter	Grower	Finisher
Dry matter (DM)	91.4	91.3	90
Crude protein	20.9	18.8	17.1
Ether extract	5.70	6.50	6.80
Crude fibre	2.40	2.70	3.00
Ash	4.90	4.40	4.40
N-free extracts	57.5	58.9	58.7
Starch	39.2	48.5	48.5
Calculated ME (MJ/kg DM)*	13.6	15.5	15.3
Calcium (g/kg)	7.34	6.11	6.47
Phosphorus (g/kg)	5.70	5.80	5.40

ME = metabolisable energy; N = nitrogen
*Source: Sibbald (1980)

Breast

Each breast was divided into two parts: one part was ground by Retsch GRINDOMIX GM200 knife mill (4 000 rpm per 10 s; Hann, Germany) and lectured by FOSS NIR systems 5000 (Hillerød, Denmark), WINISO software (v1.5) and small ring cup load cells; based on the spectra, 89 breast samples were selected and proximate composition, fatty acid profile and cholesterol content analysis were carried out. On the other breast sample physical analysis were conducted: thawing losses, CIE *L** (lightness), *a** (redness) and *b** (yellowness) analysis by Konika Minolta CM-508c Spectrophotometer (Konica Minolta Sensing Americas Inc., Ramsey, NJ, USA) with 8 mm window diameter and D65 illuminant, and meat texture analysis by Texture Analyzer TA-XT2i (Stable Micro Systems, Godalming, United Kingdom), Warner-Bratzler V blade 2 mm thick and velocity of 2 mm/s.

Leg

Thawing losses were measured on one thigh per animal and dissection provided skin, fat

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and bones; each component was weighed and meat weight was obtained from the difference in the weight of the whole frozen sample and the three parts mentioned above. Length, smaller diameter and fracture toughness of tibia and femur were measured (Instron 1000 instrument; Warner-Bratzler Shear Force, Turin, Italy) according to the specifications detailed by Matics et al. (2014). Meat was ground by the Retsch grindomix GM200 knife mill (Duesseldorf, Germany) (4 000 rpm per 10 s) and a total of 72 samples were dried (60 °C until the weight was constant), ground again (8 000 rpm per 10 s) and proximate composition was determined.

Statistical analysis

Data were analysed testing the effect of the Y content group (low, medium and high) on the studied parameters by using the general linear model procedure (SAS Institute 1994, Cary, USA). Data were analysed by the following model:

$$y_{ij} = \mu + \alpha_i + e_{ij} \tag{1}$$

where:

y_{ij} – an observation;

μ – overall mean;

α_i – effect of the yolk content;

e_{ij} – random residual term ~ N (0, σ^2_e).

Significance was calculated at the P < 0.05 confidence level.

RESULTS AND DISCUSSION

Tables 2 and 3 describe the response of the slaughter traits and yields of each genotype to the Y content effect. In EE chickens many parameters were significantly influenced (P < 0.05) such as slaughter weight (3 633 *vs* 3 311 *vs* 3 434 g for low, medium and high Y content, respectively), breast weight (777 *vs* 706 *vs* 712 g for low, medium and high Y content, respectively), leg weight (840 *vs* 754 *vs* 793 g for low, medium and high Y content, respectively) and abdominal fat content, whereas only the breast incidence on slaughter weight (SW) was affected in Tetra-H hybrid.

The present findings are in line with the results obtained by Finkler et al. (1998), where albumen, which is the main source of water in the egg, was demonstrated to be the main determinant of hatchling size. A study by Ulmer-Franco et al. (2010) testing the relationship between hatching egg characteristics, chick quality, broiler performance and considering three egg weights showed that chicks hatched from eggs with smaller yolks, which were produced by younger hens, had lower body weight (BW) than those hatched from eggs with larger yolks which were laid by older hens. This result was confirmed by the study of Vieira and Moran (1999), who found

Table 2. Effect of egg yolk content on meat-type broiler slaughter yields

Parameter	Yolk content			P-value	RSD
	low	medium	high		
Birds (No.)	24	26	29		
SW (g)	3 633^b	3 311^a	3 434^{ab}	< 0.05	423.9
Grill ready weight (g)	2 430^b	2 196^a	2 275^{ab}	< 0.05	274.8
Breast (skin + bones) (g)	777^b	706^a	712^a	< 0.05	92.0
Legs (skin + bones) (g)	840^b	754^a	793^{ab}	< 0.05	109.0
Breast fillet (g)	506^b	454^a	455^a	< 0.05	67.0
Abdominal fat (g)	28.1	32.0	46.3	ns	28.5
Grill ready weight (yield) (% on SW)	66.8	66.2	66.3	ns	2.70
Legs (% on SW)	23.0	22.7	23.0	ns	1.3
Breast (skin + bones) (% on SW)	21.5	21.3	20.9	ns	1.4
Breast fillet (% on SW)	13.9	13.6	13.3	ns	1.2
Abdominal fat (% on SW)	0.77^a	1.00^{ab}	1.33^b	< 0.05	0.78

^{a,b}Means in the same row with different superscript letters differ significantly at P < 0.05

RSD = residual standard deviation; SW = slaughter weight

https://doi.org/10.17221/122/2024-CJAS

Table 3. Effect of egg yolk content on dual-purpose hybrid (LL Tetra-H) slaughter yields

Parameter	Yolk content			*P*-value	RSD
	low	medium	high		
Birds (No.)	29	30	29		
SW (g)	2 672	2 633	2 663	ns	256.3
Grill ready weight (g)	1 766	1 702	1 744	ns	179.4
Breast (skin + bones) (g)	555	520	527	ns	60.7
Legs (skin + bones) (g)	612	599	612	ns	65.5
Breast fillet (g)	330	319	330	ns	43.1
Abdominal fat (g)	35.4	35.7	30.9	ns	18.6
Grill ready weight (yield) (% on SW)	66.2	64.6	65.3	ns	3.3
Legs (% on SW)	22.9	22.7	22.8	ns	1.3
Breast (skin + bones) (% on SW)	20.9[b]	19.8[a]	19.8[a]	< 0.01	1.5
Breast fillet (% on SW)	12.4	12.2	12.4	ns	1.1
Abdominal fat (% on SW)	1.36	1.37	1.13	ns	0.65

[a,b]Means in the same row with different superscript letters differ significantly at $P < 0.05$

RSD = residual standard deviation; SW = slaughter weight

a positive correlation between the nutrients of the yolk sac and the performance of broilers. This could be explained by the fact that lipids present in the yolk sac provide the greatest part of energy that is required by the developing embryo and so a smaller proportion of yolk could penalise developing embryos. Despite this, from our results concerning the EE genotype, it was noticed that chicks hatched from eggs with low Y content were heavier than those hatched from eggs with medium and high Y content. Furthermore, the live weight (LW) of 11-weeks-old EE chickens was significantly higher in low Y content groups than in medium Y content groups and it was not different from the high Y content groups; by virtue of these observations, we could not confirm the previously mentioned findings. The suggestion made by Tahir et al. (2011) that chick weight may influence BW at 50 days of age, demonstrated by a strong linear relationship, was corroborated also by our results when heavier EE chicks at hatch belonging to the low Y group showed higher SW.

Moreover, Abiola et al. (2008) studying the effect of egg size on broiler hatchability perceived that larger birds hatched from the heaviest eggs showed the highest dressing percentage and the best meat/bone ratio and that light chickens had the lowest abdominal fat percentage. Even if in our study the results also showed that the low Y content EE group, which demonstrated higher hatching body weight and SW, exhibited the best yields, not the same traits, evidenced by Abiola et al. (2008) were interested by this improvement. In addition, lighter birds displayed the lowest abdominal fat percentage, whereas we found the opposite condition: low Y content animals, which were heavier, presented the lowest abdominal fat content (0.77% in SW).

An additional consideration can be extrapolated by the observation of the results presented in Tables 4, 5, 6 and 7 on the effect of Y content

Table 4. Effect of egg yolk content on breast meat rheological traits of meat-type broilers

Parameter	Yolk content			*P*-value	RSD
	low	medium	high		
Birds (No.)	23	25	27		
Breast sample (g)	207[a]	180[b]	177[b]	< 0.001	28.1
Thawing losses (%)	6.71	5.99	5.95	ns	1.89
Cooking losses (%)	23.8	22.9	22.7	ns	2.5
pHu	5.73	5.79	5.75	ns	0.10
Colours					
L^*	43.3	44.6	43.5	ns	2.5
a^*	−1.80	−1.91	−1.65	ns	0.57
b^*	3.93	3.63	3.62	ns	1.91
Chroma	4.67	4.64	4.16	ns	1.39
Hue	65.8	66.9	67.5	ns	21.0
WBSF (kg/cm^2)	1.64	1.46	1.67	ns	0.38

[a,b] Means in the same row with different superscript letters differ significantly at $P < 0.05$

a^* = redness; b^* = yellowness; L^* = lightness; ns = non significant; pHu = ultimate pH; RSD = residual standard deviation; WBSF = Warner-Bratzler shear force

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Table 5. Effect of egg yolk content on breast meat rheological traits of dual-purpose hybrids (LL Tetra-H)

Parameter	Yolk content			P-value	RSD
	low	medium	high		
Birds (No.)	29	30	29		
Breast sample (g)	119	118	122	ns	23.4
Thawing losses (%)	6.59	6.20	6.70	ns	1.87
Cooking losses (%)	25.1	24.3	24.8	ns	2.5
pHu	5.81	5.81	5.79	ns	0.11
Colours					
*L**	43.7	44.2	44.5	ns	2.8
*a**	–1.66	–1.79	–1.93	ns	0.57
*b**	3.11	3.47	3.33	ns	1.91
Chroma	3.81	4.24	4.03	ns	1.49
Hue	60.5	58.8	62.5	ns	22.9
WBSF (kg/cm^2)	1.65	1.51	1.57	ns	0.37

*a** = redness; *b** = yellowness; *L** = lightness; ns = non significant; pHu = ultimate pH; RSD = residual standard deviation; WBSF = Warner-Bratzler shear force

Table 6. Effect of egg yolk content on thigh rheological traits of carcasses of meat-type broilers

Parameter	Yolk content			P-value	RSD
	low	medium	high		
Birds (No.)	23	26	27		
One leg weight (g)	410	376	400	ns	5.8
Leg thawing losses (%)	2.22^{B}	1.46^{A}	1.67^{A}	< 0.001	0.54
Meat/bone ratio	4.83	4.54	4.89	ns	0.58
Bones (%)	14.8	15.6	15.7	ns	1.8
Skin (%)	10.7	11.1	11.6	ns	2.1
Dissectible fat (%)	3.43	3.60	3.36	ns	0.94
Meat (%)	71.0	69.6	69.3	ns	2.7
Femur (%) thigh bones	36.6	36.0	36.6	ns	2.3
Femur (%) thigh	5.43	5.62	5.74	ns	0.63
Femur length (mm)	101	101	103	ns	4.5
Tibia length (mm)	143.7^{ab}	141.3^{a}	145.3^{b}	< 0.05	5.8
Femur MD (mm)	9.92	9.81	10.09	ns	0.54
Tibia MD (mm)	8.3	8.34	8.37	ns	0.59
Tibia strength (kg/cm^2)	36.8	34.6	36.3	ns	10.1

^{A,B,a,b}Means in the same row with different superscript letters differ significantly at $P < 0.01$, and 0.05, respectively
MD = minor diameter; ns = non significant; RSD = residual standard deviation

Table 7. Effect of egg yolk content on thigh rheological traits of carcasses of dual-purpose hybrids (LL Tetra-H)

Parameter	Yolk content			P-value	RSD
	low	medium	high		
Birds (No.)	29	29	30		
Leg weight (1 leg) (g)	306	297	306	ns	57.3
Leg thawing losses (%)	2.33	1.97	2.13	ns	0.64
Meat/bone ratio	4.09	4.00	4.13	ns	0.55
Bones (%)	17.2	17.4	17.0	ns	2.2
Skin (%)	10.9	11.1	11.5	ns	2.3
Dissectible fat (%)	2.52	2.58	2.74	ns	0.86
Meat (%)	69.3	68.8	68.7	ns	2.0
Femur (%) thigh bones	38.0	37.8	38.0	ns	1.6
Femur (%) thigh	6.52	6.57	6.45	ns	0.74
Femur length (mm)	99.0	99.6	99.9	ns	6.2
Tibia length (mm)	139.9	139.9	140.0	ns	9.0
Femur MD (mm)	9.99	9.73	9.99	ns	0.99
Tibia MD (mm)	8.38	8.23	8.41	ns	1.04
Tibia strength (kg/cm^2)	29.7	28.2	28.7	ns	8.4

MD = minor diameter; RSD = residual standard deviation

on breast and thigh rheological traits: for both genotypes the meat traits were not affected by Y content. Two exceptions were represented by leg thawing losses and tibia length of EE animals (Table 6): for the former parameter losses were higher in low Y group compared to medium and high groups (2.22 *vs* 1.46 *vs* 1.67% for low, medium and high Y content groups, respectively). As for the tibia length of EE animals, it was longer in high Y content group (143.7 *vs* 141.3 *vs* 145.3 mm for low, medium and high Y content groups, respectively) than in the medium one.

Breast and leg proximate composition and cholesterol content of EE and LL chicken genotypes were not affected by Y content (Tables 8, 9, 10, and 11). The same results were observed for the FA profile of EE and LL breast meat (Tables 12 and 13), where only some single fatty acids (reported in tables) were influenced by Y content, however, apparently without a specific physiological meaning. The EE chickens belonging to the medium Y content group showed higher C18:0 and C18:2 *cis*-9, *trans*-11 contents when compared to low and high Y content groups ($P < 0.05$). The medium Y content group displayed

https://doi.org/10.17221/122/2024-CJAS

Table 8. Effect of egg yolk content on breast meat proximate composition (g/100 g meat) and cholesterol content (mg/100 g meat) of meat-type broilers

Parameter	Yolk content			*P*-value	RSD
	low	medium	high		
Birds (No.)	24	26	26		
Moisture	74.3	74.4	74.0	ns	0.7
Protein	23.7	23.7	23.9	ns	0.6
Fat	0.71	0.66	0.67	ns	0.28
Ash	1.20	1.18	1.18	ns	0.09
Cholesterol	52.0	52.6	52.7	ns	2.6

ns = non significant; RSD = residual standard deviation

Table 9. Effect of egg yolk content on breast meat proximate composition (g/100 g meat) and cholesterol content (mg/100 g meat) of dual-purpose hybrids (LL Tetra-H)

Parameter	Yolk content			*P*-value	RSD
	low	medium	high		
Birds (No.)	27	30	26		
Moisture	74.6	74.8	74.9	ns	0.6
Protein	23.7	23.6	23.4	ns	0.5
Fat	1.16	1.15	1.15	ns	0.07
Ash	0.61	0.49	0.57	ns	0.22
Cholesterol	51.8	52.6	51.8	ns	1.6

ns = non significant; RSD = residual standard deviation

Table 10. Effect of egg yolk content on leg meat proximate composition (g/100 g meat) of meat-type broilers

Parameter	Yolk content			*P*-value	RSD
	low	medium	high		
Birds (No.)	23	21	21		
Moisture	73.8	73.3	74.2	ns	2.4
Protein	19.9	20.4	19.7	ns	1.8
Fat	5.26	5.12	4.98	ns	1.09
Ash	1.05	1.11	1.05	ns	0.13

ns = non significant; RSD = residual standard deviation

Table 11. Effect of egg yolk content on leg meat proximate composition (g/100 g meat) of dual-purpose hybrids (LL Tetra-H)

Parameter	Yolk content (Y)			*P*-value	RSD
	low	medium	high		
Birds (No.)	27	24	27		
Moisture	75.0	74.9	74.9	ns	0.59
Protein	19.9	20.1	19.9	ns	0.40
Fat	4.14	4.07	4.06	ns	0.58
Ash	1.02	1.03	1.07	ns	0.08

ns = non significant; RSD = residual standard deviation

Table 12. Effect of egg yolk content on breast meat fatty acid profile (% of total FA methyl esters) of meat-type broilers

Parameter	Yolk content			*P*-value	RSD
	low	medium	high		
C18:0	8.40^{a}	9.16^{b}	8.66^{ab}	< 0.05	0.97
SFA	35.0	35.8	34.9	ns	1.6
MUFA	40.9	39.3	41.0	ns	0.5
C18:2 *cis*-9, *trans*-11	0.08^{ab}	0.10^{b}	0.06^{a}	< 0.05	0.03
PUFA	20.2	20.6	20.3	ns	2.2
n-6	19.4	19.7	19.5	ns	2.1
n-3	0.53	0.52	0.51	ns	0.07
n-6/n-3	37.1	38.2	38.8	ns	3.4

^{a,b}Means in the same row with different superscript letters differ significantly at $P < 0.05$

MUFA = monounsaturated fatty acids; ns = non significant; PUFA = polyunsaturated fatty acids; SFA = saturated fatty acids

higher values ($P < 0.05$) of C20:0 and C20:2 FA also in Tetra-H chickens compared to the low Y group.

Unfortunately, from our knowledge no other research works have studied the effect of the Y content on meat traits of chickens (or other birds), so our results could not be compared with other works. The paucity of significant results of the Y content group in relation to breast and thigh rheological traits, breast and thigh proximate composition such as breast FA composition, was probably associated with the fact that, as demonstrated in many studies (Castellini et al. 2002; Dalle Zotte 2006; Azcona et al. 2008; Ponte et al. 2008; Betti et al. 2009; Farhoomand and Checaniazer 2009; Pekel et al. 2009; Zhao et al. 2009; Laudadio and Tufarelli 2010; Widyaratne and Drew 2011), nutritional factors and genetics are the most critical aspects in chicken commercial production. In fact, they both can have a significant effect on growth performance and carcass quality. In the present experiment, the Y content was demonstrated to affect the body weight of hatched chicks in both genotypes and, even if some performance traits and yields of the EE genotype were also influenced by the studied effect, the Y content group resulted almost completely insignificant when observing performance traits and yields of LL Tetra-H and

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Table 13. Effect of egg yolk content on breast meat fatty acid profile (% of total FA methyl esters) of dual-purpose hybrids (LL Tetra-H)

Parameter	Yolk content			*P*-value	RSD
	low	medium	high		
C20:0	0.11[a]	0.12[b]	0.11[ab]	< 0.05	0.02
SFA	35.2	35.7	35.6	ns	1.4
MUFA	38.9	37.3	38.3	ns	2.1
C20:2	0.25[a]	0.29[b]	0.26[ab]	< 0.05	0.06
PUFA	21.5	22.0	21.4	ns	1.4
n-6	20.6	21.0	20.5	ns	1.3
n-3	0.53	0.52	0.52	ns	0.05
n-6/n-3	39.5	40.8	39.4	ns	3.0

[a,b]Means in the same row with different superscript letters differ significantly at $P < 0.05$

MUFA = monounsaturated fatty acids; ns = non significant; PUFA = polyunsaturated fatty acids; SFA = saturated fatty acids

results on carcass quality of both genotypes. Different response of the two genotypes, which were the EE and the LL Tetra-H, to the tested effect could be explained by the known influence of selection on chicken metabolism, as Berri et al. (2001) explained studying experimental and commercial broiler lines. Yolk content influenced the body weight of hatched chicks but, as the animals grew, it was observed that this effect concerned almost exclusively productive performances, particularly those of the meat-type genotype. On the contrary, breast meat colour, breast and thigh proximate composition, somatic characteristics and breast FA profile were not influenced by the studied effect probably because these characteristics are mostly dependent on the genetics and diet.

CONCLUSION

The present work demonstrated how the yolk content (Y) group, which was measured by computed tomography, allowed to select high-quality meat-type animals characterised by higher hatching weight and the best productive performances in terms of growth rate, live weight, slaughter weight, breast and thigh weights, and with lower abdominal fat content. Specifically, the low Y content group was the most positive from this point of view. These findings would bring positive advantages to hatcheries in terms of chick quality and also to farmers in terms of economic revenues, because they would rear robust animals that would guarantee a higher probability of survival in the first rearing period and that are characterised by a high slaughter weight at the end of the productive cycle.

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Conflict of interest

The authors declare no conflict of interest.

REFERENCES

Abiola SS, Meshioye OO, Oyerinde BO, Bamgbose MA. Effect of egg size on hatchability of broiler chick. Arch Zootec. 2008 Dec 12;57(217):83-6.

Andrassy-Baka G, Romvari R, Milisits G, Suto Z, Szabo A, Locsmandi L, Horn P. Non-invasive body composition measurement of broiler chickens between 4–18 weeks of age by computer tomography. Archiv Anim Breed. 2003 Oct 10;46(6):585-95.

Azcona JO, Garcia PT, Cossu ME, Iglesias BF, Picallo A, Perez C, Gallinger CI, Schang MJ, Canet ZE. Meat quality of Argentinean "Camperos" chicken enhanced in omega-3 and omega-9 fatty acids. Meat Sci. 2008 Jul;79(3):437-43.

Berri C, Wacrenier N, Millet N, Le Bihan-Duval E. Effect of selection for improved body composition on muscle and meat characteristics of broilers from experimental and commercial lines. Poult Sci. 2001 Jul;80(7):833-8.

Betti M, Perez TI, Zuidhof MJ, Renema RA. Omega-3-enriched broiler meat: 3. Fatty acid distribution between triacylglycerol and phospholipid classes. Poult Sci. 2009 Aug;88(8):1740-54.

Brenoe UT, Kolstad K. Body composition and development measured repeatedly by computer tomography during growth in two types of turkeys. Poult Sci. 2000 Apr; 79(4):546-52.

Casiraghi E, Lucisano M, Pompei C, Dellea C. Cholesterol determination in butter by high performance chromatography. Milchwissenschaft. 1994 May;49(4):194-6.

https://doi.org/10.17221/122/2024-CJAS

Castellini C, Mugnai C, Dal Bosco A. Effect of organic production system on boiler carcass and meat quality. Meat Sci. 2002 Mar;60(3):219-25.

Dalle Zotte A, Cullere M, Alberghini L, Catellani P, Paci G. Proximate composition, fatty acid profile, and heme iron and cholesterol content of rabbit meat as affected by sire breed, season, parity order, and gender in an organic production system. Czech J Anim Sci. 2016 Sep 30;61(9):383-90.

Dalle Zotte A. Thermal meal treatment improves some meat quality traits in chicken. In: 52nd International Congress of Meat Science and Technology; 2006 Aug 13-18; Dublin, Ireland. 2006. p 121-2.

Daumas G, Monziols M. An accurate and simple computed tomography approach for measuring the lean meat percentage of pig cuts. In: 57th International Congress of Meat Science and Technology; 2001 Aug 7-12; Ghent, Belgium. 2001. p 7-12.

EC 1998. Commission Directive 98/64/EC of 3 September 1998 Establishing Community methods of analysis for the determination of amino acids, crude oils and fats, and olaquindox in feeding stuffs and amending Directive 71/393/EEC. OJEU. L257: p 14.

Elibol O, Brake J. Effect of egg weight and position relative to incubator fan on broiler hatchability and chick quality. Poult Sci. 2008 Sep 1;87(9):1913-8.

Farhoomand P, Checaniazer S. Effects of graded levels of dietary fish oil on the yield and fatty acid composition of breast meat in broiler chickens. J Appl Poult Res. 2009 Oct 1;18(3):508-13.

Finkler MS, Van Orman JB, Sotherland PR. Experimental manipulation of egg quality in chickens: influence of albumen and yolk on the size and body composition of near-term embryos in a precocial bird. J Comp Physiol B. 1998 Feb;168:17-24.

Harms RH, Hussein SM. Variations in yolk: Albumen ratio in hen eggs from commercial flocks. J Appl Poult Res. 1993 Jul 1;2(2):166-70.

Kuchida K, Fukaya M, Miyoshi S, Suzuki M, Tsuruta S. Nondestructive prediction method for yolk: Albumen ratio in chicken eggs by computer image analysis. Poult Sci. 1999 Jun 1;78(6):909-13.

Latshaw JD, Bishop BL. Estimating body weight and body composition of chickens by using noninvasive measurements. Poult Sci. 2001 Jul 1;80(7):868-73.

Laudadio V, Tufarelli V. Growth performance and carcass and meat quality of broiler chickens fed diets containing micronized-dehulled peas (Pisum sativum cv. Spirale) as a substitute of soybean meal. Poult Sci. 2010 Jul 1; 89(7):1537-43.

Matics ZS, Szendro ZS, Odermatt M, Gerencser ZS, Nagy I, Radnai I, Dalle Zotte A. Effect of housing conditions on production, carcass and meat quality traits of growing rabbits. Meat Sci. 2014 Jan;96(1):41-6.

Milisits G, Andrassy-Baka G, Romvari R. Predictability of fat-free mass and fat content in intact hen’s eggs using electrical conductivity. Ital J Anim Sci. 2010 Jan;4(3):95-7.

Milisits G, Andrassy-Baka G, Romvari R. Prediction of hen's eggs composition by means of the TOBEC method. Bul Univ Sti Int Agric Med Vet Cluj-Napoca, Ser Zootehnie Biotehnol. 2005 May;61:1-6.

Milisits G, Donko T, Suto Z, Bogner P, Repa I. Applicability of computer tomography in the prediction of egg yolk ratio in hen's eggs. In: 17th International Symposium Animal Science Days; 2009 Sep 15-18; Padova, Italy: Abano Terme; 2009. p 234-6.

Mitchell AD, Rosebrough RW, Conway JM. Body composition analysis of chickens by dual energy X-ray absorptiometry. Poult Sci. 1997 Dec;76(12):1746-52.

Miyoshi S, Kuchida K, Mitsumoto T. Selection for high and low yolk-albumen ratio in chickens v. effects of selection and relaxation on egg component traits. JPS. 1996 Jan; 33(6):329-38.

Pekel AY, Patterson PH, Hulet RM, Acar N, Cravener TL, Dowler DB, Hunter JM. Dietary camelina meal versus flaxseed with and without supplemental copper for broiler chickens: Live performance and processing yield. Poult Sci. 2009 Nov 1;88(11):2392-8.

Ponte PI, Alves SP, Bessa RJB, Ferreira LMA, Gama LT, Bras JLA, Fontes C, Prates JAM. Influence of pasture intake on the fatty acid composition, and cholesterol, tocopherols, and tocotrienols content in meat from free-range broilers. Poult Sci. 2008 Jan 1;87(1):80-8.

Reijrink IAM, van Duijvendijk LAG, Meijerhof R, Kemp B, van den Brand H. Influence of air composition during egg storage on eggs characteristics, embryonic development, hatchability, and chick quality. Poult Sci. 2010 Sep 1; 89(9):1992-2000.

Romvari R, Szendro Zs, Jensen J, Sßrensen P, Milisits G, Bogner P, Horn P, Csapo J. Noninvasive measurement of body composition of two rabbit populations between 6 and 16 weeks of age by computer tomography. J Anim Breed Genet. 1998 Mar;115(1-6):383-95.

Schmidt GS, Figueiredo EAP, Saatkamp MG, Bomm ER. Effect of storage period and egg weight on embryo development and incubation results. Braz J Poult Sci. 2009 Mar;11(1):1-5.

Sibbald IR. Metabolizable energy in poultry nutrition. Biosci. 1980 Nov 1;30(11):736-41.

Swennen Q, Janssens GP, Geers R, Decuypere E, Buyse J. Validation of dual-energy X-ray absorptiometry for determining in vivo body composition of chickens. Poult Sci. 2004 Aug 1;83(8):1348-57.

https://doi.org/10.17221/122/2024-CJAS

Tahir M, Cervantes H, Farmer CW, Shim MY, Pesti GM. Broiler performance, hatching egg, and age relationships of progeny from standard and dwarf broiler dams. Poult Sci. 2011 Jun 1;90(6):1364-70.

Ulmer-Franco AM, Fasenko GM, O'Dea Christopher EE. Hatching egg characteristics, chick quality, and broiler performance at 2 breeder flock ages and from 3 egg weights. Poult Sci. 2010 Dec 1;89(12):2735-42.

Vieira SL, Moran Jr ET. Broiler chicks hatched from egg weight extremes and diverse breeder strains. J Appl Poult Res. 1998 Dec 1;7(4):392-402.

Vieira SL, Moran Jr ET. Effects of egg of origin and chick post-hatch nutrition on broiler live performance and meat yields. J World's Poult Sci. 1999 Sep 18;55(2):125-42.

Widyaratne GP, Drew MD. Effects of protein level and digestibility on the growth and carcass characteristics of broiler chickens. Poult Sci. 2011 Mar 1;90(3):595-603.

Willemsen H, Everaert N, Witters A, De Smit L, Debonne M, Verschuere F, Garain P, Berckmans D, Decuypere E, Bruggeman V. Critical assessment of chick quality measurements as an indicator of posthatch performance. Poult Sci. 2008 Nov 1;87(11):2358-66.

Williams TD, Monaghan P, Mitchell PI, Scott I, Houston DG, Ramsey S, Ensor K. Evaluation of a non-destructive method for determining egg composition using total body electrical conductivity (TOBEC) measurements. J Zool. 1997 Mar 6;243(3):611-22.

Wilson HR. Interrelationships of egg size, chick size, posthatching growth and hatchability. Worlds Poult Sci J. 1991 Sep 18;47(1):5-20.

Zhao JP, Chen JL, Zhao GP, Zheng MQ, Jiang RR, Wen J. Live performance, carcass composition, and blood metabolite responses to dietary nutrient density in two distinct broiler breeds of male chickens. Poult Sci. 2009 Dec 1;88(12):2575-84.

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