CARCASS AND MEAT QUALITY OF SPENT HENS FROM DUAL PURPOSE VS LAYER GENOTYPES WHEN FED A BY-PRODUCT DIET

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Abstract – Millions of spent hens end up every year unused as food; this mostly due to changes in cooking habits and low meat yield. Dual purpose genotypes, from which the males are fattened and females used for egg production, may have a higher carcass value than specialized layer hybrids. Since the former have a lower laying performance than the latter, they may also be less demanding in terms of diet quality in the late laying phase. We compared laying performance, carcass and meat quality of one novel and two ancient dual purpose genotypes and a layer hybrid in the late laying phase fed either a commercial laying hen diet or a diet composed of food industry by-products but no soybean products. The ancient dual purpose genotypes had a lower laying performance but more valuable carcasses than the layer genotype, with intermediate results found for the novel dual purpose genotype. There were also some meat quality differences. The by-product diet had negative consequences on most performance and carcass parameters. In terms of intake and laying performance, the adverse effect was pronounced in the layer genotype and did not occur in the two ancient dual purpose breeds.

Key Words – feed-food competition, meat yield, organic diet, performance

I. INTRODUCTION

Common laying periods of hens last for about one year. Afterwards, these so called spent hens are slaughtered or even culled directly on the farm and discarded in biogas plants. The reason for this practice is that it became increasingly difficult to market spent hen carcasses due to changes in cooking habits and the low meat yield of specialized layer genotypes. In addition, large abattoirs including those in Switzerland are no longer willing, to slaughter spent hens. This means that a valuable protein source and tasty meat with a low fat content is lost [1]. To prevent the waste of spent hen meat, it is currently often harvested from the carcasses and then processed to sausage or convenience food. However, efficient processing needs a significant meat yield per carcass. This may be given in so-called dual purpose genotypes, i.e. genotypes which produce reasonable amounts of both eggs and meat. In addition, meat from spent hens is tougher than that from broilers due to the higher collagen content and cross-linkage [2]. It seems that in processed food this toughness remains unnoticed because the consumer acceptance did not differ between patties produced from broiler or spent hen meat [3]. Western commercial laying hen diets are mainly composed of cereals and soybean meal. Due to the concept of ‘feed no food’ and environmental concerns in soybean production, alternative energy and protein sources are sought. Therefore, the aim of the present study was to compare three dual purpose genotypes in performance, meat yield and quality with a commercial layer hybrid when fed a diet composed of food industry by-products in opposition to a commercial layer diet.

II. MATERIALS AND METHODS

Thirty-eight individually kept hens of the four genotypes Lohmann Brown Plus (LB+, layer hybrid, n=10), Lohmann Dual (LD, novel dual purpose genotype, n=10), Belgian Malines (BM, an ancient large-framed dual purpose breed, n=9) and Schweizer Huhn (CH, another ancient dual purpose genotype, n=9) were investigated. At the start of the experiment they were already entering their 43th laying week. The hens were slaughtered after 54 weeks of lay. The hens had *ad libitum* access to feed and water, half of them each to one of two different diets. The control diet (C) was based on corn, soybean meal and wheat (11.5 MJ/kg ME and 168 g/kg CP) whereas the ‘by-product” diet (E) was based on broken rice, sweet lupine, wheat bran, brewer’s grains, fava beans and rapeseed cake (10.4 MJ/kg ME and 183 g/kg CP). After the 12 weeks on the respective diet, the hens were weighed and then slaughtered by stunning and exsanguination. Feathers, feet, organs, head, neck and abdominal fat were removed. The carcasses were stored at 4 °C for 24 h and then weighed. Dressing percentage was calculated as the proportion of carcass weight of final bodyweight (BW). Breast muscles and legs were removed from the carcasses and weighed. The legs were then skinned, deboned and the remaining meat was weighed again. All breast and leg meat together was considered as meat yield. The pH was measured with a pH-Meter (testo 205, Rausser, Ebmatingen, Switzerland) in the left breast muscle 24 h after slaughter. To determine thaw and cooking loss, the right breast meat was weighed prior to freezing, after being thawed and after being cooked to a core temperature of 74 °C in a water bath. Shear force was subsequently measured with a Volodkevich device [4] mounted on a texture analyzer (5kN ProLine, Zwick GmbH & Co. KG, Ulm, Germany). Data were analyzed using the GLM procedure of SAS (version 9.3, SAS Institute Inc., Cary, NC, USA) with genotype, diet and their interaction as fixed effects. The significance of difference among individual Least Square Means was estimated with Tukey's procedure. For all data, $P < 0.05$ was considered as significant.

III. RESULTS AND DISCUSSION

As expected, there were significant genotype and diet effects in almost all performance, carcass and meat quality traits measured (Tables 1 and 2).

Table 1 Effect of genotype on performance, carcass and meat quality

Genotype	LB+	LD	CH	BM	SEM	P-value
Feed intake (g/d)	97^{bc}	90^{c}	114^{a}	109^{ab}	4.3	<0.001
Laying percentage	65^{a}	55^{a}	31^{b}	21^{b}	6.1	<0.001
Final BW (kg)	1.8^{c}	1.9^{c}	2.6^{b}	3.2^{a}	0.11	<0.001
Dressing percentage	57^{c}	61^{b}	61^{ab}	64^{a}	0.6	<0.001
Carcass weight (kg)	1.0^{c}	1.1^{c}	1.6^{b}	2.1^{a}	0.07	<0.001
Breast proportion (%)	18^{b}	24^{a}	18^{b}	19^{b}	0.5	<0.001
Leg proportion (%)	36^{a}	33^{b}	35^{ab}	37^{a}	0.8	0.002
Meat yield (g)	412^{c}	526^{c}	659^{b}	905^{a}	34.4	<0.01
Thaw loss (%)	3.1^{ab}	4.1^{a}	1.8^{c}	2.3^{bc}	0.36	<0.001
Cooking loss (%)	15.6	15.2	13.8	15.7	0.61	0.14
Shear force (N)	21^{a}	17^{b}	19^{ab}	19^{ab}	1.0	0.03

$^{a-d}$Means within a row carrying no common superscript are significantly different (P<0.05).

Feed intake was greatest in CH, lowest in LD, and intermediate in BM and LB+ (Table 1). The LB+ and LD hens had a greater average laying percentage than the CH and BM. The LD were slightly more tolerant to low feed quality than the LB+, but both experienced performance losses especially also because they did not compensate the lower energy content of the by-product diet by a higher feed intake. For the ancient breeds at this phase of laying, a diet composed of food industry by-products is fully sufficient. Together this led to an interaction of genotype and diet ($P < 0.001$). The greatest final BW was obtained by the BM hens, followed by the CH hens, whereas LD and LB+ hens were lighter. The BM are heavy hens and they have higher maintenance requirements than lighter hens and thus the unproductive part of feed consumption is higher. In addition, their laying performance was low and therefore the result was a very unfavorable feed efficiency (g egg/g feed). In laying percentage there was an interaction ($P = 0.001$) between genotype and diet in a way that LB+ and LD performed better with Ctrl whereas the ancient dual purpose genotypes with by-product diet)

Dressing percentage was greatest for BM, followed by CH and LD and smallest for LB+. (Table 1). Accordingly, the carcass weight was greatest for BM, followed by CH, and was smallest for LD and LB+. The breast proportion was greater for LD than for all other genotypes. Leg proportion was smallest for LD and greatest for BM and LB+ with intermediate values for CH. The small leg proportion of the LD hens could have resulted from the dwarf gene [5] which, at the same time, decreases feed intake and shortens the legs. Meat yield was greatest in BM, followed by CH and smallest in LD and LB+. Meat yield of the LB+ was similar to that found by Loetscher *et al.* [6] in another brown layer genotype (Isa Warren). The present findings indicate that all dual purpose genotypes (not significant for LD) were superior to the specialized layer hybrid in this important trait for commercialization of meat harvested from spent hens. The pH in the left breast muscle remained unaffected by the genotype and by the diet. This level is consistent with that found by Loetscher *et al.* [7]. Also, Rizzi *et al.* [8] found similar pH values in a number of different genotypes, except for one. Thaw loss was greatest in meat from LD and smallest in CH with intermediate values for LB+ and BM. Cooking loss was not affected by genotype. The meat of dual purpose hens had a smaller maximal shear force than the one of the layer hybrids. Still even the LB+ meat had a smaller shear force, and thus was likely more tender, in our study than that described by others [7].

The effect of diet on performance, carcass composition and meat quality traits is presented in Table 2. Laying hens, although inclined to eat for energy saturation, ate less feed with the by-product diet. Therefore, they could not complement the intake of ME as shown with Lohmann Brown hens by Li *et al.* [9]. In consequence, final BW, laying percentages and carcass weights were smaller as well whereas dressing percentage remained unchanged. Breast proportion was similar in both diets, whereas leg proportion was smaller in the co-product diet. Meat yield was not affected by the diet. Water-holding capacity (thaw and cooking loss) was less favorable and shear force was greater with the by-product diet.

Table 2 Effect of diet on performance, carcass and meat quality across all genotypes

Treatment diet	By-prod	Ctrl	SEM	P-value
Feed intake (g/d)	97	108	2.9	0.01
Laying percentage	35	52	4.2	<0.01
Final BW (kg)	2.2	2.5	0.07	0.02
Dressing percentage	61	60	0.4	0.53
Carcass weight (kg)	1.4	1.5	0.05	0.04
Breast proportion (%)	19	20	0.34	0.75
Leg proportion (%)	34	36	0.5	0.02
Meat yield (g)	597	654	23.6	0.10
Thaw loss (%)	3.2	2.4	0.25	0.02
Cooking loss (%)	16.0	14.2	0.42	0.01
Shear force (N)	20	17	0.7	<0.01

IV. CONCLUSION

Regarding only the meat yield, i.e. the meat that can actually be used for food production, BM performed best. With respect to meat quality traits like shear force (highly correlated with tenderness) and water-holding capacity, the spent hens from the novel dual purpose genotype LD performed better than those of the ancient dual purpose breeds (CH and BM) and the layer hybrid (LB+). However, for a comprehensive evaluation, other important traits have to be taken into account as for example feed intake, laying performance and also the price that is paid for these spent hens. Overall, LD and LB+ were performing best, LD was slightly better on the meat side (quality and yield) than LB+, and LB+ was better in laying performance. Unexpectedly, the meat yield was not affected by the diet.

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