

growing one (7.89 vs 1.77). The number of capillaries per muscular area was also higher in slow-growing strain. These results support previous studies in breast muscle that showed a reduced blood supply by capillary vessels and a higher presence of GF in fast-growing strains. Moreover, we found different features of myopathy associated with GF. Some of them were represented by HF, splitting fibers and internal nuclei are also characteristic of human muscular dystrophies (eg. Duchenne). Accordingly, muscle hypertrophy of meat-type chickens favoured fiber dystrophy that may develop breast muscle anomalies such as white stripping and wooden breast responsible for significant economic losses.

P069

Effects of dietary insect meal from *Hermetia illucens* on the expression of genes related to methionine metabolism in rainbow trout (*Oncorhynchus mykiss*)

Chiara Ascione¹, Laura Gasco², Simona Rimoldi¹, Geciana Terova¹

¹Dipartimento di Biotecnologie e Scienze della Vita, University of Insubria, Italy

²Dipartimento di Scienze Agrarie, Forestali e Alimentari, University of Torino, Italy

Contact: geciana.terova@uninsubria.it

With most wild fish capture fisheries at or above maximum sustainable yield, aquaculture cannot rely any more on oceanic resources for the manufacturing of aqua feeds and such feed options are just not sustainable. This means that fishmeal (FM), will increasingly be used in combination with other ingredients in fish diet. Plants already deliver the majority of the protein to farmed fish diets due to the abundance, and low cost. However, inclusion of vegetable meals in aqua feeds is limited since they could lead to a number of adverse effects. Therefore, research on new protein sources is needed. FAO indicates insects as an innovative and high potential source of protein to be employed in aqua feed manufacturing, due to their high nutritional value, especially in terms of crude protein content. Insect-based meal could thus become a sustainable and commercially viable alternative to FM in aquaculture. One of the most promising insect species for commercial exploitation is the black soldier fly (BSF), *Hermetia illucens*. The larvae of BSF grow on different organic substrates consuming twice their weight each day and the prepupa contain a very high percentage of protein (36-48%) on a dry matter basis. However, the BSF larvae are characterized by a relative deficiency in some indispensable aminoacids such as methionine (Met), cysteine, and threonine yet having a better aminoacid profile than the vegetable meal.

Accordingly, we evaluated the effect of dietary inclusion of BSF larvae meal, as replacement for fishmeal, on fish growth performances and the transcript levels of genes involved in Met resynthesis (BHMT, SAHH) and net Met loss (taurine synthesis) (CBS) in rainbow trout (*Oncorhynchus mykiss*) liver.

Results of the feeding trial (3 months) showed no significant differences in specific growth rate of fish that received 25 or 50% of FM/BSF meal substitution in comparison to control (CTRL) fish that did not receive insect-meal in the diet. SAHH gene was affected by the diet, showing higher expression in CTRL group in comparison to BSF25 and BSF50 groups. The expression of BHMT was not different in fish fed with different diets. Finally, the highest expression of CBS gene was found in the CTRL group as compared to BSF25 one, whereas the expression of CBS in the BSF50 group was similar to that of fish fed with other diets.

In conclusion, *H. illucens* meal is an innovative raw material that seems to be promising as an alternative to FM in trout diets.

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P070

A comparison of water distribution and protein oxidation between poultry and rabbit meat

Giulia Baldi, Francesca Soglia, Luca Laghi, Claudio Cavani, Massimiliano Petracci

Dipartimento di Scienze e Tecnologie Agro-Alimentari, Alma Mater Studiorum University of Bologna, Italy

Contact: m.petracci@unibo.it

In the last years, proton Nuclear Magnetic Resonance (NMR) relaxometry has been successfully applied to study water mobility and distribution in pork. In addition, although neglected for decades, the impact of protein oxidation on meat quality traits has been recently reviewed. Within this context, considering the incomplete knowledge on water distribution and mobility in white meats and the lack of information concerning protein oxidation, this study aimed at provide reference values on chicken, turkey and rabbit meat. For this purpose, rabbit (*longissimus lumborum* muscles from 11 weeks-old males slaughtered at 2.7 Kg), chicken (*pectoralis major* muscles from medium-size 44 days-old male broiler slaughtered at 3.0 Kg) and turkey (*pectoralis*

major muscles from 20 weeks-old male birds slaughtered at 21 Kg) meat samples ($n = 8/\text{specie}$) were selected 24 h *post-mortem* and used to assess ultimate pH, colour ($L^*a^*b^*$), NMR relaxation properties and protein oxidation. In detail, proton transverse relaxation (T_2) decay curves were recorded, at the operating frequency of 20 MHz, with a Bruker (Milan, Italy) Minispec PC/20 spectrometer, while protein carbonylation was assessed following a novel 2,4-dinitrophenylhydrazine (DNPH)-based method. Data were analysed using one-way ANOVA with Tukey's multiple comparison test. Overall, ultimate pH values and colour were consistent with previous studies. If compared to both chicken and turkey, rabbit meat exhibited a remarkably higher proportion of the extra-myofibrillar water fraction (2.4 and 2.8 *vs* 8.4%; $p < .001$) and a consequent decrease in the intra-myofibrillar one (93.7 and 93.3 *vs* 88.5%; $p < .001$). However, although increased, the extra-myofibrillar water in rabbits appeared to be more tightly bound (lower T_2) in comparison to both chicken and turkey meat (130.3 *vs* 286.3 and 210.6 ms; $p < .001$). These dissimilarities might be related to the different muscle fibre characteristics (*e.g.* type, size, *post-mortem* acidification behaviour, etc.). As for protein oxidation, significantly higher carbonyls content were found in turkey and rabbit in comparison with chicken meat (3.10 and 3.60 *vs* 1.11 nmol/mg of protein; $p < .001$). The lower protein oxidation level observed in chicken meat might be likely related to its lower iron content if compared to both turkey and rabbit meats. In conclusion, providing reference values, this study improved the current knowledge concerning poultry, turkey and rabbit meat quality characteristics.

P071

Hepatic metabolites S-adenosyl methionine (SAM) and S-adenosyl homocysteine (SAH) as signals of methionine nutritional deficiency in rainbow trout (*Oncorhynchus mykiss*) fed on diets with partial replacement of fishmeal with insect (*Hermetia illucens*) meal

Chiara Ceccotti¹, Laura Gasco², Chiara Ascione¹, Genciana Terova¹

¹Dipartimento di Biotecnologie e Scienze della vita, University of Insubria, Italy

²Dipartimento di Scienze Agrarie, Forestali e Alimentari, University of Torino, Italy

Contact: genciana.terova@uninsubria.it

The metabolism of the indispensable amino acid methionine mainly occurs in the hepatic tissue of fish, where the enzyme

methionine adenosyltransferase (MAT) is highly functioning. In several methylation reactions that occur in liver, the activated methionine, S-adenosyl methionine (SAM), serves as a donor of methyl groups for methyltransferases and is converted to S-adenosyl homocysteine (SAH). Therefore, the SAM/SAH ratio represents an indicator of cellular methylation status being also very important for homocysteine (Hcy) metabolism. Hcy is involved in the methionine regeneration (transmethylation) and in the trans-sulfuration pathway, which produces cystathionine, cysteine, glutathione, and taurine.

In aquafeeds that use high percentages of vegetable meal to replace fishmeal (FM), the methionine could be a limiting amino acid that must be added to the fish diet. Similarly, the insect meal in particular that from black soldier fly (BSF), *Hermetia illucens*, is characterized by a relative deficiency in some indispensable aminoacids including methionine yet having a better aminoacid profile than the vegetable meal. Therefore, we evaluated the effect of dietary inclusion of BSF larvae meal as replacement for FM on the concentration of SAM, SAH and SAM/SAH ratio in rainbow trout (*Oncorhynchus mykiss*) liver.

We set a 90-day feeding experiment with 360 trouts. Two fish groups were fed with increasing FM/BSF meal substitutions [25% (BSF25) and 50% (BSF50)] without any methionine supplementation and a third control group was fed a FM-based diet (BSF0). SAM and SAH concentrations were analyzed by HPLC.

Hepatic SAM concentrations resulted significantly higher in BSF50 group (65.71 ± 5.86 nmol/g) compared to BSF0 (59.39 ± 2.44 nmol/g) and BSF25 (61.17 nmol/g) groups. On the contrary, the lowest hepatic SAH concentration was measured in BSF50 group (17.28 ± 1.53 nmol/g), whereas in the other two groups, SAH concentrations increased linearly with decreasing hepatic SAM concentrations. Therefore, SAM/SAH ratio increased linearly with the percentage of dietary BSF inclusion.

In conclusion, BSF_meal could be a potential candidate for FM substitutions in rainbow trout feeds; it seems to maintain high levels of hepatic SAM and to promote the removal of Hcy through trans-sulfuration or transmethylation pathway.

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