Adjusting methionine source and level to improve pork quality traits

Whilst methionine is already added to pig diets to facilitate growth, producers are not always aware of the extra benefits of feeding a specific source.

Supplying methionine in the form of liquid OH-Methionine, at a level exceeding TSAA growth requirements, has been shown to improve meat quality parameters.

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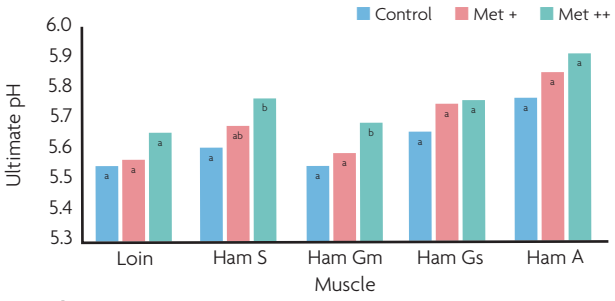
The sensory and technological quality of pork is linked to modifications in muscle energy storages and oxidative process.

Both of them can be influenced specifically by supplementation with OH-Methionine. As observed in trials, ultimate pH is increased with OH-Methionine and, as a consequence, ham yield.

It is of prime economic importance that nutritionists consider meat quality effects when formulating diets, along with performance, feed efficiency and meat yield.

Fig. 1a.



Key

Met +	OH-Met supplemented at 3 x TSAA requirements
Met ++	OH-Met supplemented at 5 x TSAA requirements
Ham S	Semimembranosus
Ham Gm	Gluteus Medius
Ham Gs	Gluteus Superficialis
Ham A	Adductor

Fig. 1b

	Drip loss from loin (%)		
	Control	Met +	Met++
4 days post-mortem	6.0[a]	6.5[a]	4.5[b]
7 days post-mortem	7.9[a]	8.2[a]	6.3[b]

[a, b] groups are significantly different (P<0.05).

Fig. 1a. The effect of OH-Met supplementation on ultimate pH in loin and ham muscles and Fig. 1b. The effect of OH-Met supplementation on drip loss from pork loin (Longissimus muscle).

Methionine sources

After lysine and threonine, methionine, leading to further sulphur compounds, is the third limiting amino acids in a pig's diet. In the growing and finishing periods, sulphur amino acids (methionine and cysteine) requirements are generally met through feedstuffs.

However, supplementary methionine may be needed and even a slight deficiency will affect growth and hence economic returns.

Studies are now demonstrating that including hydroxy-methionine above growth requirements is beneficial for meat quality in pigs.

There are three sources of methionine used in animal nutrition L-methionine, DL-methionine (DL-Met) and hydroxy-methionine (OH-Met).

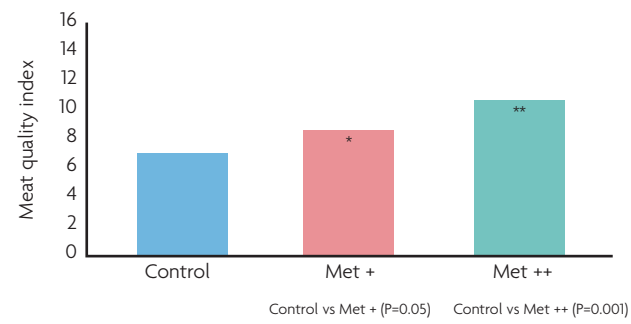
It has been demonstrated that the three sources are as efficient in sustaining growth in poultry and swine. Beyond the need as building block for protein synthesis, downstream sulphur metabolites of methionine are implicated in antioxidant molecules and OH-Met shows additional benefits, in terms of antioxidant properties. Indeed, OH-Met is more efficiently converted to cysteine and taurine than L-Met or DL-Met through the transsulphuration pathway.

Cysteine is then used for glutathione synthesis that, along with taurine, improves the oxidative status of muscles. By enhancing cellular redox status, hydroxy-methionine helps protecting muscle and therefore improves meat quality parameters.

Moreover, methionine and sulphur metabolites are involved in many cellular regulations affecting energy storage that is of primary interest on glycogen muscle load that would determine the muscular pH drop post-mortem.

Considering all these elements it was proposed to look deeper at nutritional strategies involving sulphur amino acids supply through hydroxy-methionine to influence meat quality traits.

Fig. 2. Meat quality index. MQI = - 41 + 11.01 (pHu Semimembranosus) - 0.231 (L* Gluteus Superficialis) + 0.105 (WHC Gluteus Superficialis) depending on treatments.



Pre-slaughter methionine boost increases ultimate pH of meat

In order to determine the effects of supplying high dietary levels of methionine for 14 days pre-slaughter, a trial in finishing pigs was carried out at INRA Rennes, France. From 70 -105kg female pigs were fed a control diet adequate in methionine and cysteine (Met+Cys) to TSAA requirement: 0.45%.

Then, between 105-120kg they either continued with the control diet or one of the two experimental diets. Both treatments used hydroxy-methionine; the first at three times the level of the control (0.89% Met+Cys) and the second five times higher than control (1.33% Met+Cys).

Short term feeding of these levels

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Parameter	Explanation	Economic impact
Ultimate pH	After slaughter there is a drop in pH of the muscle, which reduces water-holding capacity. Along with protein oxidation, this effect leads onto drip loss.	A difference of 0.1 pH unit in the semimembranosus muscle (ham) corresponds to 1% of the yield of cooked ham.
Drip loss	Meat is 75% water – its ability to hold water reduces post-mortem drip loss (particularly if cut), due to changes in the cellular structure (membrane) and muscle contraction. Depending on ultimate pH and protein isoelectric point.	The weight of saleable meat decreases at the processing plant and visually reduces customer acceptability on shelves. As well as increasing the potential for microbial growth and hence reducing shelf life.
Colour	Oxidation of myoglobin affects redness of the meat, whereas changes in pH affect the lightness. Colour is measured using a spectrophotometer, which gives values of L (lightness), a* (redness) and b*(yellowness).	Lightness (L) of meat is a particularly important visual quality for consumers. Meat that is paler indicates a lower pH, less water holding capacity and greater drip loss.
Marbling	The presence of intramuscular fat is known as marbling.	This improves the eating quality of meat and hence its monetary value.
Shear force	The force needed to cut meat which is an indirect measurement of tenderness.	If high, meat is less tender, both important sensory qualities for consumers.

Table 1. Presentation of main sensorial and technological meat quality parameters.

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of hydroxy-methionine was not detrimental for feed intake, growth performance, carcase composition or commercial value of finishing pigs. This increased dietary OH-methionine supply did not impact the ham and loin muscle yields between the groups.

Supplying methionine in the form of OH-Met, at a level exceeding TSAA growth requirements, improved several meat quality parameters. The ham and loin muscles of pigs fed supra-nutritional methionine levels had higher ultimate pH levels, which was significantly higher in the group fed the greatest level compared to control (Fig. 1a).

The lower drop in ultimate pH of loin and ham indicates an improvement in the technological quality of meat. Drip loss tended to be lower in the group fed the highest level of hydroxy-methionine – whether it was measured four or seven days post-mortem (Fig. 1b).

Meat colour parameters were affected by methionine supplementation, lower C* (chroma) and h* (hue angle) with the highest level of hydroxy-methionine leading to redder meat. Moreover, with the highest OH-met dose, colour parameters appeared more stable over time. From these parameters and the ultimate pH of the ham, a meat quality index was calculated.

Hydroxy-methionine supplementation significantly improved this index, indicating an improvement in technological pork quality (Fig. 2).

In terms of redox status, in comparison to control, glutathione in the loin muscle was higher in the group fed the greatest level of hydroxy-methionine and intermediate in the group fed the lower level of hydroxy-methionine. These differences may result in an improved synthesis of glutathione by transsulphuration of methionine.

Long term hydroxy-methionine supplementation improves tenderness of meat

A trial in growing/finishing pigs was carried out at Sichuan Agricultural University, China. The aim was to study the effect of increasing dietary total standard-ileal-digestible sulphur amino acids (SID-TSAA) to 25% above NRC recommended levels. This was achieved by supplementing pig diets for a 20-week period (~11 to 110 kg) – with either DL-Methionine or DL-hydroxy-methionine. Carcase and meat quality traits of pigs fed the two trial diets were compared to those fed control diets (NRC 2012).

Shear force of the Longissimus muscle tended to decrease with increased consumption of TSAA compared to control (Fig. 3). This agrees with previous research that higher levels of TSAA improve the tenderness of meat. It was therefore particularly interesting that only pigs fed OH-Met had a significantly higher marbling score than the control group.

Supplementation with OH-Met resulted in a higher ultimate pH than meat from pigs in the DL-Met or control groups. Muscle from female pigs fed DL-Met and OH-Met had reduced drip loss compared to the control group. It was concluded that increasing the level of TSAA in growing-finishing pig diets improved tenderness and water holding capacity.

Whilst supplementing with hydroxy-methionine specifically and positively affected pH value at 45 min post-mortem and marbling score. These observations are thought to be due to positive effects on lipogenesis and oxidation.

Commercial implications

The studies presented show that some of the main sensorial and technological pork quality parameters are improved when OH-Met is fed above growth requirements; and do not impair growth or carcase value.

Supplementation of hydroxy-met at five times TSAA growth requirements, for 14 days pre-slaughter, resulted in an increase of 0.1 units of ultimate pH – improving the yield of ham by 1%.

When OH-Met was fed for 20 weeks even lower levels of drip loss were observed, along with positive effects on marbling.

Meat quality is important for producers to achieve the best return on investment. Therefore, any nutritional strategy that can improve parameters related to tenderness and drip loss is worth consideration.

The fact that feeding higher levels of hydroxy-methionine improves technological quality of pork, in particular reducing drip loss, is of economic importance to the pig value chain. ■

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Fig. 3. The effect of methionine source of meat quality traits of pigs.