Breakthrough in stress periods: how polyphenols regulate oxidative stress

During the period around calving, dairy cows are exposed to high metabolic stress. This makes them particularly vulnerable to various illnesses, such as milk fever, ketosis and mastitis, even extending as far as fatty liver syndrome.

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These illnesses not only have a negative influence on the well-being of the animals, they also cause high economic losses, as the animals do not deliver the (milk) performance that corresponds to their genetic potential. Furthermore, poor health status in the period around parturition can have massive long-term consequences for fertility and performance.

The latest test results from the Educational and Research Centre for Animal Husbandry, Hofgut Neumuehle (a research cooperation arrangement between the University of Giessen and the Bingen University of Applied Sciences) show that a breakthrough could be achieved in the transit phase of the cow by feeding a feed additive rich in polyphenols (AntaOx, Dr Eckel GmbH, Germany).

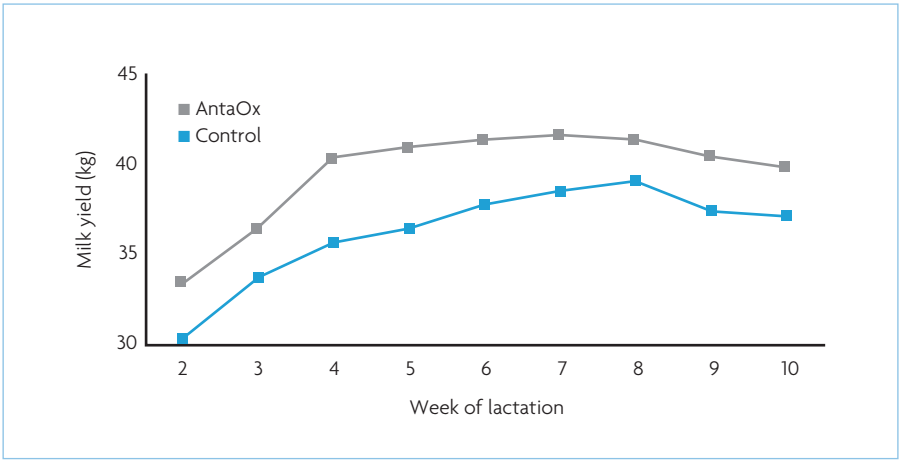

Fig. 1. Milk yield in the first 10 weeks of lactation after calving (Gessner et al., 2015).

The liver – at risk after calving

Milk production after calving requires a high-energy outlay. This cannot be covered solely via the feed, as feed uptake capacity is limited. That is why energy must be mobilised additionally via fat breakdown.

The resulting non-esterified fatty acids (NEFA) accumulate partly in the liver and are stored there. This can lead to fatty liver syndrome.

The formation of a fatty liver, especially in freshly lactating cows, is the cause of further health problems.

Undesired possible consequences in the further course of events are reduced fertility and permanently reduced performance.

The liver is the central organ for metabolism. Inflammation processes and stress reactions that have a negative effect both on the animal performance and on the actual liver function can be observed here.

Beneficial for humans and animals

Polyphenols are members of a large family of plant-derived compounds classified as flavonoids and non-flavonoids. Polyphenols of the flavonoid class have been shown to exert several beneficial effects in humans and animals.

Besides their antioxidative potential, flavonoids have strong anti-inflammatory properties. In studies with various models of inflammation such as obese rats, rats fed a high-fat diet or rats challenged with endotoxins, dietary supplementation with various types of flavonoids reduced the level of inflammation in the liver.

Recently, it has been shown that flavonoids are, moreover, able to attenuate endoplasmic reticulum stress in liver and muscle cells.

Whereas a great number of studies dealing with anti-inflammatory properties of flavonoids has been performed in humans and rodents, information is lacking about the potential beneficial effects of flavonoids in farm animals – especially in dairy cattle.

Breakthrough in the transit phase

In an experiment conducted at the Educational and Research Centre for Animal Husbandry, Hofgut Neumuehle, it has recently been shown that the polyphenol-rich feed additive AntaOx displays a positive health and performance effect in dairy cows.

Certain genes that are responsible for the inflammation and stress reactions in the liver are down-regulated when AntaOx is added. The liver fat content – measured via the share of triglycerides (mg/g) and cholesterol (mg/g) in the liver – was lower in the AntaOx group (-40% and -21%) than in the control group without polyphenol-rich additive.

However, AntaOx does not only inhibit

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the inflammation and exercise a positive influence on the liver function.

Inflammation processes consume a great deal of energy. If it is possible to reduce such inflammation reactions, correspondingly more energy remains available for performance. This effect is shown in an impressive difference in (milk) performance.

The experimental animals in the AntaOx group produced on average 3.6kg more milk per day during the experimental period than the animals in the control groups without a feed additive (Fig. 1).

In addition, they produced more milk fat and milk protein per day (Table 1).

These results prove the positive effects of AntaOx, not only on animal health but also on performance.

Reducing oxidative stress with polyphenols during heat stress

The period around parturition and high ambient temperatures have one thing in common – they are a burden on animal health and can have negative effects on performance.

The temperature optimum for dairy cows lies between 5 and 20°C. Heat stress for cows already starts at a temperature of more than 24°C and 70% atmospheric humidity. High ambient temperatures lead to a free radical overload. This is a pathophysiological metabolic state known as 'oxidative stress'. Oxidative stress triggers inflammatory processes, loss of performance and a range of diseases.

Numerous feeding trials in monogastric animals have shown that the valuable flavonoids in AntaOx support the body's own defence system and reduce oxidative stress.

They do this by neutralising free radicals, which renders them harmless. The valuable flavonoid combination was also shown to reduce inflammatory processes triggered by oxidative stress. Inflammatory responses in the body are mostly associated with heat generation, which in times of heat stress is the very opposite of what is needed.

Reducing inflammatory responses has a positive effect on the animal's ability to regulate its temperature, since less body heat needs to be released.

Table 1. The daily milk yield and milk composition of Holstein cows fed the control diet or the diet supplemented with AntaOx in average of week 2-9 of lactation (Koch et al., 2015).

Variable	Control	AntaOx
DMI (kg/d)	16.6[a]	17.2[a]
Net energy intake (MJ NEL/d)	114.3[a]	118.4[a]
Energy balance (MJ NEL/d)	-29.9[a]	-36.5[a]
Milk yield (kg/d)	35.4[a]	39.0[b]
ECM (kg/d)	33.9[a]	37.0[b]
Fat (%)	4.03[a]	3.92[a]
Protein (%)	3.20[a]	3.22[a]
Lactose (%)	4.80[a]	4.83[a]
Fat (kg/d)	1.37[a]	1.47[a]
Protein (kg/d)	1.09[a]	1.21[b]

[a,b] Different letters in a row indicate significant difference between the groups ($p<0.05$).

Conclusion

The extensive experiments show that the use of the flavonoid-rich AntaOx supports farmers by improving animal health and boosting performance. AntaOx makes a directly measurable contribution to the profitability of their farm – especially in stress periods. ■

References are available from the author on request