

Nature's osmolyte power to combat heat stress in ruminants

High temperature and humidity can cause heat stress in ruminants, which often results in economic losses to the sector. A natural betaine with the simultaneous benefits of a methyl donor and an osmolyte has been shown to reduce the energy requirements of osmoregulation and to enhance animal and reproductive performance.



by Dr Deepashree Kand,
Danisco Animal Nutrition
and Health (IFF).
www.animalnutrition.dupont.com

Heat stress is a common concern for the animal sector. For instance, under hot and humid conditions, ruminants suffering from excessive heat load feed less as a strategy to decrease metabolic heat production. This ultimately leads to a decrease in body weight gain, milk yield and fertility.

Dairy cows in particular are highly sensitive to these conditions as they have high metabolic energy expenditures due to milk production and a greater difficulty to balance body heat production and loss. Reproduction rates also decrease as thermal stress negatively affects folliculogenesis, oocyte maturation as well as embryonic development and survival. Aside from affecting production, heat stress can also become an animal welfare issue.

On a metabolic level, heat stress endures stress-related molecules,

like cortisol, that are associated to altered hormonal status and change the metabolic crosstalk. With the physiological homeostasis compromised, important changes in protein and fat metabolisms occur that negatively affect ruminant livestock production, reproduction, and health status.

Lower protein and fat production as well as storage in the body and in the milk are immediate consequences of reduced feed intake. In addition, fatty acids are mobilised from the adipose tissue and, if in excess, are re-esterified into triglycerides and stored in the liver causing fatty liver disease when energy supply is reduced.

Heat stress also decreases the diversity of commensal gut bacteria and their compounds, and alters pH, thereby affecting rumination and compromising digestion, absorption, and nutrient supply.

The management of heat stress in ruminants is therefore a multifaceted issue for livestock producers. Aside from improving housing conditions (good ventilation and insulation of barns, sufficient shade), nutritional strategies must be developed that help cattle cope with the harsh environmental conditions.

Natural betaine supplementation is increasingly recognised by cattle farmers as an important solution to mitigate heat stress.

Betaine - dual mode of action

As ruminants' respond to heat stress with a decrease in feed intake to reduce metabolic heat production and maintain a constant body temperature, supplementation that optimises feed digestibility and uptake is needed. Betaine is such a

supplement. Betaine is a trimethyl derivative of the amino acid glycine ((CH₃)₃NCH₂COO) with two main physiological roles: it acts as an osmolyte and as a methyl donor.

As an osmolyte, betaine protects cells from dehydration by maintaining water molecules in the cell and reduces the energy expenditure of ion pumps.

As a methyl donor, betaine contributes three methyl groups to the transmethylation cycle without needing conversion, unlike choline, a classic methyl donor in animal nutrition.

Transmethylation is vital for cell function, with methyl groups being used to form creatine, a critical molecule in the energy metabolism of the muscle or phosphatidylcholine, that is also a major component of cell membranes. These properties explain betaine's biological effects.

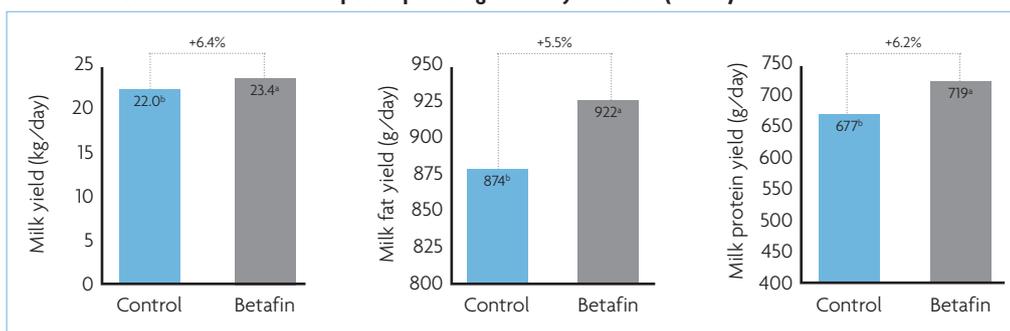
Overall, betaine supplementation, for one, counteracts the negative effects of reduced energy supply and, on the other side, allows for the maintenance of performance during stress.

Betaine hydrates, reduces energy expenditure and favours methyl groups metabolism.

As a methyl donor betaine helps to mobilise fat from liver tissue and hence maintains liver health. This, in turn, improves fibre digestibility and feed use efficiency.

Another important benefit is that betaine protects gut integrity and health by promoting the growth of commensal microbes. A diverse and functionally active microbial community prevents digestive conditions such as leaky gut.

Fig. 1. Effect of Betafin supplementation on milk yield, milk fat and milk protein yields of heat-stressed grazing cows. ^{a,b} Values without a common superscript are significantly different (P<0.05).



Preemptively addressing heat stress with a natural product

Betafin is a natural betaine product directly extracted from sustainable sugar beet (*Beta vulgaris*) molasses and vinasses.

Used as a feed additive in animal nutrition, its dual action can help mitigate heat stress and maintain profitable livestock production.

Continued on page 10

Continued from page 9

Research has shown that Betafin improves cattle performance, in particular milk yield and composition in grazing cows exposed to heat stress (Fig. 1).

The study was conducted for 22 days during summer with heat-stressed grazing cows (Holstein × Friesian) fed with concentrates (commercial cereal grain-based pellets), pasture, and silage and/or hay.

A natural betaine was added to either 0 (control) or 2g/kg (Betafin) to the concentrate diet, yielding approximately 15g/day in total.

Dietary betaine increased milk yield by 6.4% ($P < 0.05$) resulting in an additional 1.4kg milk/day, when compared to non-supplemented cows. Milk fat (+48g/day) and protein (+42g/day) yields increased by 5.5% and 6.2%, ($P < 0.05$), respectively, compared to the control diet.

The benefit of natural betaine to cattle reproduction was also shown in another trial with heat-stressed dairy cows (Fig. 2).

A four-month trial with dairy cows (Karan Fries) exposed to heat stress showed that supplementation with Betafin shortened the calving to first

service interval from 102 to 75.3 days as compared to the control treatment.

Another indicator of fertility is the number of services per conception. Treatment with natural betaine, however, decreased the number of services by 30.8% ($P < 0.05$) to 2.0 services instead of 2.89 in the control group. These results underscore that Betafin supplementation mitigates the negative effects of heat stress on dairy cows' reproductive efficiency.

In conclusion, betaine is the only dietary methyl donor that also regulates osmoregulatory functions.

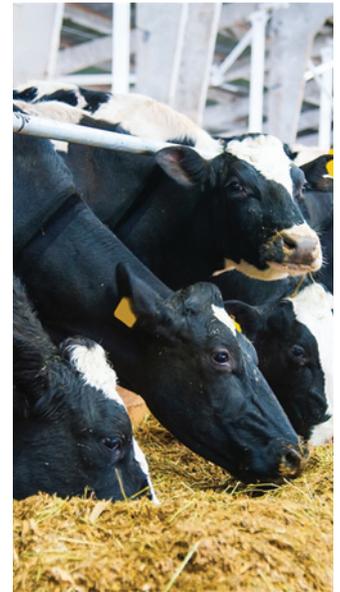
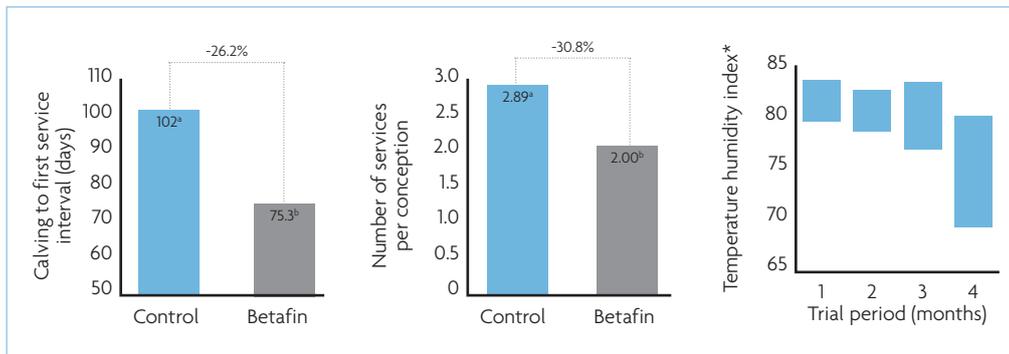


Fig. 2. Effects of Betafin supplementation on the reproductive performance of heat-stressed dairy cows. ^{a,b}Values without a common superscript are significantly different ($P < 0.05$). *The temperature humidity index (THI) is a measure of heat stress with upper critical limit of THI for cattle being 72 units.



It reduces the energy requirements of osmoregulation and enhances animal performance by improving body weight, as well as milk nutritional value and yield.

Supplementation with Betafin natural betaine has proven to be an effective strategy to mitigate the consequences of heat stress for a dairy cow's milk production and fertility. ■