The influence of palm kernel expeller on liver copper in Waikato dairy herds

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Back in 2008, a trial was conducted to analyse liver copper (Cu) in dairy cows from twelve herds in the Waikato comparing cull cow meat works and biopsy results. (Grace *et al*. 2010). The findings included high liver Cu levels with mean herd concentrations of up to 2610µmol/kg. A notable observation from the study was the widespread use of Cu supplementation, often in conjunction with palm kernel expeller (PKE) feeding. It was noted that farms implementing long-term copper supplementation programmes in conjunction with PKE feeding faced an increased risk of chronic copper toxicity. The researchers suggested that it might be possible to stop supplementation for an extended period and still maintain liver Cu concentration within the reference range of >100µmol/kg (Grace and Knowles 2010), whist feeding PKE

A second trial was then carried out to assess the consequences of withdrawing Cu supplements for twelve months from two herds selected from the previous trial. The object was to obtain further information on the changes in the concentrations of Cu in liver of herds managed under typical Waikato farm conditions (Hittmann *et al*. 2010).

Method

Two spring calving herds were selected, typical in terms of trace element management and liver Cu concentrations in the region. Herd 5 consisted of 210 Friesian cows on a 52-hectare farm and Herd 11 of 350 Jersey cows on a 101 hectare farm. The herds were wintered on the milking platform, fed pasture, conserved feeds, PKE fed at 2-4kg/cow/day (Table 1) and no Cu supplements were supplied. The concentration of Cu in liver biopsies from the same 9-10 cows per herd was repeated on a total of three occasions between April 2009 and May 2010.

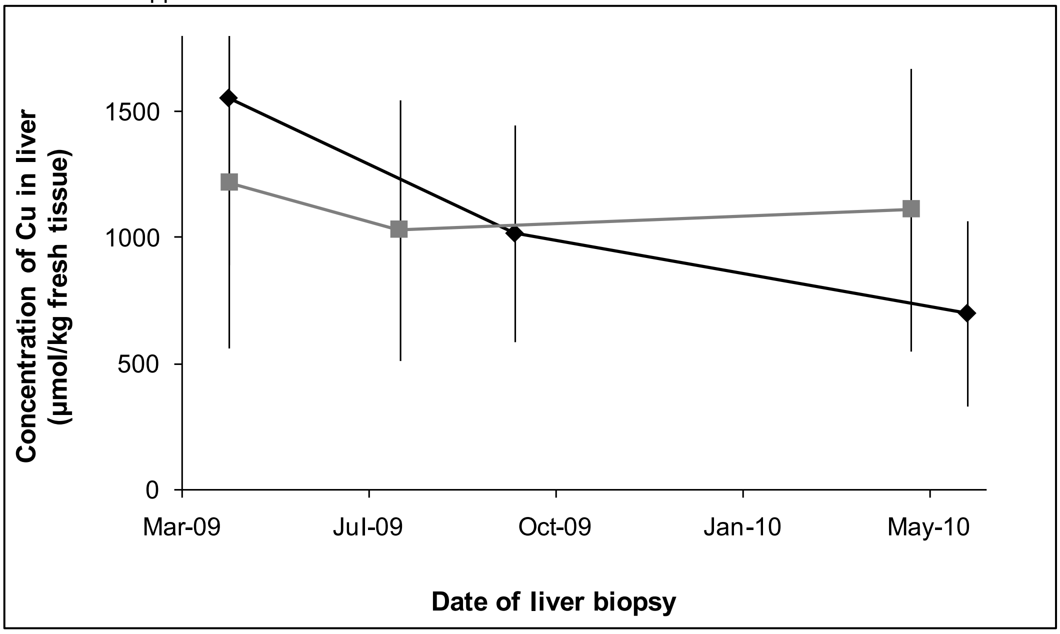
Table 1. PKE kg per cow per day as fed throughout the period of the trial in two spring calving Waikato dairy herds.

	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Farm 5 (PKE as fed/cow/day)	-	-	-	-	2	4	4	4	4	4	-	-
Farm 11(PKE as fed/cow/day)	-	2	4	4	4	2	-	2	4	4	3	

Results and discussion

The autumn pastures on these farms in April 2009 contained 10mg Cu, 0.2-0.3mg molybdenum (Mo) and 3.5-4.0g S per kg Dry Matter (DM). The initial herd mean concentrations of Cu in liver were herd 5, 1500 (SD 590) and herd 11, 1250 (SD 640) µmol/kg fresh tissue. In the absence of Cu supplements the mean concentrations decreased over 12 months to 705 (SD 370) and 1120 (SD 560) µmol/kg, respectively (Figure 1). The rate of depletion of liver Cu reserves was found to be proportional to initial concentration of Cu in liver and to dietary Cu intake, such that a high concentration led to faster loss according to first-order kinetics.

Figure 1. Changes in mean (± SD) concentration of Cu in liver of dairy cows from herd 5 (♦) and herd 11 (■) fed pasture, conserved feeds and varying amounts of Cu-rich palm kernel expeller but not given any mineral Cu supplements



Cu supplementation was not necessary during the trial period for these two dairy herds and in this case the Cu status of both herds was more than adequate to maintain health and productivity. It was concluded that the bodyweight of the cows, the quantity of PKE fed and the duration of feeding were factors in the rate of depletion of liver Cu reserves in these herds.

Palm kernel expeller as a supplementary feed in dairy cattle

PKE is a by-product from the extraction of oil from the kernel of palm tree fruit. Most of the shell of the kernel is removed and the remainder pressed to remove most of the palm kernel oil, leaving the residual as PKE.

PKE has been imported from Indonesia and Malaysia into New Zealand since 2003, primarily as a feed supplement for the dairy industry. Imports peaked at 2.24 million tonnes in 2016 but despite fat evaluation index guidelines imposed by dairy companies. New Zealand is still the world's largest importer of PKE, with imports of 1.98 million tonnes in 2023 (United States Department of Agriculture 2024). PKE remains as a significant feed supplement for New Zealand dairy cattle.

PKE contains high and variable inorganic Cu with concentrations generally ranging from 20.5-29mg/kg. The primary source is from contamination by Cu based treatments used to control fungal and bacterial diseases in palm oil plantations.

As the external shell is exposed to the Cu treatment, palm kernel seeds not properly de-shelled increase the Cu content of the PKE, so the concentration of Cu is proportional to the amount of external shell remnants present in the PKE (Duduyemi *et al.* 2016)

Copper and facial eczema

The interaction between copper (Cu) and zinc has been shown to adversely affect the status of both these minerals in dairy cows (Smith *et al.* 2010). This relationship is particularly relevant in the context of facial eczema, where Zinc plays a significant role in dairy cow health.

Cu is also implicated in the pathogenesis of hepatic biliary damage via the cyclic reduction and autooxidation of sporidesmin, the mycotoxin responsible for facial eczema, resulting in production of “active oxygen” species from the mycotoxin (Munday 1987).

This was demonstrated in a New Zealand case study (Dawson and Laven 2007) which showed that excess Cu intake, as reflected by liver concentrations >2,000µmol/kg fresh liver, was associated with the failure of Zinc therapy to prevent facial eczema in dairy herds.

Conclusion

The Cu status of dairy herds should be monitored, and the management of Cu supplementation must take into account all sources contributing to animals’ daily Cu intake. As PKE is effectively a Cu supplement, careful consideration should also be made of the contribution that PKE makes to overall Cu intake.

Where Cu supplementation has been excessive and there is risk of chronic Cu toxicity, Cu supplements should be withdrawn for a period commensurate with the expected rate of liver Cu depletion.

When using zinc to prevent facial eczema in cattle in the autumn, any Cu supplementation programme should not begin until after completion of the zinc therapy. When the risk of facial eczema is high, where practicable PKE should be removed from the diet.

References

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