Copper plays an important role in mammary gland health

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Mastitis has been described as the most common and costly disease in dairy production causing over 38% economic losses due to reduced milk production, treatment cost, increased labour, withheld milk following treatment and premature culling.

According to studies, the cost of mastitis ranges from €145-325 per cow per year, depending on monetary unit and country. These economic consequences could be even worse in the future, since the incidence of mastitis is increasing. Clinically, mastitis is caused due to the penetration of pathogenic micro-organisms into the teat canal, which invade the mammary tissue, causing an inflammatory response. As a consequence changes occur in the milk, such as an increase in somatic cell counts (SCC). Due to this, SCC is widely used to monitor udder health and milk quality.

Somatic cell counts

From an economic point of view, it must be mentioned that SCC not only provide information about udder health but has direct consequences, since the efforts to reduce bulk milk SCC results in substantial extra milk revenues.

Moreover, the higher global milk production (European milk supplies have increased by 5.4% in 2014) cannot be absorbed automatically by the market (demand is growing only by 1%), which along with the increasing higher production costs and the low prices of raw milk, reduce dairy farms' net margins year by year, thus worsening the perspectives of the dairy sector.

Furthermore, mastitis also has other consequences. From the social point of view, bacterial contamination of milk from the affected cows also poses a risk to public health through zoonoses and/or resistance to antibiotics after a prolonged use of them.

Environmentally, the frequent use of antibiotics also pollutes water and reduces soil microbiota, the latter of which is essential for the correct functioning of the agro-ecosystems.

Thus, the concept of one health (animal health, environmental health, and human health) must be the way to proceed, in order to carry out an integrative health risk management, while increasing dairy farms' economic sustainability.

This intricate context led to the definition of many strategies aimed at reducing mastitis' prevalence and its consequences. For example, the main strategies are the use of antibiotics, proper management, milking techniques, effective use of teat dipping and also dry period therapy. However, these techniques will not be effective if animals are not provided with the correct amounts of trace minerals.

Among them, it is widely accepted that zinc has been shown to be really important for mammary gland health. However, copper has also been reported to influence the resistance to mastitis, but further research is needed into the effect of this element in this regard.

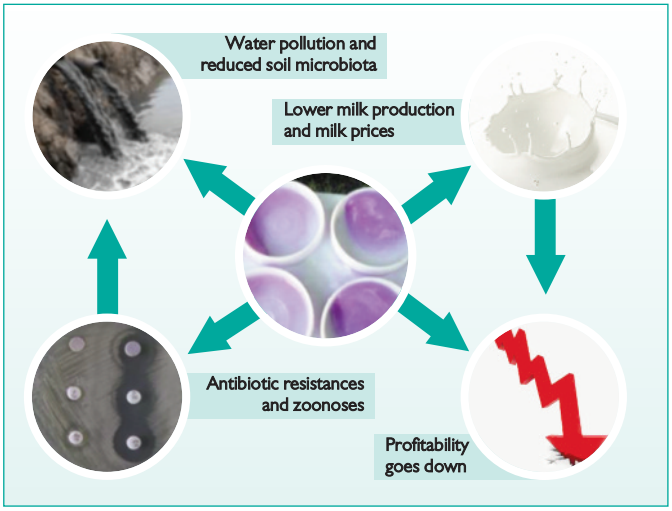

Fig. 1. The consequences of increased somatic cell counts.

Table 1. Parameters recorded, definitions and units.

Parameter	Definition and units
Zinc level	ppm
Copper level	ppm
Mean somatic cell count	mean of all selected farms during the year 2014 (cells/ml)
Farms with SCC	% of farms having cows with SCC >200,000 cells/ml
Prevalence of SCC	% of cows with SCC >200,000 in milk (average of all farms)
New infections rate	% of cows of the farm with SCC >200,000 that before starting the study showed values of SCC <200,000
Cure rate during lactation	% of cows that, after having a SCC >200,000, showed a SCC <200,000
New infections rate after calving	% of cows having a SCC >200,000 after calving, while their SCC before calving was <200,000
Cure rate during the dry period	% of cows that had a SCC >200,000 during the lactation cycle, and showed a SCC <200,000 during the dry period
Rate of clinical mastitis	%

Norel's study

In the face of this gap in knowledge, Norel decided it was time to carry out a study.

The objectives were:

- To evaluate the relationship between the levels of dietary zinc and copper, and udder health.
- Contribute to fill this gap of knowledge by means of a scientific study carried out under real conditions (commercial farms).

Experimental design

- **Duration of the trial, sampling frequency and date:**

The samples were taken during the course of 2014 (from February to

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the end of November). Milk samples were taken monthly for every single farm. Data of Dairy Herd Improving were used to analyse key performance index (KPI) of udder health monthly for every single farm.

The mineral content of the diets was assessed only once per farm. As diets were not modified during the experiment, it was possible to correlate the mean value of the udder health parameters with the minerals content of the diets.

- **Farms and cows selected:**

Some 50 dairy cow farms representative of the Spanish sector, and located in different areas of Spain, were selected. All cows were Holstein breed. The average number of cows per farm was 160 and the average milk yield per cow reached 33 litres per cow and per day.

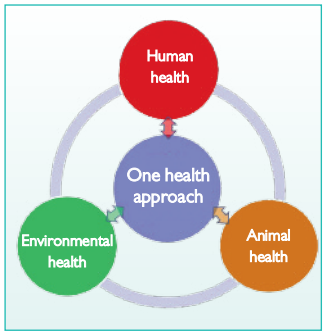
- **Production systems and milking management:**

Cows were housed in cubicles and dry lots and they were mainly milked twice a day.

- **Samples analysis:**

Servet Talavera took diet samples and calculated the KPI of udder health. The diet samples were analysed by 'Laboratorio Finca Mouriscade'.

Fig. 2. An integrated approach.



Parameter	Value
Zinc level (ppm)	68.34
Copper level (ppm)	14.63
Mean SCC (cells/ml)	255,040
Farms with SCC (%)	76.00
Prevalence of SCC (%)	28.44
New infections rate (%)	15.06
Cure rate during lactation (%)	34.10
New infections rate after calving (%)	20.30
Cure rate during the dry period (%)	65.60
Rate of clinical mastitis (%)	6.95

Table 2. Total sample (all farms) mean values for the parameters recorded.

Parameters recorded

Firstly, mean values were calculated for the sample with regard to the parameters shown in Table 1.

Secondly, bivariate correlation analyses were performed in order to assess the relationship between the level of dietary zinc and copper.

Results and discussion

Table 2 shows the results belonging to the first step of the statistical analysis of the information.

Mean of somatic cell counts was higher than 200,000 cells/ml when measured as an average of all farms; 76% of all farms and 28% of all cows showed such values.

Thus, SCC should be reduced, since farmers are losing the opportunity to increase their gross incomes. Calving is an important point of the productive cycle on which more managerial measures should be implemented, since infections increased by 20.3% within such a period.

During the dry period, additional measures would help to increase the cure rate (65.60% in the present study) of affected animals.

The average mastitis incidence in the population studied was lower than that reported in other studies (ranging from 11 to 40% according to Pérez-Cabal et al., 2008).

On the one hand, dietary zinc levels were significantly correlated only (and weakly) with the parameter cure rate during the dry period (R2=0.1362; p=0.0083).

Furthermore, mean somatic cell count showed a tendency to be correlated (R2=0.064638; p=0.0749).

On the other hand, dietary copper levels were correlated with mean somatic cell count (R2=0.138; p=0.0079) and monthly rate of clinical mastitis (R2=0.0927; p=0.0316).

For other parameters, some tendencies were observed: prevalence of SCC (R2=0.0636; p=0.0772), new infections rate (R2=0.0639; p=0.0697).

Interestingly, zinc levels were correlated to udder health parameters in a lower degree than copper, despite the fact that copper levels were below recommendations.

This is consistent with the arguments previously mentioned, and supports the results of Scaletti et al. (2003 and 2012) with regard to the role of dietary copper and enhanced resistance to mastitis.

Nevertheless, these results must be taken into consideration cautiously, since many aspects are probably influencing them, such as:

- Interactions among minerals.
- Levels of zinc were above recommendations in most cases.

Conclusions

Although further research is required to improve our existing knowledge about copper's role in mammary gland health, mineral interactions do not work precisely, so that the use of 'organic' (also called 'chelated') minerals is needed in order to avoid such undesirable interactions. In this sense, organic sources of minerals that combine zinc and copper may be of great interest as a basic tool to increase mammary gland resistance and health, and thus avoid the negative effects of mastitis. ■

References are available on request from the author