

Will the use of DON detoxification of feed using sodium metabisulfite and sodium sulfite increase the level of sulfite in feed?

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Data sheet

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Background

The Danish Agricultural Agency, The Ministry of Food, Agriculture and Fisheries of Denmark, require knowledge on the use of sodium metabisulfite and sodium sulfite for detoxification of DON (**Deoxynivalenol**) in grain. These compounds are suggested to be sprayed on the grain, thereby inactivating DON. The DON mycotoxin is found in grains and associated primarily with Fusarium, which is a fungal plant pathogen. There is a concern that sulfite levels in animal products will increase. Below are the questions asked. Questions 2 and 3 are considered overlapping to a large degree.

1. How much sodium metabisulfite and sodium sulphite is used per kg of grain for a detoxification for DON in grains?
2. Will the use of DON detoxification of feed using sodium metabisulfite and sodium sulphite increase the level of sulfite in feed and how much/kg of grain?
3. How much the sulfite level increases/kg grain when using sodium metabisulfite and sodium sulfite, respectively, by a preventive detoxification.
4. How is sulfite absorbed, distributed, metabolized and excreted when sulfite is entering the animal body and how is it eliminated? Particular interest is in how much sulfite will be excreted into milk and other animal matrices.

Reply

A search in Web of Science Core Collection (November 6, 2024) gave 110 results according to this search structure with focus on pigs and cows:

[1] dairy OR cow* OR cattle OR ruminants (All Fields) results 669,300

[2] pig* OR sow* OR swine (All Fields) results 933,856

[3] Sodium Sulfite (All Fields) results 3,975

[4] sodium metabisulfite (All Fields) results 1,275

Combined Searches (1 OR 2) AND (3 OR 4) results 128

Refined by [Document Types: Article OR Review Article] AND [Research Areas: Agriculture OR Food Science Technology OR Veterinary Sciences OR Physiology] results 110.

According to titles and abstract of the 110 articles, 21 relevant articles were identified: 14 articles were on pigs and 7 articles on ruminants. By exploring citations of these articles, 3 additional relevant articles were found on ruminants. These 24 articles were, if appropriate, the basis for answering the four questions.

1. How much sodium metabisulfite and sodium sulfite is used in grain for DON detoxification?

To answer this question, information on the efficacy and method of distribution into grain is necessary. The amount of sodium metabisulfite and sodium sulfite needed to neutralize DON, will probably also depend on the DON concentrations and grain humidity. The applied concentrations of sodium metabisulfite and sodium sulfite are reported in some articles, although some authors applied sodium metabisulfite and sodium sulfite to a compound diet including several ingredients, whereas others applied sodium metabisulfite and sodium sulfite to a specific dietary ingredient, often a DON contaminated batch of grain or soy products.

Amounts of sodium metabisulfite (SMB) and sodium sulphite (SoS) reported in pig experiments:

- Becker et al. (2022): 0.50% SMB in diet.
- Mwaniki et al. (2021): 0.3% SMB in diet
- Shawk et al. (2019): 0.25% SMB and 0.50% SMB in diet
- Frobose et al. (2017): 1.0% SMB in diet.
- Frobose et al. (2015): 1% to 5% SMB in dried distiller's grains with solubles (DDGS).
- Dänicke et al. (2010): 0.5% SMB/kg triticale
- Burnham et al. (2000): 1% SoS in soy products.
- Piao et al. (2000): 0.5%, 1.0%, and 1.5% SoS in extruded soybean meal.
- Castro et al. (1979): 0.1% SoS in diet.
- Tran et al. (2018): 0.5% SoS in wet-preserved maize.
- Paulick et al. (2018): 0.5% SoS in wet-preserved maize.
- Paulick et al. (2015): 0.5% g SoS to maize meal

In pig experiments, sodium metabisulfite have been supplemented at the highest concentration in on average 0.565% in compound diets, 0.5% in triticale, and up to 5% in DDGS. Sodium sulfite has been supplemented at highest concentrations to a compound diet in 0.1%, and to soy products and maize meal in average concentrations of 0.8%.

Amounts of sodium metabisulfite (SMB) reported in cow experiments:

- Lee et al. (2022): 0.6% SMB in fresh biomass fruit and vegetable discards

2. Does this detoxification increase sulfite levels in feed, and by how much per kg?

Molar mass of sodium metabisulfite ($\text{Na}_2\text{S}_2\text{O}_5$): 190.11 g/mol. Molar mass of sulfite (SO_3): 80.06 g/mol. The proportion of sulfite in sodium metabisulfite is $2 \times 80.06 / 190.11 = 84.2\%$.

Molar mass of sodium sulfite (Na_2SO_3): 126.04 g/mol. Molar mass of sulfite (SO_3): 80.06 g/mol. The proportion of sulfite in sodium sulfite is 63.5%.

If sodium metabisulfite is supplemented at 0.565% in the diet, the amount of sulfite in the diet is approximately 4.8 g/kg. If sodium sulfite is supplemented at 0.1% in the diet, the amount of sulfite in the diet is approximately 0.64 g/kg.

3. How much does sulfite increase per kg of grain with preventive detoxification?

The articles all used sodium metabisulfite and sodium sulphite to prevent toxic effect by DON and experiments have used concentration equivalent to add 4.8 g sulfite/kg diet as sodium metabisulfite, and 0.64 g sulfite/kg diet as sodium sulfite.

4. How is sulfite processed in animals, and how much is excreted into milk and other matrices?

None of the articles on pigs addressed metabolism of sodium metabisulfite and sodium sulfite. They primarily focus on the effects of these compounds on animal performance, nutrient utilization, and health parameters.

The articles on sodium metabisulfite or sodium sulfite to ruminants did not contain studies on the metabolism of these compounds. However, a study by Weigand et al. (1972) fed sulfite to four dairy cows corresponding to 18.4 to 20.2 g SO_2 per cow per day over a period of 110 days. The authors did not report which mineral or salt the sulfite was provided as. They found over a period of 15 weeks an average sulfite level of 1.53 mg SO_2 /l milk not statistically different from the control herd with a level of 1.39 mg SO_2 /l milk. The sulfite levels in the blood were low and did differ from control cows. In urine samples, the sulfite levels were 6.5 mg SO_2 /l, somewhat higher than in the control cows with 2.8 mg SO_2 /l urine. There were no statistical differences between experimental and control cows in respect of behaviour, body temperature, heart activity and rumen motility. Sulfite feeding also had no effect on the haematocrit, haemoglobin, red and white cell blood counts and serum enzyme activity.

In Weigand et al. (1972), although sulfite seems excreted with urine and not through milk, there are no quantitative measures allowing a mass balance calculation.

Conclusion

There is a lack of knowledge on the metabolism of sodium metabisulfite and sodium sulfite, and it is not possible to conclude on potential accumulation of sulfite in animal products.

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