Original Contribution

ALTERNATIVES TO THE USE OF ORGANIC TRACE MINERALS (FE, SE AND CU) IN PREVENTION OF SOME DEFICIENCY STATES IN PIGS
(A review)

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ABSTRACT

The aim of this review is to present the use of organic trace elements (Fe, Se and Cu) in the prevention of some deficiency diseases in pigs. Trace minerals are extremely important for the animal. They play primary functions as tissue structure building material and participate in a number of enzyme systems, regulating the main vital cellular and systemic functions. They stimulate the immune response and improve the reproductive traits, the production of meat and milk. Normally, they are present in the diet, but their bioavailability depends on their content in soil, plants and foodstuff. The trace elements iron (Fe), copper (Cu) and selenium (Se) have an essential effect on health status, which invariably controls the economic output in pig breeding. For example, inadequate levels of these elements result in deficiency diseases, which include iron deficiency anaemia, oesophago-gastric ulcer syndrome prevalent among growing piglets and fattening pigs.

The review of literature shows that the aetiological aspect of those diseases is not adequately discussed as well as the application of organic trace elements in the prevention of these deficiency states in industrial pig breeding.

Key words: pigs, iron deficiency anaemia, ulcer, trace elements, organic trace minerals

INTRODUCTION

Trace minerals are extremely important for the animal. They perform primary functions as tissue structure components and, via participation in several enzymatic systems, regulate main vital functions of cells and of the organism as a whole. They stimulate the immune response and improve the reproductive properties, the meat and milk productivity (1-3).

Normally, they are present in the diet, but their bioavailability depends on their content in soil, plants and foodstuff (4,5). The trace elements iron (Fe), copper (Cu) and selenium (Se) have an essential effect on health status and productivity of pigs. Their shortage results in disease states like iron deficiency anaemia and oesophago-gastric ulcer syndrome prevalent mostly among growing piglets and fattening pigs.

The principal signs observed in piglets are pale skin, fast exhaustion, sometimes pale yellow colouring of the skin, pale periocular mucous membranes, haemorrhagic signs, muscle weakness, etc. The disease should be distinguished from zoonoses, gastric ulcers resulting in significant loss of blood, porcine
enteropathy, rectal prolapse, gastric and intestinal torsion and unbalanced nutrition (10).

The diagnosis is made on the basis of clinical signs, decrease in haemoglobin content and erythrocyte counts (11, 12).

The oesophago-gastric ulcer syndrome affects predominantly growing and fattening pigs. The disease is mainly characterized by oesophago-gastric ulcerations in the non-glandular part of the oesophagus (a small part of the stomach near the oesophagus). There is limited information about the herd incidence of the oesophago-gastric ulcer syndrome but the available studies point out that in more than 50% of slaughtered pigs, there are gastric erosions and lesions (13). Its cause is still unclear but it is supposed that the ulcer is closely related to offering very finely ground feeds. As predisposing factors, some diet components, stress, congenital diseases and bacterial infection could be also involved.

Because of the difficulties related to the experimental reproduction of the disease, the recent studies determined it as being of poly-aetiological origin (13,14). According to Mitov et al. (15) the presence of spiralled bacteria in porcine stomachs is one of possible causes. Some studies substantiated the relationship between these microorganisms and the ulcerative lesions of the oesophageal part of the stomach in pigs (16,17), whereas others do not observe such an association (18). In spite of contradictory data, the prevailing opinion is that the bacterial aetiology of the disease is related to the presence of Helicobacter spp. in porcine stomach with predominance of H. helmannii type 1 and type 2 (4,19).

Clinically, the disease could be seen in several forms (Table 1) and should be differentiated from some diseases with a similar course.

**Table 1. Clinical forms of gastric ulceration (PHMS, 1989)**

<table>
<thead>
<tr>
<th>Clinical form</th>
<th>Differential diagnosis</th>
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<tbody>
<tr>
<td><strong>Peracute</strong></td>
<td>Traumatic rupture or torsion of internal organs, liver, small intestine, Mulberry heart disease Intoxication with chemical weapon</td>
</tr>
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<td>– completely healthy animals regardless of their age are found dead or collapsed following exercise or excitement. The corpses are most commonly pale, the stomach is thinned, distended and full of clotted blood. Blood clots are partially attached to eroded blood vessels located at the ulcerated margin of cardiac mucosa.</td>
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<tr>
<td><strong>Acute</strong></td>
<td>Haemorrhages from internal organs Proliferative haemorrhagic enteropathy (acute campylobacteriosis) Dysentery Intoxication with chemical weapon Coccidiosis</td>
</tr>
<tr>
<td>– weakness, refusal to stand up, pale mucous membranes, anaemia, dyspnoea. The haemoglobin and erythrocyte counts are reduced. The animals are anorectic; haematemesis and melena are observed</td>
<td></td>
</tr>
<tr>
<td><strong>Subacute or chronic</strong></td>
<td>1. Other enteric conditions (for example campylobacteriosis, dysentery). 2. Pneumonia. 3. Residual effect of post weaning coliform enteritis</td>
</tr>
<tr>
<td>– stunted growth due to inappetance or complete loss of appetite, weight loss are observed. Occasional discharge of dark faeces. Blood analysis shows signs of microcytic anaemia.</td>
<td></td>
</tr>
<tr>
<td><strong>Subclinical</strong></td>
<td>in most cases, there are no clinical signs</td>
</tr>
</tbody>
</table>
other substances, stimulating erythropoiesis. In addition, coarsely ground forages or antibiotic therapy is given if pulmonary oedema or pneumonia is present, (6,13). When a hereditary cause is suspected, the animals should not be bred (25,26).

As prophylactic measures, the ordinary diet of pigs is traditionally supplemented with trace element premixes present as inorganic sulphates, chlorides, carbonates and oxides. Their antagonism with other trace and macroelements results in decreased absorption and reduction of their activity (27). The assimilation of trace elements is often limited by their utilization. During feeding, the inorganic trace elements are combined with nutritive components and are turned into insoluble complexes.

The last trends in modern pig breeding are related to application of organic trace elements for improvement of health and reproductive status and stimulation of productivity in animals (4, 12). Their detection and application in animals help in the prevention and treatment of deficiency diseases in industrial pig breeding. Trace minerals are responsible for protecting cells from the so-called oxidative stress via their inclusion in the antioxidant function of enzymes glutathione peroxidase (Se), superoxide dismutase (Zn, Cu, Mn) (28,29,30). The organic forms however, are utilizable peptides or amino acids that are directly assimilated by the intestinal tract (12). Inorganic forms of selenium are absorbed intact through the intestinal mucosa, the mucous cell membranes and pass into the plasma (31).

The information on the application of organic iron in pigs is relatively few. Lewis et al. (32) reported that the addition of iron under the form of iron methionine has a better biological activity than the iron sulphate. Moreover, the effect of iron is closely related to that of copper. The latter is needed for utilization of iron under the form of ceruloplasmin, increasing its ferooxidase activity (14).

There are various sources of organic copper comprising, amino acid chelated copper (33,34), copper-methionine complex (9) and copper-lysine complex (27). In their studies, Apgar et al. (35) reported that copper concentrations in the liver of fattening pigs were higher after supplementation of organic (copper-lysine) compared to inorganic copper (CuSO₄). The application of organic copper under the form of Cu-lysine in the feed of weaned pigs results in enhanced growth and decreased morbidity rates. This is due to the increased mRNA activity of pituitary growth hormone and the immune system (36).

Selenium is an integral part of porcine diet and, combined with vitamin E, is vital for the optimal productivity and animal health (37,38). Organic forms of selenium include selenium amino acid complex, selenomethionine and selenocysteine (39). In monogastric animals, 70-80 % of inorganic selenium intake is not utilized (40). The organic forms, however, are presented for microbial degradation and are utilized far better (60-70 %) than inorganic ones (41).

In their studies, Vendeland et al. (42) showed that selenium-amino acid complex is absorbed in the small intestine via a sodium-dependent system that is related to the metabolic pathway of selenomethionine and selenocysteine. Selenomethionine is a precursor of selenocysteine that is consecutively metabolized to selenide, assisted by the β-liase. Selenides from all selenium sources are extremely important and play a key role in the metabolism of this trace element (10).

The biological effects of organic selenium are various: prevention of oxidative stress, improved function of the thyroid gland, maintenance of the cellular redox-system, maintenance of the immune system, detoxication of heavy metals and some xenobiotics. Some methylated selenium components have an anticarcinogenic effect (11, 43) All these make organic selenium better in the prevention of almost all porcine diseases (28).

Aside their high biological activity and utilization, the excretion of organic trace elements from the organism is very little compared to inorganic ones. This is associated with better environmental protection (7,33).

The application of inorganic trace minerals in the form of either Sel-plex (Alltex, Inc.) or Bioplex (Alltex, Inc.) growth promoters in pig breeding industry is well studied (28,31,44,45). Yet, there are no sufficient data on the application and the effect of organic forms of trace minerals in the prophylaxis of diseases, such as iron-deficiency anaemia and the oesophago-gastric ulcer syndrome. Future studies in this field would add to the prevention programmes aimed at eradicating iron-deficiency anaemia, ulcerative diseases and other trace elementoses. All these would contribute to considerable reduction of losses associated with pig breeding.
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