STUDIES ON ALLEVIATION OF INDUSTRIAL FLUOROSIS IN BAOTOU GOATS

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SUMMARY: Industrial fluorosis of goats in Baotou has a history of more than 20 years. Since the 1980s the following alleviating measures have been adopted: 1) chemical feed supplementation to counteract and reduce digestion of fluoride; 2) removal of goats from high to low fluoride areas; 3) relocation of goats from low to high fluoride areas for reproduction; 4) grass cultivation and/or low fluoride grass storage for use as goat feed during dry season; 5) dry season nutrient supplementation; 6) mechanical trimming of sawteeth. Some of the measures have resulted in longer goat life-spans and a corresponding increase in herdsmen’s incomes.

Key words: Alleviation; Goats; Industrial fluorosis.

Introduction

Industrial fluorosis in Baotou livestock was first noted in the early 1970s. According to a 1975 investigation, the fluoride-polluted area was as large as \(108 \times 96 \text{ km}^2\), and fluoride-affected animals totalled 600,000. 1 The main clinical feature of animal fluorosis is sawteeth, which resulted from high fluoride levels in dry season grass, and low fluoride levels in green season grass. When the teeth are disfigured severely enough to affect food (grass) intake and mastication, animals die at a young age from hunger and cachexia. 2 This disease resulted in rapid decrease of livestock in the Baotou region. For instance, the Bigeti pastoral area had 10,905 head of livestock in 1970, and in 1976 the total had dropped by 37% to 6866 head. 3

The fluoride pollution problem was not solved completely, in the past, owing to technical difficulties. So veterinary researchers and environmental conservationists implemented some alleviating measures, in order to reduce tooth abrasion, lengthen animal life-span, and decrease economic loss.

Measures and Results

1) Studies of fluoride-counteracting chemicals

In order to identify a chemical that increased fluoride excretion or reduced fluoride toxicity, and then improve tooth quality and slow down tooth abrasion, Ca (CaCO_3 and bone meal), Mg (MgCl_2), B (NaB_4O_7), Al (KA1(SO_4)_2) and Se (Na_2SeO_3 and Se element) were tested in experimental and natural conditions during different periods of between 4 and 18 months. Results showed that elements did not contribute to deceleration of tooth abrasion, though some produced a trend to increase fluoride excretion.

2) Removal of goats from high to low fluoride areas

To decrease fluoride intake, Wang 4 shifted 40 goats, aged 1 to 3 years, born in a high fluoride area, to a low fluoride area for 13 months. Mean urinary fluoride during the 13 months was 10.8 ppm, compared with 6.4 ppm of control goats, while fecal fluoride levels showed no significant difference. Bone fluoride decreased to 1,377 ppm from 2,445 ppm at first, but teeth developed in the high fluoride area

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showed signs of fast abrasion. Apparently bone fluoride levels can be reduced through urinary excretion, but preventive measures should begin at age 6 months in spring-born to ensure permanent teeth development in low fluoride conditions.

3) **Relocation of goats from low to high fluoride areas**

For social and economic reasons, relocation of goats from high to low fluoride areas is only practicable on a small scale, and it is impossible to remove all goats from areas of high fluoride pollution. Thus goats whose permanent teeth were well developed (about 3 years old) were relocated from a low to a high fluoride areas. Their teeth little affected by fluoride, these goats lived longer and conceived several times. The offspring were used as meat at three years. This measure effectively increased herd size and herdsmen’s incomes.  

4) **Grass Cultivation and use of low fluoride grass storage in fluoride-polluted areas for dry season goat feed**

Grass fluoride levels in the Baotou region fluctuate seasonally. In winter and spring (November to April) the dry grass is continually polluted by dust-borne fluoride, in addition to containing high fluoride in itself. Conversely, in summer and autumn (May to October) green grass, growing continuously, is polluted by comparatively little dust-borne fluoride which is partially washed away by frequent rains (see Table 1). This change in grass fluoride levels is one of the important causes of differential tooth hardness and sawteeth development. To protect goat teeth from high fluoride levels, two methods were tested: 1) grass cultivation where suitable; and 2) natural green grass storage in polluted areas.

<table>
<thead>
<tr>
<th>Time</th>
<th>N</th>
<th>Before wash</th>
<th>After wash</th>
<th>Dust F, ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry grass seasons (11 - 4 months)</td>
<td>84</td>
<td>204.4 ± 66.5</td>
<td>113.3 ± 50.4</td>
<td>91.2 ± 33.8</td>
</tr>
<tr>
<td>Green grass seasons (5 - 10 months)</td>
<td>72</td>
<td>27.0 ± 13.6</td>
<td>16.9 ± 7.6</td>
<td>10.2 ± 8.2</td>
</tr>
</tbody>
</table>

Tests prove that both are effective. First and second incisors and all molars of goats born in the winter can be protected if they are thus fed during their first dry season; and all incisors and molars of goats born in the spring can be protected if they are thus fed during their first two dry seasons.

5) **Dry season nutrient supplementation**

Lengthening goat life-spans remains a problem in areas where herdsmen cannot afford to buy goats from low fluoride areas, or where conditions do not permit grass cultivation and low fluoride grass storage.

In recent investigations, we suggested that in addition to high grass fluoride, malnutrition, including protein and Ca deficiencies in the dry season, is also a serious factor contributing to the rapid abrasion of some teeth. The cause of
this malnutrition is the gradual decrease in both quantity and quality of feed grass during the dry season. A comparative study of grass quality showed that green grass contained, on a dry matter basis, 13.7-19.1% protein, some fiber, and had a 60-70% digestion rate in vitro, and 7.9-11.8 MJ/kg metabolic energy; while dry grass contained about 5% protein, more fiber, and had a 21.9-45.4% digestion rate in vitro and 2.8-6.5 MJ/kg metabolic energy. Thus, nutrient supplementation during the dry season, for goats whose teeth are developing, can improve the overall health of the animal, and may improve tooth quality, but does not completely solve the problem of fluoride intake.

Experiments showed that nutrient supplementation, especially large quantities of protein, not only improved the overall health of goats, but improved tooth quality and reduced the abrasion rate of teeth. At present, this measure has been used by more and more herdsmen because it can lead to significant economic gains, and is also attractive as a fluorosis-counteracting method because it is not restricted by natural conditions.

We supplied 15-35 kg of food to each goat, of any age, over a wide area - to 70,000 goats in 1993 and to 130,000 in 1994. Apart from the expected long-term gain of lengthened life span, we observed this year (1995) the following immediate returns: 1) fewer deaths from famine in the latter part of Spring; 2) more conceptions, fewer abortions, and a higher kid survival rate; 3) increase in wool and down, and in meat. The economic gains far exceed the cost of the extra food.

6) **Mechanical trimming of sawteeth**

When teeth appear uneven, intake and mastication are affected. Wang introduced a method of trimming sawteeth by using special scissors to trim protrusions of long teeth, thereby improving mastication function. After a week of trimming teeth, grass residue was no longer evident in the mouth, and after 5 months of teeth trimming fecal fiber decreased and body weight increased (see Table 2).

<table>
<thead>
<tr>
<th>Group</th>
<th>Fecal fiber % green season</th>
<th>Fecal fiber % dry season</th>
<th>Net body weight gain kg 4 months of green season</th>
<th>Net body weight gain kg 1 month of dry season</th>
</tr>
</thead>
<tbody>
<tr>
<td>control</td>
<td>12.8</td>
<td>13.7</td>
<td>4.2</td>
<td>-0.5</td>
</tr>
<tr>
<td>trimmed</td>
<td>9.4</td>
<td>10.6</td>
<td>9.4</td>
<td>0.3</td>
</tr>
</tbody>
</table>

Trimmed teeth had improved mechanical digestive ability for grass fiber over control teeth. It is thus clear that this method can reduce economic losses over a period of time, though it too does not solve the problem of fluoride intake.

Some of the measures described here successfully lengthened goat life-spans and increased herdsmen’s income. Comprehensive adoption of these measures would no doubt be as successful under conditions where the problem of fluoride pollution has not yet been solved.
References

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