Developing a herbivore diet for Emmen Zoo

Marcus Clauss
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EAZA Academy Liberec 2017
Request ... and Counter-Request

- Design a pelleted diet suitable for captive moose and other wild ruminants
- To be produced at a local feed mill
- At the same time, deliver a higher level of energy than forages, and prevent the occurrence of rumen acidosis

- *Zoo pays for travel/accommodation*
- *Recipe to be made publicly available*
Approach

• Starch not a major source of energy but pectins (from beet pulp) – low acidic potential
Approach

- Starch not a major source of energy but pectins (from beet pulp) – low acidotic potential
- Forage-based (lucerne meal) – fibre fermentation and fatty acid profile
Approach

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- Forage-based (lucerne meal) – fibre fermentation and fatty acid profile
- Linseed – fatty acid profile
Supplementing the diet of captive giraffe (Giraffa camelopardalis) with linseed extraction chips

Abstract
Captive giraffe (Giraffa camelopardalis) are reported to have low linolenic acid concentrations in body tissues in comparison with free-ranging individuals. However, it is not known whether this merely reflects a different diet, or whether it impairs body functions. As linseed contains significant amounts of linolenic acid, the feeding of linseed extraction chips might be a practical way of supplementation. Captive giraffe with low linolenic acid status in their blood lipids (compared to domestic ruminants) were introduced to a diet that included linseed extraction chips. Blood lipids of animals from which samples were available after the change in dietary regime (n = 2) showed an increase in linolenic acid content. One of the animals had a history of skin lesions resistant to treatment. The skin lesions improved markedly during the course of linseed supplementation. While long-term effects of either linolenic acid deficiency or linolenic acid supplementation in giraffe remain to be demonstrated, these results suggest that giraffe might benefit from the addition of linseed extraction chips to their diet.

Keywords
polysaturated fatty acids, linolenic acid, skin lesion, peracute mortality syndrome

1. Introduction
It has been reported that captive giraffe (Giraffa camelopardalis) have a much lower content of polysaturated fatty acids (PUFA) in body tissues than
Approach

- Starch not a major source of energy but pectins (from beet pulp) – low acidotic potential
- Forage-based (lucerne meal) – fibre fermentation and fatty acid profile
- Linseed – fatty acid profile
- High levels of copper for cervids, also acceptable for giraffids and many bovids but not sheep
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- Linseed – fatty acid profile
- High levels of copper for cervids, also acceptable for giraffids and many bovids but not sheep
- Sodium bicarbonate as a buffer against rumen acidosis
Buffer substance

Effect of subacute ruminal acidosis on the preference of cows for pellets containing sodium bicarbonate

J. L. Cumby1, J. C. Plaizier1, I. Kyriazakis2, and B. W. Nocek3

1Department of Animal and Poultry Science, University of Guelph, Ontario, Canada; 2Animal Biology Division, Scottish Agricultural College, Edinburgh, UK; 3Department of Animal and Poultry Science, University of Guelph, Ontario, Canada

Accepted 14 December 2000.

Cumby, J. L., Plaizier, J. C., Kyriazakis, I., and McBride, B. W. 2001. Effect of subacute ruminal acidosis on the preference of cows for pellets containing sodium bicarbonate. Can. J. Anim. Sci. 81:149-152. Lactating cows were given a choice between two test pellets during a 3-wk experiment. Intake of test pellets containing 4% sodium bicarbonate increased over that of control pellets. Key words: Acidosis, diet choice, dairy cattle, sodium bicarbonate

THE INFLUENCE OF SODIUM BICARBONATE AND DEHYDRATED ALFALFA AS BUFFERS ON STEER PERFORMANCE AND RUMINAL CHARACTERISTICS

T. E. Stroud, J. E. Williams, D. R. Ledoux and J. A. Paterson
University of Missouri–Columbia 65211

Summary

A 95-d feedlot trial utilizing 3 Angus and 3 Angus × Hereford steers (450 kg) was conducted to determine the effects of adding dehydrated alfalfa pellets (Dehy) or a combination of Dehy + sodium bicarbonate (Dehy + NaHCO3) to a 74.6% cracked corn (CC) – 12% cottonseed hull (CSH) control diet on average daily gain (ADG), feed efficiency and nutrient digestion. The Dehy treatment resulted in greater (P < 0.05) ADG during the 77- to 95-d period compared with the control diet. The Dehy + NaHCO3 treatment increased (P < 0.05) ADC and feed efficiency for the 77- to 95-d period. The Dehy and Dehy + NaHCO3 treatments improved (P < 0.05) mean dry matter (DM) and neutral detergent fiber (NDF) digestibilities compared with the control diet. A metabolism trial utilizing three rumen-fistulated Hereford steers (450 kg) in a 3 × 3 Latin square design was conducted to determine the effects of Dehy, NaHCO3, and a combination of Dehy + NaHCO3 on rumen fluid pH, volatile fatty acid concentration and nutrient digestibility. The Dehy and Dehy + NaHCO3 treatments increased (P < 0.05) rumen pH to 5.5, 5.5 and 5.0 on d 10, 30 and 60, respectively. The Dehy and Dehy + NaHCO3 treatments improved (P < 0.05) DM, NDF and N digestibilities compared with the control diet. Although Dehy and Dehy + NaHCO3 increased ADC and nutrient digestibility, Dehy + NaHCO3 was associated with a further improvement in rumen and blood variables of acid-base status.

Key Words: Dehydrated Alfalfa Pellets, Sodium Bicarbonate, Finishing Diet, Digestibility.

Introduction

With the increased feeding of concentrates, research interest has been generated in the use of forages as aids in the prevention of acidosis conditions. Dietary buffers are used to attenuate ruminal pH and prevent acidosis (Huntington et al., 1977). In many instances, buffers have improved animal performance (Nicholson and Cunningham, 1961). Buffer supplementation results in a more consistent improvement in cellulose digestion (Emmanuel et al., 1970; Terry et al., 1970). Cheng et al. (1955), among others, have suggested that maintenance of a rumen pH of 6.8 to 7.0 through the use of buffers may be responsible for the increased nutrient digestion often associated with the feeding of buffers. Legumes, especially alfalfa, have been shown to increase ruminal pH and buffer capacity compared with grasses (Merente, 1979; Van Soest, 1982). Ha et al. (1983) demonstrated that the addition of alfalfa and 2% NaHCO3 to a high concentrate diet resulted in similar increases in rumen pH and decreases in blood lactic concentration in lambs. Stroud (1983) demonstrated that 10% dehydrated alfalfa improved rumen buffering capacity below pH 5 in steers fed a 75% concentrate diet. The objective of these studies was to evaluate the effects of dehydrated alfalfa pellets and dehydrated alfalfa pellets plus NaHCO3 on performance, feed intake and nutrient digestibility, as well as blood and ruminal physiologic variables in feedlot cattle.

Experimental Procedure

Steer Performance Trial. A 95-d feedlot trial with 33 Angus and Angus × Hereford steers (450 kg) was conducted to determine the effect of supplementing a cracked corn-based diet with dehydrated alfalfa pellets (Dehy) and NaHCO3 on rate and efficiency of gain, feed intake and

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Key Words: Acidosis, diet choice, dairy cattle, sodium bicarbonate
Suitable species
Reindeer and similar species

Benefits
• Small pellet size for greater acceptability.
• Adequate levels of Vitamin E and Selenium.
• Contains 2.5% Sodium Bicarbonate which helps prevent acidosis and supplies bicarbonate ions which are essential for cellulolytic bacteria.

Ingredients
Barley, Wheat, Wheat Feed, Grass Meal, Oat Hulls and Bran, Sodium Bicarbonate, Soya Bean Oil, Vitamins and Minerals.
(Ingredients may be subject to change due to seasonal availability)

Feeding recommendations
Designed for Ad-Lib feeding throughout the year. Adequate good quality hay and browse should also be provided. The animals will adjust food intake from virtually nothing during winter to about 5kg or more, per animal per day during summer and prior to the rut. During rut, food consumption reduces considerably and animals may lose some of their body condition but this should be regained by increased food consumption for the short period after the rut.

During winter and early spring the animals will eat very little and will dramatically lose body condition. This is natural and, provided the animals are healthy, with good deposits of back-fat at the onset of winter, there will be no deleterious effects.

Additional information
Modified from a formula provided by Mr Richard Knock at the Zoological Society of London, Whipsnade Park.

Calculated analysis
(Unless otherwise stated nutrients are expressed as total calculated levels)

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>10.00</td>
</tr>
<tr>
<td>Crude Fat</td>
<td>5.69</td>
</tr>
<tr>
<td>Crude Protein</td>
<td>12.19</td>
</tr>
<tr>
<td>Crude Fibre</td>
<td>10.07</td>
</tr>
<tr>
<td>Ash</td>
<td>11.01</td>
</tr>
<tr>
<td>NFE</td>
<td>50.28</td>
</tr>
<tr>
<td>Acid Detergent Fibre (ADF)</td>
<td>11.93</td>
</tr>
<tr>
<td>Neutral Detergent Fibre (NDF)</td>
<td>28.19</td>
</tr>
<tr>
<td>Starch</td>
<td>27.44</td>
</tr>
<tr>
<td>Metabolisable Energy (ME)</td>
<td>8.04</td>
</tr>
<tr>
<td>Lysine</td>
<td>5.53</td>
</tr>
<tr>
<td>Methionine</td>
<td>0.22</td>
</tr>
<tr>
<td>Calcium</td>
<td>0.69</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>0.68</td>
</tr>
<tr>
<td>Sodium</td>
<td>1.37</td>
</tr>
<tr>
<td>Magnesium</td>
<td>0.37</td>
</tr>
<tr>
<td>Copper</td>
<td>18.81</td>
</tr>
</tbody>
</table>

Vit. A (added as Retinyl Acetate) 8000 IU/g
Vit. D3 (added as Cholecalciferol) 200 IU/g
Vit. E (added as dl-alpha-tocopherol acetate) 6000 IU/kg

For further information
Email: info@mazurifoods.com
Tel: +44 (0)1376 511 260
Fax: +44 (0)1376 511 247
www.mazuri.eu

Reindeer Pellets

Description
Reindeer Pellets are designed as a complete food fortified with vitamins and minerals – this diet provides the nutritional balance needed to meet production needs. It can be fed as sole source of nutrients during breeding, or fed with a small amount of hay or meze.

Features and Benefits
• Pellet form - Easy to feed, minimizes waste.
• Small pellet size - For greater acceptability.
• Suitable for tough feeding - Added convenience.

Product Form
• Pellet size: 5/32 diameter x 17/2 length.

Guaranteed Analysis

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude protein not less than</td>
<td>12%</td>
</tr>
<tr>
<td>Crude fat not less than</td>
<td>5%</td>
</tr>
<tr>
<td>Crude fibre not less than</td>
<td>18%</td>
</tr>
<tr>
<td>Calcium (Ca) not less than</td>
<td>0.9%</td>
</tr>
<tr>
<td>Phosphorus (P) not less than</td>
<td>0.7%</td>
</tr>
<tr>
<td>Salt (NaCl) not less than</td>
<td>0.4%</td>
</tr>
<tr>
<td>Sodium (Na) not less than</td>
<td>1.2%</td>
</tr>
</tbody>
</table>

Ingredients
Ground oats, dehydrated alfalfa meal, wheat middlings, soybean meal, soybean oil, DL-methionine, dehulled soybean meal, salt, calcium carbonate, magnesium oxide, choline chloride, menadione dimethylpyrimidinol bisulfite (vitamin K), ascorbic acid (vitamin C), pyridoxine hydrochloride, thiamin hydrochloride (a preservative), cholecalciferol (vitamin D3), dl-alpha tocopheryl acetate (vitamin E), biotin, vitamin A acetate, calcium pantothenate, vitamin B12 supplement, thiamine mononitrate, niacin, nicotinic acid, folic acid, manganese oxide, zinc oxide, ferrous carbonate, copper sulphate, zinc sulphate, calcium lactate, cobalt carbonate, sodium selenite.

Feeding Directions
Feed Reindeer Pellets ad libitum with a small amount of hay or meze throughout the year. Feed consumption may be reduced during the rut season. Always keep plenty of fresh, clean water available to animals.
THE FORMULATION OF A BEET PULP-BASED PELLETED FOOD FOR CAPTIVE WILD RUMINANTS AND PRELIMINARY EXPERIENCES

C. BERNDT, A. KLARENBEK, T. HEJCKMAN, J. HUMMEL and M. CLAUS

Affiliation:
1. Noorder Dierenpark, Hoofdstraat 18, Postbus 1010, 7801 BA Emmen, The Netherlands
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3. Zoological Garden of Cologne, Germany
4. Institute of Animal Physiology, Physiological Chemistry and Animal Nutrition, Munich, Germany

Poster abstract
A major challenge in captive wild ruminant nutrition is the simultaneous provision of an adequate energy supply and the prevention of rumen acidosis (1). Pectins and other soluble fibre components are a readily available energy source for ruminants, but their fermentation is not, in contrast to starch or sugars, prone to result in an acidic rumen condition (3). Therefore, the inclusion of feeds with high pectin content in the diet of captive wild ruminants has been promoted recently (2,4). The acquisition of a new pair of moose (Alces alces) at Emmen Zoo, Netherlands, led to the formulation of a new pelleted food with this concept in mind. Objectives of pellet formulation were a high proportion of pectin-rich ingredients, a low proportion of starches and sugars, a mineral composition with a high copper content considered appropriate for cervids and other wild ruminants except sheep, and the inclusion of sodium bicarbonate as a buffering substance to provide additional protection against rumen acidosis.

The formula consists of beet pulp/citrus pulp (22.5%), soy products (22.5%), Lucerne meal (22.5%), sunflower hulls (12.5%), wheat (8.0%), molasses (2.5%), cellulose powder (2.5%), linseed (2.0%), vitamin-mineral premix (2.2%), sodium bicarbonate (1.5%). The calculated analysis of this product is (on a dry matter basis): crude protein 16.8%, crude fat 5.7%, crude fibre 22.3%, crude ash 8.5%, starches and sugars 16.4%; neutral detergent fibre 40.7%, acid detergent fibre 26.0%. Subtracting protein, fat, ash, neutral detergent fibre and starch/sugars from 100% leaves a residual 12.0%, which will mostly represent the pectin fraction. Copper is added at 22 mg/kg dry matter.

The pellet has been fed to 2 moose, 13 giraffes (Giraffa camelopardalis), 44 impalas (Aepyceros melampus), 3 Lesser kudus (Tragelaphus imberbis), 4 pudus (Pudu pudu) and 32 guanacos (Lama guanicoe) for nearly a year. The pellets were accepted readily by all individuals. No adverse effects of the pellets were noted so far. Compared to earlier years, the skin condition of the impala group was judged to have improved. While beet pulp may cause problems due to swelling in the oesophagus in horses and therefore should be offered soaked, it is commonly fed un-soaked to domestic ruminants. The pellet was offered un-soaked to all 98 animals; only in one case (a giraffe bull) were problems observed in the form of regurgitation/vomiting approximately 15 minutes after food intake which is believed to be due to an oesophageal stricture. A conclusive evaluation of the new food will be possible after several years of feeding.
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Example Recipes for Pelleted Diets Fed to Browsers*

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>% Original Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beet pulp</td>
<td>22.5</td>
</tr>
<tr>
<td>Soy extraction meal</td>
<td>22.5</td>
</tr>
<tr>
<td>Alfalfa meal</td>
<td>22.5</td>
</tr>
<tr>
<td>Sunflower hulls</td>
<td>12.5</td>
</tr>
<tr>
<td>Wheat</td>
<td>8.0</td>
</tr>
<tr>
<td>Molasses</td>
<td>2.5</td>
</tr>
<tr>
<td>Cellulose powder</td>
<td>2.5</td>
</tr>
<tr>
<td>Linseed</td>
<td>2.0</td>
</tr>
<tr>
<td>Sodium bicarbonate</td>
<td>1.0</td>
</tr>
<tr>
<td>Mineral/vitamin supplements</td>
<td>4.0</td>
</tr>
<tr>
<td>NDF† (% dry matter)</td>
<td>40.7</td>
</tr>
</tbody>
</table>

ZOO AND WILD ANIMAL MEDICINE
Current Therapy

VOLUME

MURRAY E. FOWLER, DVM, DIP, ACZM, ACVIM, ABVT
President Emeritus, Zoological Medicine
Institute of Veterinary Medicine
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E. L. MILLER, DVM, DIP, ACZM
Director of Animal Health and Conservation
Dr. Louis Fox

Zoological Society of San Diego
American Association of Veterinary Medicine and Surgery
College of Veterinary Medicine
Trinity University
Maurine, Missouri
Commercial product

**HERBIVORES**

**Browser**

Suitable for: Browsing zoo herbivores, as for example giraffe, okapi, roe deer, moose, duiker, and intermediate feeders as deer, goats etc.

**YOUR BENEFITS**

- Balanced fiber composition, highly suitable for browsers with high contents of fermentable fiber from apple pomace, soybean hulls and beet pulp
- Protein content adapted to the needs of browsers with regard to the lower protein content of European alfalfa
- Calculated corresponding to the latest information on herbivore feeding
- Little cereals and thus lower in sugar and starch
- High levels of vitamin E and organic selenium
- Copper supplemented for the higher needs of cervids
- Biotin supplemented for horn and fur
- With an appropriate ration composition there is no need of additional supplements thanks to bicarbonate for the prevention of ruminal acidosis
- Linseed products for a naturally high content of omega-3-fatty acids
- Bicarbonate for the prevention of ruminal acidosis
- No mineral iron is substituted
- High levels of vitamin E and organic selenium
- Biotin supplemented for horn and fur
- Copper supplemented for the higher needs of cervids
- With an appropriate ration composition there is no need of additional supplements thanks to adequate vitamin- and mineral supplementation
- We are happy to work with you to create an individual feeding recommendation

**TYPE OF FEED, FORM, DELIVERY QUANTITY**

- supplementary feed
- Form: pallet 8 mm round
- Delivery quantity: 25 kg paper bag

**FEED SPECIFICATIONS**

**Major nutrients (%)**

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter</td>
<td>89</td>
</tr>
<tr>
<td>Crude protein</td>
<td>20.3</td>
</tr>
<tr>
<td>Crude fat</td>
<td>3.1</td>
</tr>
<tr>
<td>Crude fiber</td>
<td>20.4</td>
</tr>
<tr>
<td>Crude ash</td>
<td>9.9</td>
</tr>
<tr>
<td>NFE</td>
<td>35.4</td>
</tr>
<tr>
<td>NDF</td>
<td>34.7</td>
</tr>
<tr>
<td>ADF</td>
<td>24.7</td>
</tr>
<tr>
<td>Starch</td>
<td>3.6</td>
</tr>
<tr>
<td>Sugar</td>
<td>3.9</td>
</tr>
</tbody>
</table>

**Energy (MJ/kg)**

- Gross energy: 16.4
- Metabolisable energy: 6.6
- Digestible energy: 10.5
- Net energy for lactation: 4.2

**Macrominerals (%)**

- Calcium: 1.3
- Phosphorus: 0.7
- Magnesium: 0.3
- Sodium: 0.6
- Potassium: 1.3
- Chlorine: 0.3

**Trace elements (mg/kg)**

- Iron: 500
- Zinc: 280
- Copper: 33
- Iodine: 2
- Manganese: 122
- Selenium: 0.7
- Cobalt: 1.1

**Vitamins (added, mg/kg)**

- Vitamin A (IU/kg): 10500
- Vitamin D3 (IU/kg): 15000
- Vitamin E: 1860
- Vitamin K3: 0.8
- Vitamin B1: 11
- Vitamin B2: 10
- Vitamin B6: 7
- Vitamin B12: 0.04
- Nicotinic acid: 80
- Pantothenic acid: 32
- Folic acid: 1.6
- Biotin: 7
- Choline: 1000
- Vitamin C: 15

**Amino acids (%)**

- Arginine: 1.2
- Lysine: 1.14
- Methionine + Cystine: 0.32
- Methionine: 0.32
- Threonine: 1.1
- Isoleucine: 1.1
- Methionine: 0.32
- Heptadecane: 1.1
- Leucine: 1.1
- Lysine: 1.1
- Threonine: 1.1
- Phenylalanine: 1.1
- Tryptophan: 1.1
- Methionine: 0.32

**Ingredients**

- Soybean hulls (NGMO), alfalfa, soybean meal (NGMO), linseed products, beet pulp, apple pomace, potato protein, wheat, cellulose, mineral and vitamin premix, molasses.

**Remarks**

- Given values are calculated averages in air-dry feed.
- Gross and metabolizable energy calculated according to Kamphues et al. 2009, digestible energy calculated according to NRC Horses 2007.
- Digestible energy calculated according to NRC Horses 2007.
- Net energy for lactation calculated according to PMV Art. 13 Anhang 6.6.
- Nutrients are subject to natural variation of the raw materials and their production process.

**OUR FEED RECOMMENDATION**

- The feed is suitable for supplementing a diet based on roughage (depending on the species grass hay, alfalfa, browse, etc.)
- Always provide free access to fresh drinking water.
- Benchmark: 0.5-1.5% of body weight per day in addition to hay ad libitum throughout the day.
- Not suitable for sheep and other copper sensitive herbivores due to the addition of copper (3 ppm in total).
- Unless soaked, this feed is less suitable for equids and animals with a tendency to esophageal obstruction because of expanding fibers (especially beet pulp).

We are happy to work with you to create individual feeding recommendations for the respective species.