*– Poster presentation –*

# New components of browser nutrition in Dvur Kralove Zoo

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Over the last five years, we have made intensive efforts to improve the nutrition of browsers in our Zoo. We concentrated mainly on black rhinos (*Diceros bicornis*), as we observed that animals in the second half of their lives showed a loss of condition at the end of winter/ start of spring and had problems with weight loss, skin lesions and lower immunity. As this is the time of year when we experience a critical lack of fresh browse, we investigated the possibility how to compensate this food during this season. Therefore we introduced two new components - Jerusalem artichoke and browse silage. We trust that our efforts were successful, because the spring condition of our black rhinos improved and this is why we would like to present some of our experiences.
In 2003 we started to feed chopped Jerusalem artichoke tubers also to giraffes (*Giraffa camelopardalis*), stems with leaves to gorillas (*Gorilla gorilla*), orang-utans (*Pongo pygmaeus*) and elephants, browse silage to elephants.

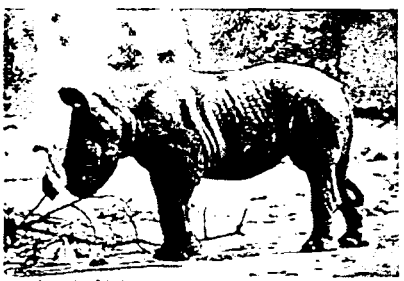

**Figure 1) Black rhinos get acquainted with browse at very young age**

Jerusalem artichoke, sunchoke, topinanbour (*Helianthus tuberosus*)
Family: Asteraceae/Compositae (aster/daisy family)
Jerusalem artichoke is a type of sunflower that is grown for its edible tuberous roots as well as its pretty yellow flowers. This is a large, gangly, multibranched perennial with rough, sandpapery leaves and stems, and numerous yellow flowerheads. It can get 3m tall and its branches can spread to nearly as much. The edible tubers are produced just below the ground on thin white rhizomes. They are segmented and knobby, 2.5-10cm long, and have crisp, white flesh. More than a dozen cultivars have been selected and named. Jerusalem artichoke grows wild in North America. Its original distribution is not clear because it was widely spread by Native Americans who cultivated it for the edible tubers.
Jerusalem artichoke is very easy to grow in almost any loose, moderately well drained soil.
Light: full sun to partial shade. Moisture: regular garden watering gives the best tuber production, but they can tolerate dry periods if they have to. Propagation: propagate Jerusalem artichokes from the tubers. Usage: Jerusalem artichoke is an attractive sunflower that works well in perennial borders and naturalistic gardens. The flowers are very attractive to butterflies and the seeds are eaten by songbirds. The edible tubers are delicious and nutritious. The tubers can be harvested anytime starting about two weeks after the flowers have faded. Expect 1-3kg of tubers per plant. Tubers can be stored fresh in a plastic bag in the refrigerator for several weeks, but it is better to leave them in the ground until you need them. Jerusalem artichokes must be brushed and scrubbed under running

water, but they do not need to be peeled. Raw Jerusalem artichokes have a sweet nutty taste which has been likened to Brazil nuts. They are especially good grated into fresh salads, and are perfect for dieters. Boiled and mashed they are rather similar to potatoes, and they can be used like potatoes in most recipes. Unlike potatoes, Jerusalem artichokes do not contain starch, but instead inulin, which is a type of oligofructose. Inulin tastes sweet and satisfies like starch, but is not digested and can be tolerated by diabetics. Jerusalem artichokes average less than 120 calories per cup.


Figure 2) Jerusalem artichoke - flowering stems

## About inulin and prebiotics

*Prebiotics*
An alternative approach to increase the numbers of beneficial bacteria in the intestines, is the addition of prebiotics to foods. These are substrates which have a specific stimulant on the growth of beneficial bacteria already resident in the colon. Suitable substrates for such bacteria are selected forms of soluble dietary fibre.
Inulin is one of these. Prebiotics are insensitive to digestive enzymes and will reach the colon intact and without losses. In the colon inulin is hydrolysed and fermented by specific caecal and colonic bacteria and it has been found, both in vitro as well as in vivo experiments, to have prebiotic properties with respect to certain beneficial species of bifidobacteria; in other words inulin has bifidogenic characteristics. At the same time some potential pathogenic strains like *Clostridium* sp. and *E. coli* are significantly reduced.

*Inulin*
Inulin is a natural prebiotic, a polymer of fructose containing short chains of fructooligosaccharides. It is a natural stock carbohydrate of plants. It has always been part of vegetal nutrition of both humans and animals.
Main sources of inulin:
Onion and leek - 2-10%
Garlic - 9-16%
Dandelion leaves - 12-15%
Jerusalem artichoke tubers - 16-20%
Chicory roots - 15-20%
Pure inulin is obtained from chicory roots by means of hot-water extraction.
Examples of beneficial effects of inulin proven in humans:

- stimulates growth and enzymatic activity of natural intestine bacteria, reduces numbers of pathogenic bacteria (*Escherichia, Clostridium*)

- the healthier intestine microflora promotes immunity, prevents from inflamations, colon-cancer and intestine infections;
- reduces colonic pH and the amount of toxic metabolites like ammonia, phenols;
- reduces fat absorbtion and decreases blood-cholesterol levels;
- stays intact during the passage of small intestine, it does not increase the blood-glucose level
- the caloric value is 0-1,5kcal (6,3kJ)/g
- significant increase in mineral absorbtion (up to 2/3), particularly calcium and magnesium

**Inulin in the diet of Dvur Kralove black rhinos since spring 2001**
November - March: feeding pure Inulin min. 50g/animal/day
March - May: feeding Jerusalem artichoke tubers 1kg/animal/day = 100-150g of inulin/day
July - September: feeding Jerusalem Artichoke green stalks with leaves, approx. 3kg/animal/day = 60-80g of inulin/day

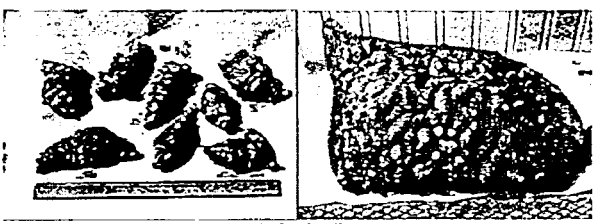

**Figure 3) and 4) Jerusalem artichoke tubers ready for feeding**

Questions
- What is the influence of Inulin at browser intestine flora and which doses are efficient?
- Are there identical or similar effects as described in humans?
- Which quantity of prebioticts is contained in common zoo-browse?
- Are the levels of oligosacharides in leaves variable throughout the year?
- What are the contents of prebiotics in natural food of browsers?

**Browse silage - published European experience**

*Zurich method*
Hatt and Clauss (2001) described, in EAZA News Special Issue on Zoo Nutrition II, how silage is made at Zurich Zoo Leaves and twigs of willow, hazel and maple are processed in a chaff cutter and then stored under pressure in 200 litter plastic containers, air-tightened and stored at a temperature not above 20°C. After six months, it is fed to their black rhinos.

*Rotterdam method*
In autumn of 2001, Rotterdam Zoo started harvesting willow browse. The cut willow branches are about 1m long, and the diameter of the branches are 1-2cm. The willow branches are bailed through a bailing machine, under similar pressure as hay being bailed. The bales are double wrapped in plastic and the dimensions are 100 x 50 x 35cm, weighing between 45 and 50kg. Due to the pressure of the bailing machine and the plastic wrapping machine, most air gets excluded from the willow bales. Every bale has to be checked to ensure no branches have pierced the plastic wrap. All holes are repaired using plastic tape.

Table 1) Chemical analysis of browse (willow, hazel and maple) before and after silage process

| | | Before | After |
|---|---|---|---|
| Dry matter (DM) | % | 47.8 | 46.8 |
| Organic matter | %DM | 96.4 | 96.2 |
| Crude protein | %DM | 4.9 | 5.3 |
| Crude fat | %DM | 1 | 1.3 |
| Crude ash | %DM | 3.6 | 3.8 |
| Crude fibre | %DM | 51.6 | 53.2 |
| ADF | %DM | 60.1 | 63.7 |
| Lignin | %DM | 14.7 | 16.6 |
| Cellulose | %DM | 45.4 | 47.1 |
| Gross energy | MJ/kgDM | 18.8 | 19 |
| Calcium | %DM | 0.9 | 0.9 |
| Phosphorus | %DM | 0.1 | 0.1 |

**Browse silage - Experience of Dvur Kralove Zoo**

For the needs of Dvur Kralove Zoo, we decided to apply the method of Zurich Zoo. The leaves and branches are harvested as late as in September, when they have matured well and contain only little water. After being processed in a chart cutter, the plant material is put in containers of 120l each (for easier manipulation). According to our experience, the best quality of silage (free of fungi and microbes) is obtained from goat willow (*Salix caprea*). So far, we have fed the silage to black rhinos for four years at a dose of half a bucket/animal/day, from December till March.

In 2004, we produced 1,900kg of browse silage.

Figure 5) Preparation of browse silage in Dvur Kralove Zoo (1)

Figure 6) Preparation of browse silage in Dvur Kralove Zoo (2)