Nutritional and energetic studies on captive Eurasian otters (*Lutra lutra*)

**Papers of Ph.D.**:

- Energy requirement: „Energy and digestive efficiency of captive Eurasian otters (*Lutra lutra*)“

- Digestibility: „Digestive efficiency in Eurasian otters (*Lutra lutra*) and investigation on chromium oxide as marker“

- Mink as model: „Comparison of digestibility and passage rate of diets in Eurasian otters (*Lutra lutra*) and mink (*Mustela vison*)“

- Comparison ex-situ / in-situ: „Comparison of the nutrient content of ex-situ and in-situ diets of Eurasian otters (*Lutra lutra*)“

- Reference values: „Dietary influence on urinary minerals, metabolites and amino acid concentrations in Eurasian otters (*Lutra lutra*)“

- Renal calculi: „Dietary risk factors for urate urolithiasis in Eurasian otters (*Lutra lutra*)“
Energy: “Energy and digestive efficiency of captive Eurasian otters (Lutra lutra)”

Objective:
- optimal supply with energy on the basis of digestible energy
  ➔ determining the apparent digestibility (AD) of energy for various diets
  ➔ Kilojoule per kg metabolic body mass per day (kJ/kg BM $^{0.75}$/ day) on AD basis
  ➔ considering season and gender

Results:
- mean AD of energy of all diets: 81% (68% for chicken to 86% for fish)
  ➔ differed between diets and must be considered for diet calculation!!
- the digestible energy intake was in average 720 kJ/ kg BM $^{0.75}$/ day
  ➔ high energy demand
- during summer only a light decrease in comparison to winter season
  (691 to 721 kJ/ kg BM $^{0.75}$/ day on AD basis)
- females have higher energy demands than males
  (738 and 698 kJ/ kg BM $^{0.75}$/ day on AD basis)
Digestibility: „Digestive efficiency in Eurasian otters (*Lutra lutra*) and investigation on chromium oxide as marker”

**OBJECTIVES:**
- Testing the suitability of chromium oxide as marker for *Lutra lutra*
- Digestibility coefficients (AD) for different diets for dry matter, crude protein, crude fat and crude fiber to allow the adjustment of feeding stuff and ration composition to the requirements

**RESULTS:**
- Chromium oxide is a suitable marker for *Lutra lutra*
- The mean AD for dry matter was 77%, for crude fiber 57%, protein 84%, fat 85%.
- ADs differed within the diets this must be considered for diet calculation!!!
- Otters have low digestibility coefficients in comparison to other carnivores

marker chromium (III) oxide
**Mink as model:** „Comparison of digestibility and passage rate of diets in Eurasian otters (*Lutra lutra*) and mink (*Mustela vison*)“

**OBJECTIVES:**
- Comparing digestive physiology to allow taking over the various scientifically based dietary recommendations of mink for the otter

**RESULTS:**
- passage rates: are little bit shorter in otters than in mink
- digestibility: are little bit lower in otters than in mink

→ in comparison to other species:
  - both species show low digestibility values as well as short passage rates

→ by keeping the small differences in mind, the dietary recommendations for mink (NRC recommendations) can be taken over for the otter!
**comparing ex-situ / in-situ:** „Comparison of the nutrient content of ex-situ and in-situ diets of Eurasian otters (*Lutra lutra*)“

**OBJECTIVES:**
- Receiving manifestations on feeding mistakes in the keeping of otters through comparing the nutrient intake in the wild and in zoos

**RESULTS:**
- used feeding stuffs in zoos are very different from the prey spectrum in the wild
- nutrient concentrations of zoo diets are significantly different for many nutrients as otters absorb in the wild:
  -> nutrient levels in the zoo diet exceeded the in-situ dietary fat content and vitamin A and B1. The in-situ diet was higher in protein, zinc and vitamin E
  
  ➡️ Caution with the supplementation of vitamin A in zoos is proposed as well as the deficiency of vitamin E

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Example of a zoo diet in Europe
Reference values for urine:

„Dietary influence on urinary minerals, metabolites and amino acid concentrations in Eurasian otters (Lutra lutra)“

Values measured in the urine:

+ uric acid
+ allantoine
+ ammonium
+ phosphate
- citrate
- oxalate
+ calcium
+ magnesium
+ potassium
+ sodium
amino acids

+ = influenced from diet
- = not influenced from diet
Renal calculi: “Dietary risk factors for urate urolithiasis in Eurasian otters (Lutra lutra)”

• Renal calculi almost exclusively from ammonium urate in Lutra lutra

• Occurrence of renal calculi in the wild: up to 23%
  Occurrence of renal calculi in zoos: up to 69%

OBJECTIVES:

→ finding reasons for the high occurrence of renal calculi

→ give recommendations for minimizing the risk for calculi in captivity

• How strong depends uric acid excretion on exogenous purine intake?

• Exists a hyperuricemia?

• How high are urine pH values?

• How high is urine ammonium concentration?

→ Urine was collected quantitatively in metabolic boxes (marker: chloride)
  for 7 diet trials with different purine contents
  and tested for pH, uric acid, ammonium, allantoin
RESULTS:

• concentration of uric acid in urine: 3.28 mmol/l urine -> high values

• urine pH: in average 6.14 -> very low

• ammonium concentrations: in average 103 mmol/l urine -> high values

  ➔ equivalent to the 3 main risk factors known for ammonium urate calculi from other species (Dalmatian dogs and humans)

• purine is metabolized to uric acid and purine content strongly correlates with uric acid excretion

  ➔ uric acid excretion - as one of the main factors for uric acid calculi – is controllable through the purine content in the diet

Feeding RECOMMENDATIONS for keeping institutions to avoid calculi:

• avoidance of feeding stuff with high purine content (e.g. herring, yeast, innards)

• proteine feeding should be close to the demand to control ammonium production

• (increase of urine pH e.g. through potassium citrate or calcium carbonate)
Results with values and descriptions for calculation of rations:

- **Optimizing the nutrition of captive Eurasian otters** *(Lutra lutra)*
  (parts of PhD-thesis: Ruff, K. (2007))

- "**Nutritional and energetic studies on captive Eurasian otters** *(Lutra lutra)"
  (complete PhD)
  Free download: http://edok01.tib.uni-hannover.de/edoks/e01dh07/541491776.pdf

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