

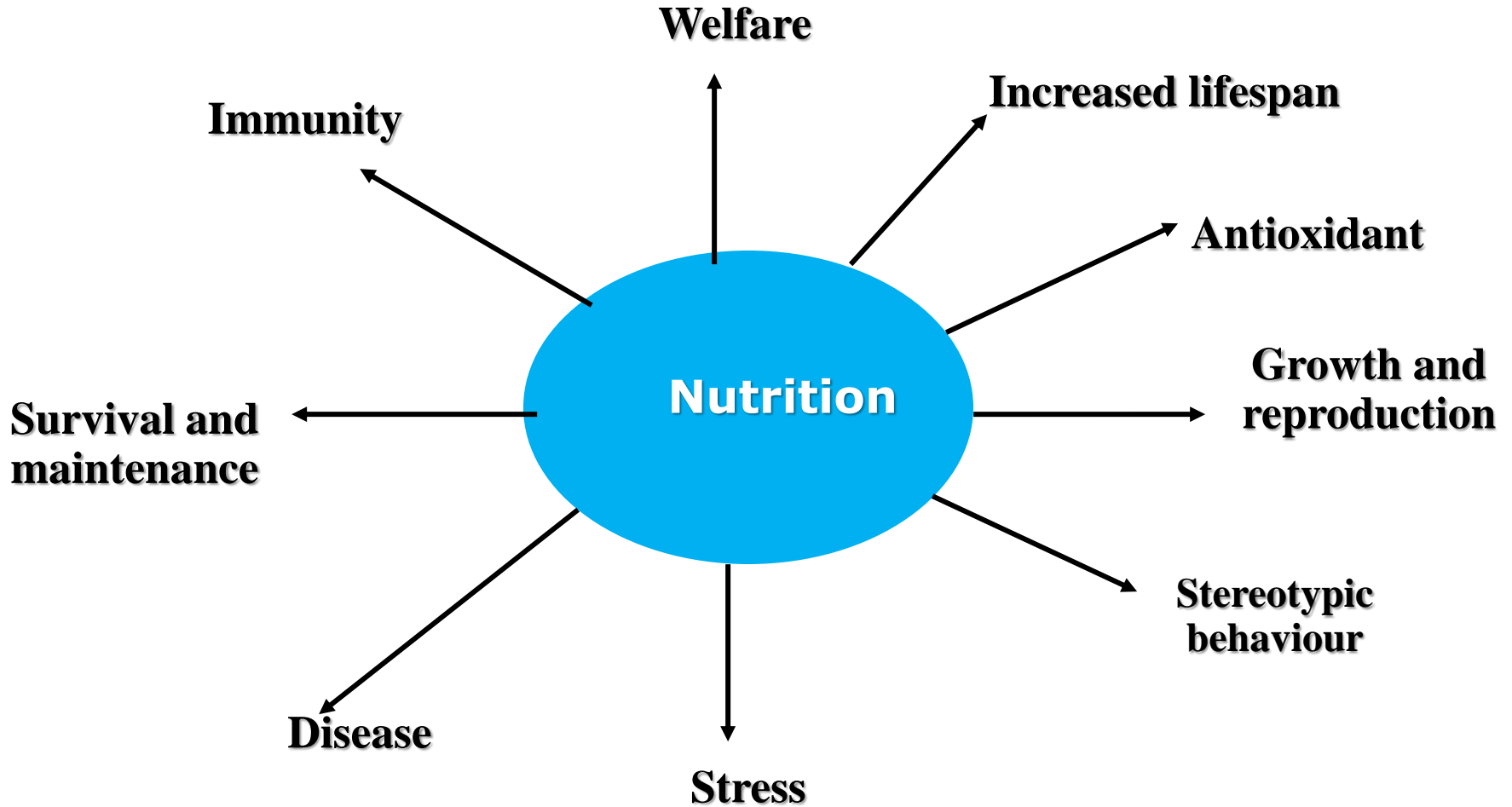
ANIMAL DIET: EXISTING SCENARIO AND FUTURE COURSE (ANN-607)



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Nutritional disorders kill slowly and smartly so as the ultimate blame goes on to some other pathological agent.

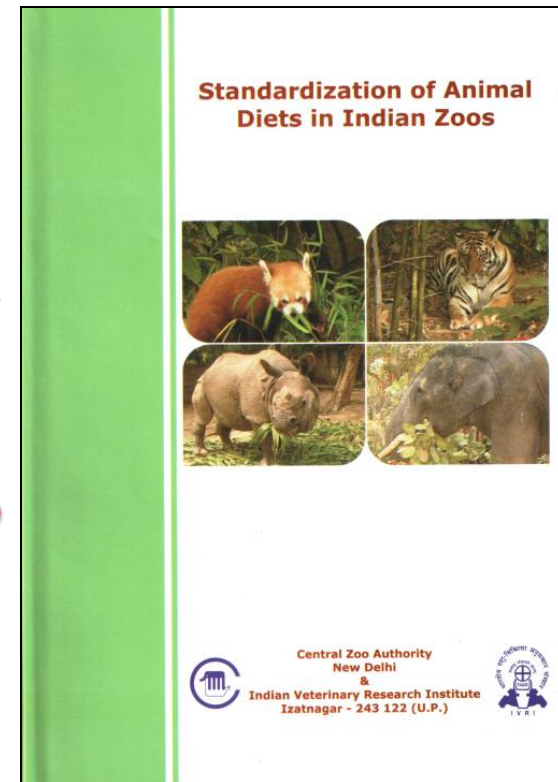
Strength

1. Feeding of natural feed ingredients
2. Adequacy of Ca in captive carnivores diet
3. Behavioural stimulation and attempts towards enrichment

Weaknesses

1. Excessive feeding of grains and concentrates to herbivores
2. Excessive feeding of meat to carnivores
3. Micronutrients (especially Zn and Cu) deficiency was widespread among herbivores

Book published by CZA

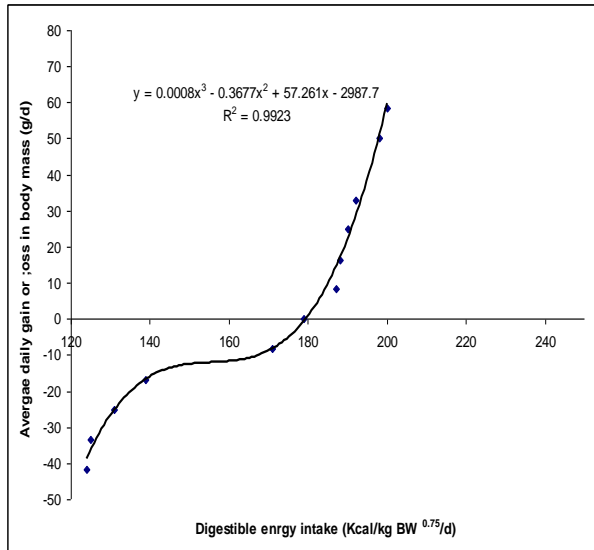


•34 zoos

•50 species of birds, reptiles and mammals

•Nutrient analysis, digestion and feeding trials

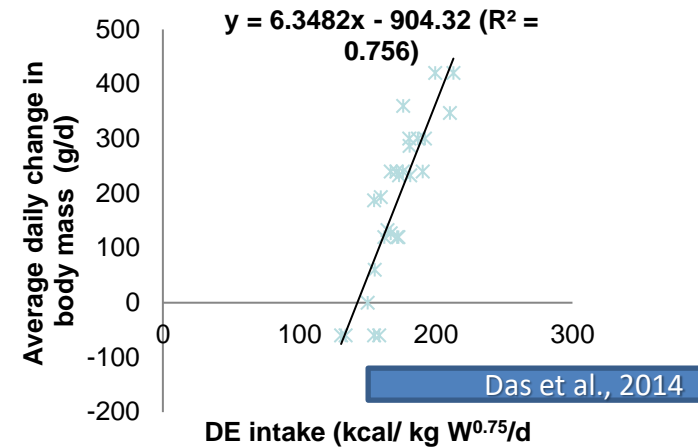
Understanding the energy needs of zoo animals



Spotted deer

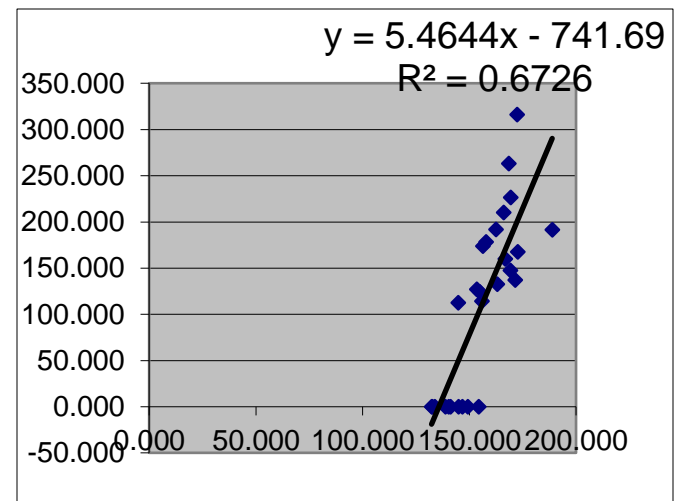
Suresh et al., 2013

Relationship between digestible energy intake (kcal/ kg BW^{0.75}) and average daily change in body mass (g/d) in captive herbivores



Das et al., 2014

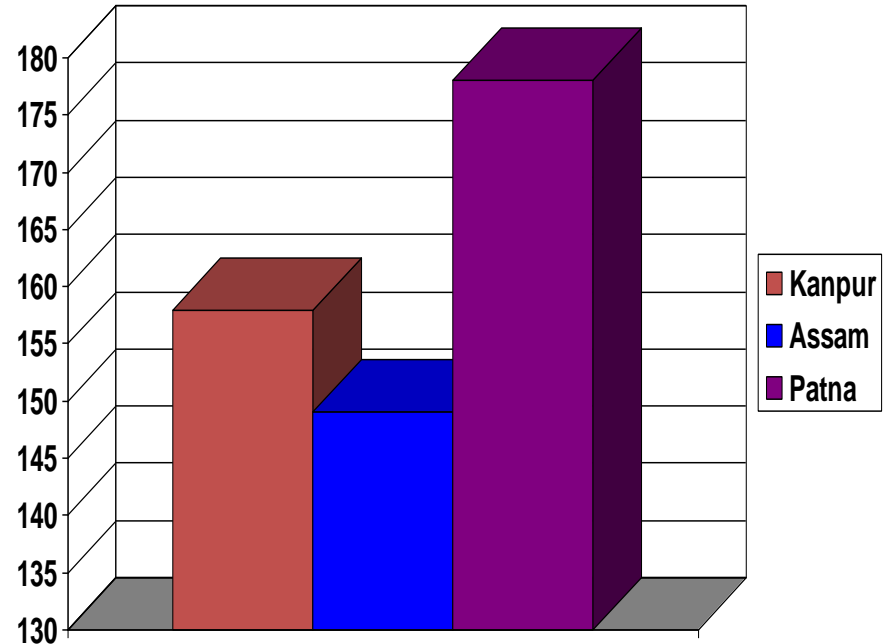
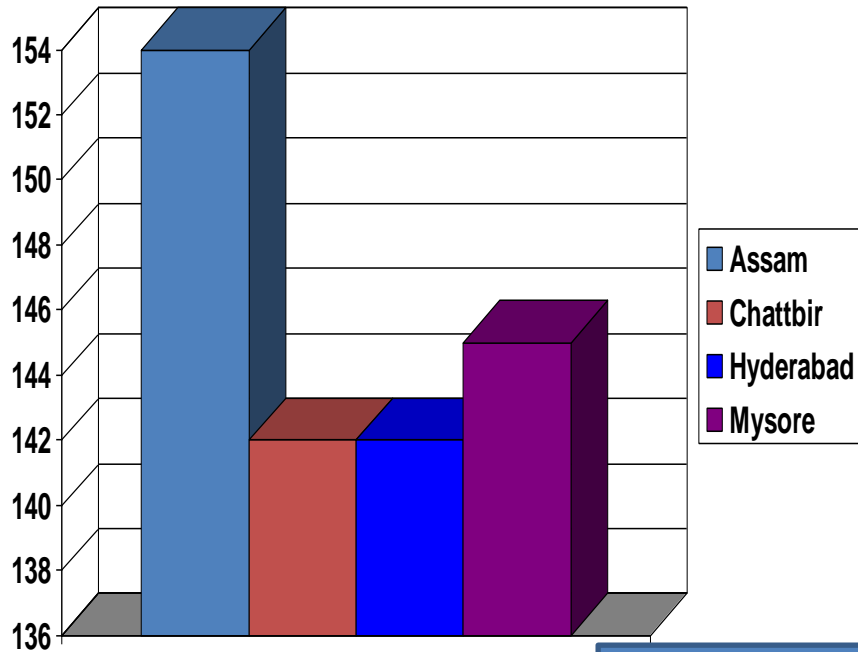
Asian elephant



Indian rhinoceros

Kumar, 2013

DE intake (kcal/kg BW 0.75/d) by elephants and rhinoceros in different zoos



Das et al., 2013b

Are mega-herbivores in Indian zoos receiving extra
calorie????

Feeding of grains and concentrates

- How much is too much ???

| Species | Desirable amount | Amount being fed |
|--------------------|---|------------------|
| Spotted deer | 0.50 kg | 1- 2.3 kg |
| Blackbuck | 0.25 kg | 0.25-0.80kg |
| Swamp deer | 1.0 -1.25 kg | 1.5 kg-2.5 |
| Brow antlered deer | 0.50 kg | 1.0- 1.5 kg |
| Wild ass | 1 kg | 1 kg |
| Indian rhinoceros | Male (2200 kg): 3 kg Female (1600 kg): 2kg | 2.7 -9.2 |
| Asian elephant | Male (4 t) : 6 kg Female (3.5 t): 5 kg | 5-14 kg |

Concentrates should never be used as a primary source of calorie

Feeding of grains and concentrates

- Disturbed metabolism**

| Species | Attributes | | |
|-------------------------|----------------------------------|--------------------------|--------------------------|
| Spotted deer | Amount of concentrates being fed | | |
| Das et al., 2013a, 2010 | 0 | 0.5 kg/ head/ d | 1 kg / head /d |
| Glucose (mg/dl) | 97.6 ^a ±1.31 | 109.7 ^b ±1.26 | 111.5 ^c ±1.03 |
| Cholesterol (mg/dl) | 97.5 ^a ±1.00 | 106.7 ^b ±1.19 | 111.0 ^c ±1.17 |
| Elephant | Amount of concentrates | | |
| Das et al., 2014 | 0.18% BW | 0.12 % BW | 0.06% BW |
| Glucose (mg/dl) | 74.8 ^a ±0.49 | 69.7 ^b ±0.91 | 65.7 ^c ±0.80 |
| Cholesterol (mg/dl) | 85.3 ^a ±5.66 | 83.1 ^a ±3.65 | 68.1±2.95 |

Consequences of feeding excessive concentrates

1. Rumen dysfunction

2. Disturbed metabolism

3. Obesity

4. Reduced reproduction

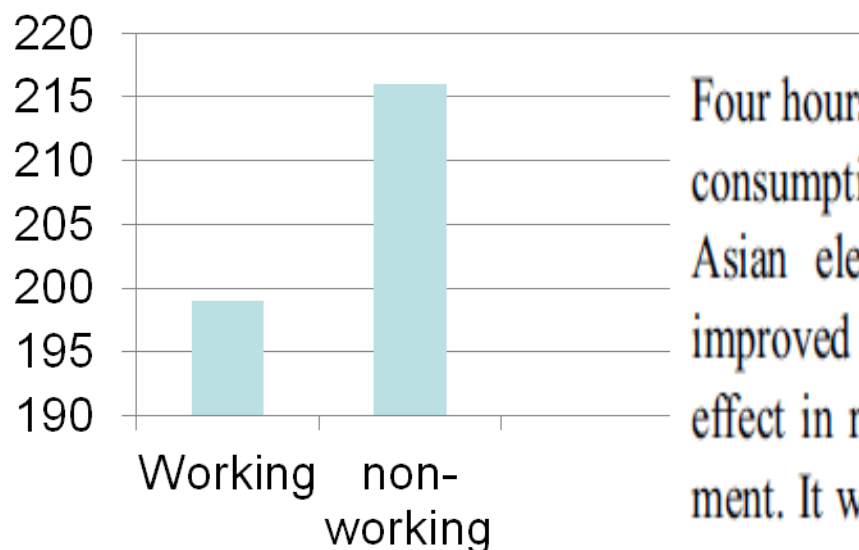
5. Hoof problems

| | Amount of concentrates fed | | |
|--------------------------|----------------------------|----------|---------|
| | 0 | 0.5% BW | 1% BW |
| Glucose (mg/dl)** | 75.80a | 96.40b | 99.00 b |
| Cholesterol (mg/dl)** | 58.60 a | 62.40 ab | 74.40 b |

Serum metabolite profile of blackbuck fed different levels of concentrates

Moderate work is beneficial for Asian elephants

DE intake per kg metabolic body size



Four hours of tourist work has no adverse impact on food consumption and blood metabolite profile of semicaptive Asian elephants, rather digestibility of nutrients was improved in working elephants. Work showed positive effect in restricting the calorie supply closer to requirement. It was concluded that 4 h of work is beneficial for captive Asian elephants.

Katole et al., 2013

Can roughages be fed ad lib. ??????????

| Parameters | Amount of rohini tree fed (kg/ elephant / d) | | |
|--|--|----------------------|---------------------|
| | 120 | 100 | 80 |
| DE (kcal/kgBW ^{0.75})* | 198.55 ^a | 186.07 ^{ab} | 166.37 ^b |
| Serum Glucose (mg dl ⁻¹)** | 82.83 ^a | 77.33 ^b | 73.17 ^c |
| Urea (mg dl ⁻¹)** | 28.17 ^a | 24.66 ^b | 23.43 ^b |
| Cholesterol (mg dl ⁻¹)* | 64.15 ^a | 62.82 ^b | 63.36 ^b |
| Creatinine (mg dl ⁻¹) | 1.53 | 1.383 | 1.442 |

Katole 2012

Amount of Rohini fed to semi-captive Asian elephants (3400 kg BW) should be restricted to 100 kg. Feeding of Rohini at this level ensured adequate supply of CP, Ca, P, Co, Fe and Zn to fulfill requirement of semi-captive elephants.

Feeding roughages ad lib. could be problematic

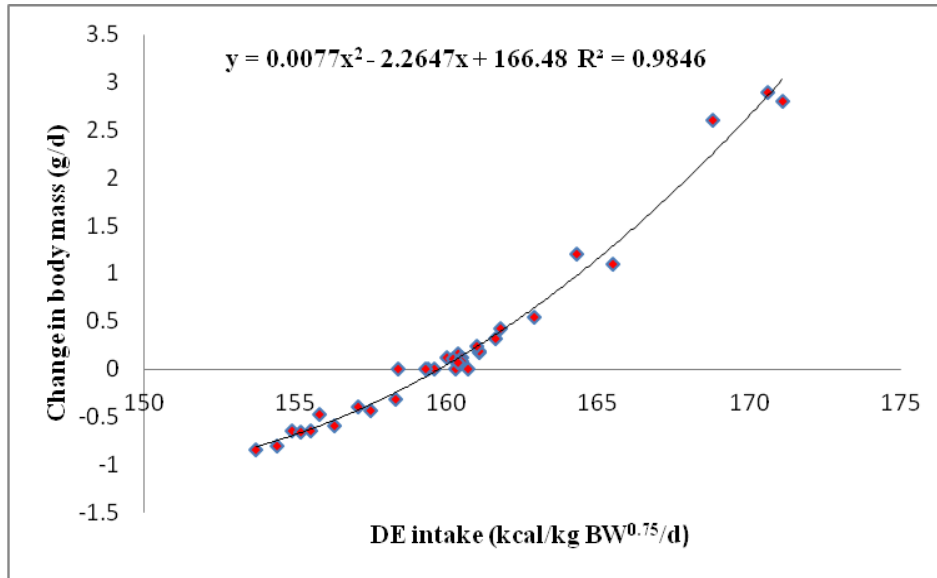
Feeding of green fodder and roughages

- Suggested guidelines according to our research*

| Species | Concentrates (~90 % DM) | Roughages (~25% DM) |
|--------------------|---|---|
| Spotted deer | 0.50 kg | leguminous fodder: 3.5 kg cereal fodder : 3 kg |
| Blackbuck | 0.25 kg | 3 kg |
| Swamp deer | 1.0 -1.25 kg | 10-12 kg |
| Brow antlered deer | 0.50 kg | 7- 9 kg |
| Wild ass | 1 kg | 15 kg |
| Indian rhinoceros | Male (2200 kg): 3 kg Female (1600 kg): 2kg | 110 kg 150 kg |
| Asian elephant | Male (4 t) : 6 kg Female (3.5 t): 5 kg | 225 kg 200 kg |

*Similar guidelines suggested for 18 species of herbivores

Understanding the energy needs of captive felids



Pradhan, 2013

Correlation between the DE intake (kcal/kg BW^{0.75}/d) and change in body mass (g/d) in captive Indian leopard (*Panthera pardus fusca*) fed conventional zoo diet

| Species | DE intake |
|-----------------|-----------|
| Leopard | 166- 182 |
| Cheetah | 150- 185 |
| Clouded leopard | 100-120 |
| Tiger | 160--251 |

DE intake (kcal/kg BW^{0.75}/d) at which captive felids can maintain body mass

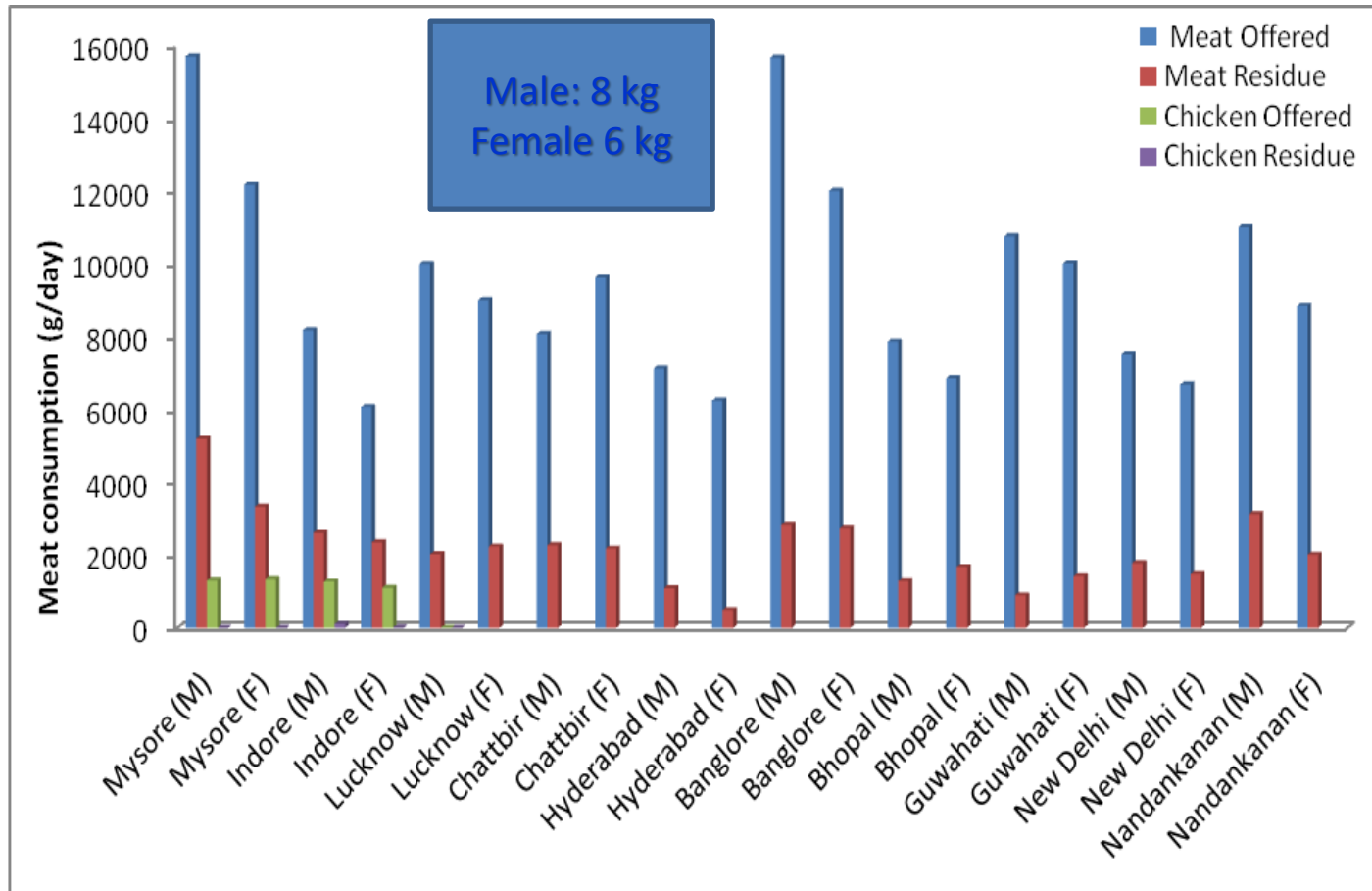
DE (kcal) intake in tigers in different Indian zoos

| Zoo | | Per day | Per kg BW ^{0.75} |
|----------|--------|----------------|---------------------------|
| Mysore | Male | 19312 | 327 |
| | Female | 17482 | 430 |
| Indore | Male | 11964.3 | 203 |
| | Female | 7988.4 | 196 |
| Lucknow | Male | 18607 | 315 |
| | Female | 15294.8 | 376 |
| Chattbir | Male | 10446 | 177 |
| | Female | 13063 | 321 |

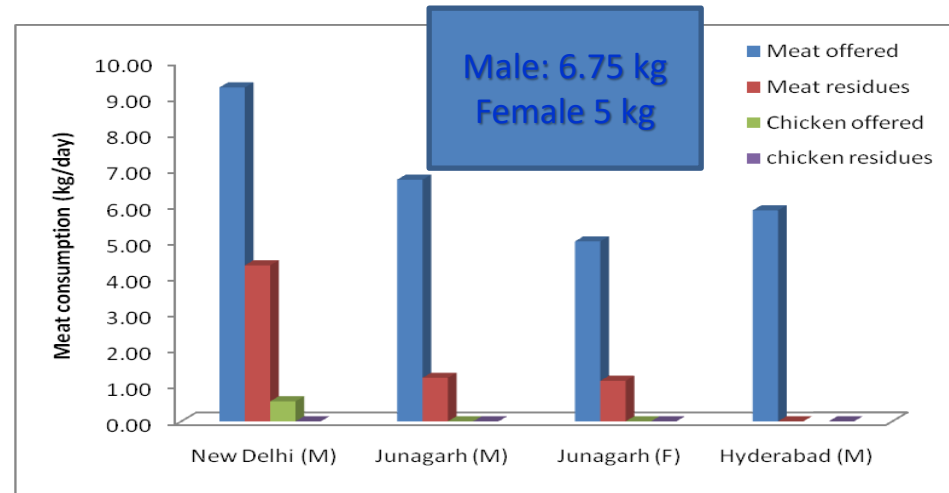
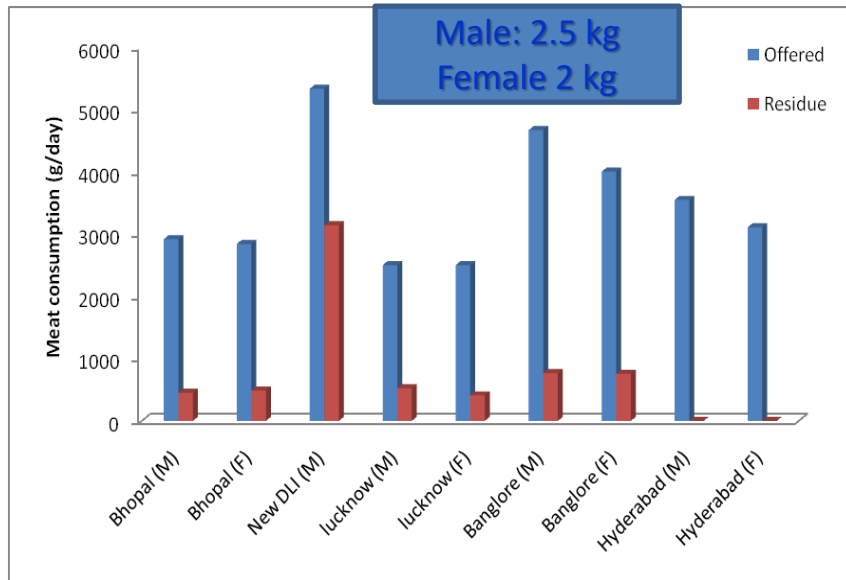
DE (Kcal) intake in tigers

| Zoo | | Per day | Per BW ^{0.75} |
|-------------|--------|---------|------------------------|
| Hyderabad | Male | 11860 | 201 |
| | Female | 11410 | 280 |
| Bangalore | Male | 26409 | 447 |
| | Female | 18394 | 452 |
| Bhopal | Male | 13644 | 231 |
| | Female | 10601 | 260 |
| Nandankanan | Male | 13293 | 225 |
| | Female | 11650 | 286 |

Feed consumption and refusals by tigers in different zoos



Feed consumption and refusals by leopards and Asiatic lions in different zoos



Meat offered and refusals in Asiatic lions at different zoos

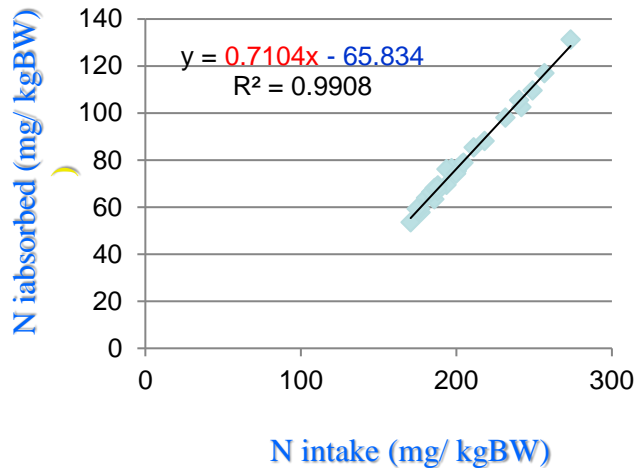
Meat offered and refusals in leopard at different zoos

Suggested guidelines for feeding Amount of meat-on- bone (kg/d) to be fed

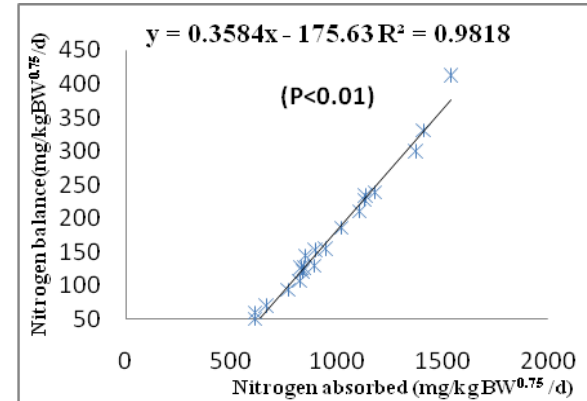
| Species | Male | Female |
|-----------------|----------|---------|
| Tiger | 8 | 6 |
| Lion | 6.75 | 5 |
| Common leopard | 2.5 | 2 |
| Snow leopard | 2.5-3.0 | 2.0-2.5 |
| Clouded leopard | 0.75-1.5 | |

- **Boneless meat must be supplemented with 7-10 g of Ca/kg meat.**
- **Vitamin fortification should be done to provide 9000 IU of vitamin A and 500 IU of Vitamin D per kg of meat on dry matter basis. Simplifying it, we can add 3000 IU of vitamin A and 150 IU of vitamin D to every kg of fresh meat.**
- **Some zoo fed liver, egg and milk as a supplement to their tiger diet. Such practices should be reassessed. It is better to use commercial vitamin supplement.**
- **Further behavioral enrichment could be provided by innovative thoughts applicable at local level.**

Estimating protein requirements of zoo animals



true protein digestibility= 0.71
MFN=65.8 mg/kg BW



Efficiency of utilization= .036
EUN= 176 mg mg/kg BW 0.75

Minimum CP requirement can be calculated as per the model of Robbins *et al.* (1993)

CP % in diet = $\{ [EUN + \text{dermal loss}) + MFN (DMI) * 6.25] / DMI / TPD \} * 100$.

Where, EUN: endogenous urinary nitrogen; MFN: metabolic faecal nitrogen; TPD, true protein digestibility

MFN can also be estimated as the fraction of fecal N that is soluble in neutral detergent solution

Intake and utilization of N in Indian rhinoceros fed three season specific diets

| Parameters | Sugarcane | Berseem | Jowar |
|-----------------------|------------------------|------------------------|-------------------------|
| N intake (g/d) | 208.23±22.27 | 361.04±40.26 | 262.95±30.98 |
| MFN (g/d) | 86.89±10.6 | 117.6±12.5 | 96.93±10.3 |
| EUN (g/d) | 35.6±3.10 | 35.77±3.11 | 35.97±3.04 |
| Total endogenous loss | 122.5±13.70 | 153.3±15.57 | 132.91±13.25 |
| CP % Diet | 5.51 ^a ±.10 | 6.44 ^b ±.06 | 5.54 ^a ±0.08 |

Kumar, 2012

- NRC (1989) recommends 8% CP for maintenance of adult horse
- NAG (1997) recommends 10-12 % CP for maintenance of adult white rhinoceros

Intake and utilization of N in Asian elephants

| Parameters | Dietary treatments | | |
|--------------------------------|--------------------|-----------|------------|
| | Group-I | Group-II | Group-III |
| N-intake (g/d) | 617±79.1 | 631±27.2 | 624±27.4 |
| N in faeces (g/d) | 396±23.3 | 390±22.5 | 391±23.1 |
| MFN (g/d) | 269±14.6 | 274±14.6 | 275±14.4 |
| EUN (g/d) | 60.7±3.43 | 60.7±3.44 | 60.6±3.43 |
| Dermal losses (g/d) | 14.8±0.83 | 14.8±0.84 | 14.73±0.83 |
| Total endogenous loss (g/d) | 344±18.8 | 349±18.9 | 350±18.4 |
| True Protein Digestibility (%) | 80.4±0.88 | 81.9±1.11 | 81.7±1.30 |
| Minimum CP (% in diet) | 5.8±0.09 | 5.9±0.09 | 6.0±0.14 |

† All the elephants were allowed to forage for 6 h/ d and were fed cut branches of Rohini tree ad lib. However, the amount of WR fed to the elephants in groups I, II, and III was 0.18, 0.12 and 0.06% of BW, respectively.

Das et al., 2014

NAG (1997) recommends 8 -10% CP for maintenance of adult Asian elephant

Intake and utilization of N in Blackbuck

| Parameter | Groups† | | |
|---------------------|--------------------------|---------------------------|---------------------------|
| | I | II | III |
| N intake* (g/day) | 8.27 ^a ± 0.25 | 12.27 ^b ± 0.30 | 16.42 ^c ± 0.36 |
| N in faeces (g/day) | 5.67 ± 0.24 | 6.27 ± 0.20 | 6.21 ± 0.12 |
| MFN (g/day) | 5.55 ± 0.22 | 5.86 ± 0.19 | 5.57 ± 0.11 |
| EUN (g/day) | 1.75 ± 0.06 | 1.71 ± 0.05 | 1.79 ± 0.05 |
| Minimum CP (% diet) | 8.28 ± 0.11 | 8.72 ± 0.23 | 8.27 ± 0.17 |

Overall, CP content of the diets was 6.9%, 10.4% and 12.7% i
respectively.

Das et al., 2012

NAG (1997) recommends 14-17% CP for medium intermediate grazers

Should we relook into the earlier recommendations or we wait for
further research data ??

CP content of diets fed to Indian Rhinoceros as compared to minimum CP content of diets required for maintenance

| Zoo | CP% in diet | Requirement |
|--------|-------------|-------------|
| Kanpur | 9.73 | 8.1* |
| | | 5.8 ** |
| Assam | 9.96 | |
| Patna | 9.32 | |

* NRC(1989) requirement for horses

** Estimated requirement for Indian rhinoceros from the present study

| CP % in diet | Roughage source | | |
|--------------|-----------------|---------|-------|
| | Sugarcane | Berseem | Jowar |
| | 7.15 | 11.53 | 8.33 |

Protein supply is dependent on season specific forage source

Intake and utilization of N is also influenced by age

| Intake and utilization of N (mg/ Kg BW^{0.75}/ d) in Asian elephants | | | |
|---|-----------------------------|-----------------------------|----------------------------|
| | Calf | Sub-adult | Adult |
| Intake | 2466 ^c ±92.1 | 2249 ^b ±33.5 | 1675 ^a ±77.5 |
| Absorbed | 1443 ^c ±48.9 | 1138 ^b ±15.5 | 812 ^a ±50.3 |
| Balance | 347.1 ^c ±33.4 | 227.5 ^b ±6.0 | 123.1 ^a ±18.9 |
| MFN losses | 714.5 ^c ±98.1 | 627.2 ^b ±19.8 | 417.8 ^a ±30.2 |
| EUN losses | 219.0 ^c ±0.0 | 189.2 ^{bA} ±0.9 | 153.0 ^{aA} ±0.0 |
| Dermal losses | 35.0±0.0 | 35.0±0.0 | 35.0±0.0 |
| Total endogenous losses | 969 ^c ±98.1 | 851.4 ^b ±20.1 | 605.8 ^a ±30.2 |
| True digestibility (%) | 82.0 ^c ±3.8 | 74.25 ^b ±1.4 | 75.8 ^a ±0.9 |
| Minimum CP%* | 9.7^a ±0.6 | 8.0^b ±0.2 | 6.0^c±0.0 |
| CP% (NAG, 1997) | 12-14 | 12-14 | 8-10 |

Are captive Asian elephant diets adequate in CP content ????

| | Guwahati | Chattbir | Hyderabad | Mysore |
|--------|-----------------|------------------|------------------|-------------------|
| CP (%) | 7.89±0.16 | 9.73±0.01 | 8.01±0.13 | 10.82±0.17 |

Ration adequacy with respect to crude protein supply

| Species | Suggested CP% | CP % in the diet being fed |
|-------------------|---------------|----------------------------|
| Cervids | 12-16 | 13.0-18.5 |
| Antelopes | 8-10 | 14.5-18.8 |
| Wild ass | 8 | 12.2 |
| Rhinoceros | 8 | 9.3-9.7 |
| Adult elephant | 8 | 7.9-10.8 |
| Growing elephants | 12 | 11.0-11.4 |
| Giant squirrel | 15 | 15.2- 16.1 |
| Monkeys | 8 | 12.0- 21.6% (LTM) |
| Langurs | 17 | 14.1- 21.5 |

Are we obsessed with feeding excessive protein to our zoo animals

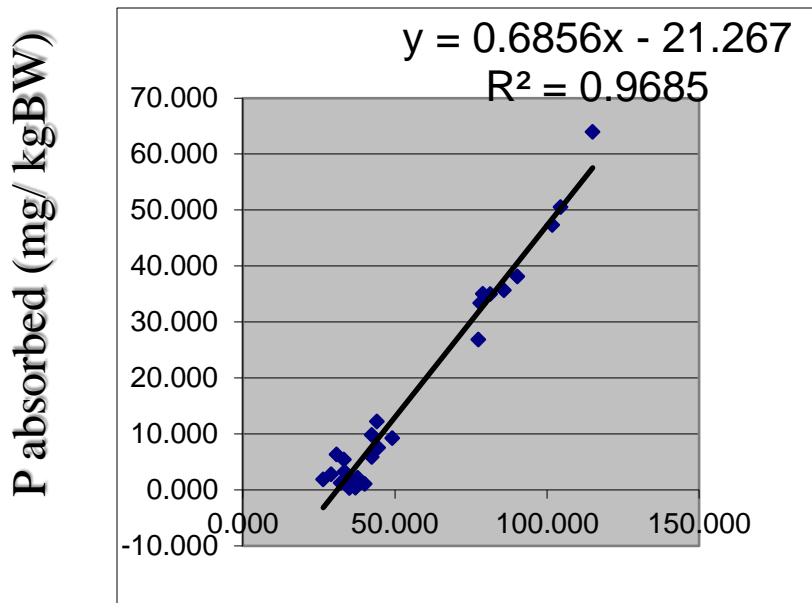
Das et al., 2013b

| Species | Suggested CP% | CP% of the diet being fed |
|--------------|---------------|---------------------------|
| Slow loris | 17 | 13 |
| Tibetan wolf | 28 | 57.4- 66.4 |
| Bear | 15 | 14.7-17,7 |
| Red Panda | 18 | 13.7 -16.5 |
| Pelican | 20-30 | 74.1-75.6 |
| Psticines | 10-15 | 12.6-14.7 |
| Hornbill | 11 | 7.2-32.2 ???????? |

Barring growing elephants, some langurs and red panda, zoo animals are generally burdened with excessive proteins

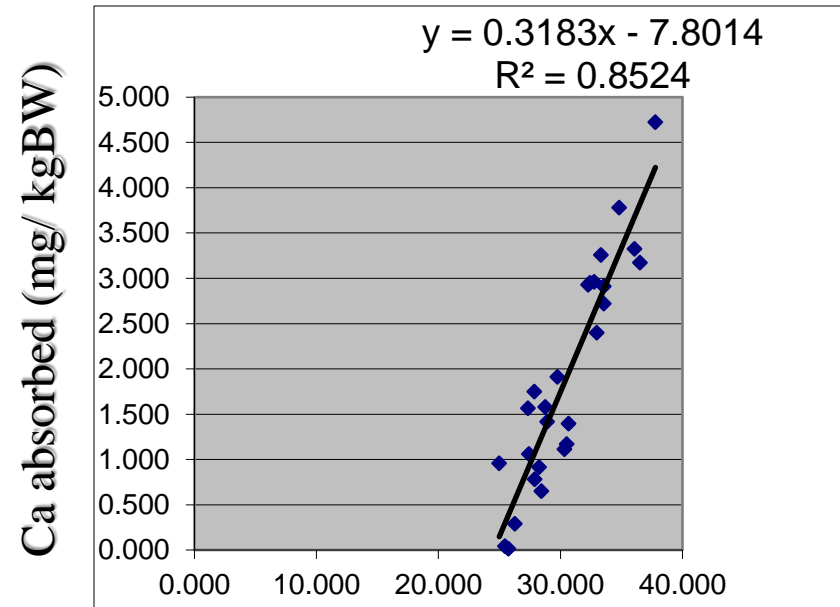
Understanding the mineral requirement of zoo animal

Correlation between intake (mg/ kg BW) and absorption (mg/kg BW) of Ca and P in Indian rhinoceros fed conventional zoo diets



Ca intake (mg/kg BW)

0.26%



P intake (mg/kgBW)

0.20%

Kumar, 2012

A comparison of the estimated mineral requirements

| | Asian elephant | | Indian rhinoceros | |
|----------------|----------------|--------------|-------------------|--------------|
| | NAG (1997)* | Our estimate | NAG (1997)** | Our estimate |
| Ca (%DM) | 0.30 | 0.23 | 0.55-0.63 | 0.26 |
| P (%DM) | 0.20 | 0.18 | 0.32-0.38 | 0.20 |
| Fe (mg/ kg DM) | 50 | 41 | 73-84 | 40 |
| Cu (mg/ kg DM) | 10 | 6.9 | 8-14 | 7.1 |
| Zn(mg/ kg DM) | 50 | 29.7 | 41-71 | 34.4 |

* Nutrition Advisory Group (NAG) recommendations for Elephants

** Nutrition Advisory Group (NAG) recommendations for white rhinoceros

Ration adequacy with respect to Cu and Zn supply

| Species | Zn requirement (ppm) | Zn content of diet (ppm) | Zn requirement (ppm) | Zn requirement (ppm) |
|----------------|----------------------|--------------------------|----------------------|----------------------|
| Cervids | 40 | 32-42 | 10 | 7.8-9.9 |
| Antelopes | 40 | 23-32 | 10 | 8-9.7 |
| Wild ass | 50 | 28.9 | 10 | 9 |
| Rhinoceros | 41-71 | 27.4-35.5 | 8-14 | 6.6-10.6 |
| Adult elephant | 50 | 20.9-30.5 | 41-71 | 8.3-11.2 |

Deficiency of Zn and Cu was widespread among captive herbivores

Conclusions

- Basic data on feed consumption, diet digestibility and utilization of macro and micro nutrients in 53 selected species is generated. Major problems identified were excessive intake of calorie, protein and deficiency of Cu and Zn in many species.
- Nutritional adequacies of diet schedules followed by different zoos have been evaluated and specific measures for improvement have been suggested.
- For further improvement, role of nutrients in improving gut health, antioxidant, immunity , reproduction and welfare of captive animals should be explored.



Thanks for kind attention!