Nutrition and food preparation for wildlife

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Abstract
The preparation of adequate, appropriate and nutritious food for wildlife is essential for successful rehabilitation. Wildlife can become unwell if good hygiene is not practiced during the preparation, presentation or storage of their food. Individuals may starve or fail to thrive in captivity as insufficient food is offered. Worse still, is that food may be offered that does not meet the nutritional needs of the individual as this can culminate in illness.
In this presentation, the following topics will be addressed:

1. Metabolic requirements associated with growth, healing. It is generally understood that the growing animal has different requirements to an adult, but it is less known the increased requirement for nutrition required for animals that are healing.
2. Understanding the role of carbohydrates, fats, protein and major vitamins. Without understanding what is the limiting nutrient in the physiology of a species, incorrect decisions about supplementation can be made.
3. Selecting, handling and storing meat and insects is important to understand to prevent the development of rickets and thiamine deficiencies, for example.
4. Hygiene for implements used in food production and storage. Inadvertent contamination of items used to prepare, give or store food items can result in infection with pathogenic agents.
5. Growing insect and other prey food items. Insects provide a readily- available source of protein – but they are only as good as the food that they are fed.

Introduction
An understanding of the importance of nutrition to wildlife is an essential part of successful rehabilitation. The wildlife rehabilitator should be able to recognise when an animal requires more food for its particular presentation. Regular weighing of the animal is a useful tool to monitor if the animal requires more or less food. Food is composed of the building blocks of protein, carbohydrates and fats. An understanding of the animal's biology is critical to providing a balanced diet. Unfortunately, too often Australian animals are fed as if they were baby humans! A good diet can rapidly become a poor diet without appropriate storage and handling.

Requirements for growth and healing
To understand requirements, a few terms need to be defined first. Resting energy requirements are those needed for maintenance – i.e. to replace lost muscle protein, maintain fat stores, grow skin/hair and for restricted activity.
Young animals require food for growth. Their energy requirements are usually twice the resting energy requirement. In other words, they need twice the amount of food in comparison with an adult of a similar size. A summary of the conditions that alter energy requirements is tabled below. Small birds and marsupials may have a much higher requirement for food than expected. It is also pertinent to consider that some species (gliders, microbats) can enter torpor voluntarily and thus reduced their requirement for food.

Table 1: physiological factors affecting energy requirements (IWRC).

Condition	Fraction of energy requirement needed
Inactive, healthy animal in cage	0.7 – 0.9
Sepsis	1.2 – 2.0
Burns	1.0 – 3.0
Trauma	1.0 – 1.2
Growth	1.5 – 3.0
Species: small raptor, songbird	2.0 – 3.0

Healing and repair are also situations where the basic requirement for food increases. If we do not meet this increased need, then a cascade of problems can occur:

- There may be delays in wound healing and fracture repair. Delays in wound healing impact on the animal by increasing scar tissue, possible fibrosis of muscles or joints and extend the time spent in care.
- There is a reduction in immunity and thus the animal becomes more susceptible to acquiring infections while in care. The natural corticosteroids are increased, also blunting the immune system.
- There are increases in resistance to insulin which can increase muscle breakdown. The consequence is an animal that has reduced muscle bulk, and this can impact on fitness and mobility.
- There are changes to the hormones governing kidney function and changes to heart function.

When all of these factors are considered, the end result is muscle weakness, a gut that does not move, and a gut lining unable to absorb further food. The consequences are an animal that is more likely to die in care from starvation or secondary sepsis.

Role of nutrients in health

We need to understand the roles of the different nutrients. What is also important to keep in mind is that there are a variety of different nutritional strategies in Australian wildlife. We also need to consider that what works for humans does not automatically work for other non-primate species. What works for carnivores (meat-eaters) is not likely to work for herbivores (plant-eaters).

Some key points about feeding wildlife:

- A variety of foodstuffs should be offered each day. This will prevent deficiencies that can exist in feeding only one food item.
- Feeding natural, whole prey items, such as fish, insects, and rats/mice is preferable to feeding artificial foods such as minced meat. Natural food items enrich the animal by allowing it to perform natural behaviours for picking up, chewing, and processing the food item. They provide a wider profile of available nutrients than artificial foods.
- Food should be offered fresh each day. If not eaten, it is discarded and not fed to another animal.
- Protected species should not be offered as food – i.e. frogs, small lizards, native rodents
- No vertebrate prey item should be fed live. Insects and feeder fish are not included.

Key nutrient groups

1. **Water** is essential for all animals and should be offered fresh each day in a container that the animal can physically access (location and dimensions). Bodies are 70% water and dehydration results in damage to many organs.

2. **Protein** is required to make muscle, feathers/fur, bone, blood and enyzmes. Proteins are made up of 20 amino acids, some of which must appear in the diet as the body cannot make them, the essential amino acids. Not all foodstuffs contain all amino acids.

   Some examples relating to Australian wildlife:

   - Seed only diet fed to parrots is deficient in the amino acid methionine and cysteine, which is required for feather growth (McDonald).

- The Brushtail possum is dependent upon protein to gain weight.
- Ringtail possums are also highly protein dependent and access this protein through coprophagy (Hume).
- Kangaroos have evolved to tolerate high variations in protein in grass as an adaptation to Australia's boom-bust climate (Hume) without scouring like cattle or sheep.

3. **Carbohydrates** are composed of cellulose, starches and sugars**.**
   - **Cellulose** is the indigestible plant fibre that herbivorous animals can break down using bacteria fermentation to obtain energy.
   - **Starches** are digestible forms of carbohydrates but are not commonly available to wild species. Examples of starches include seeds and grains, items eaten by mainly bird species.
   - **Sugars** include fructose, glucose and sucrose. Lactose is a complex sugar and marsupials lack the enzymes to effectively break it down, and thus are lactose intolerant.

   Some examples relating to Australian wildlife
   - Wombats are dependent upon high cellulose diets as they digest plant fibre for energy (Hume).
   - Sugar gliders have a small stomach designed to absorb a highly digestible high sugar diet
   - Flying foxes crush fruit to obtain the nectar and are unable to digest the fruit fibre.

4. **Fats** are required by all animals, but at low concentrations. Essential fatty acids play a role in many cell pathways, including inflammation. Fats may be accessed for carnivores by eating the fats present in prey. Herbivores obtain oils from plants.

   Some examples relating to Australian wildlife
   - Koalas can detect very low concentrations of aromatic oils present in eucalyptus leaves. These oils are toxic to koalas and smell plays an important role in detecting leaf with lower levels for consumption (Hume).
   - High fats present in sunflower seeds lead to liver failure in Australian parrots when fed as parrots have not evolved in the presence of seeds with high fat content (McDonald).
   - Echidna young require high fat diets for growth. Failure to provide these levels of fats in young echidna results in stunting and death.
   - Blue tongue lizards accumulate fat in their tails to use while they aestivate over winter when insect numbers are low.

5. **Vitamins** are organic compounds that are not made by the body. They are essentially very unstable and susceptible to alterations in light, pH and exposure to oxygen. Vitamins are required by many organs to function. There are two classes of vitamins:

   Water soluble vitamins: B, C: toxicity is rare as they are excreted through the urine.

   Fat soluble vitamins: A, D, E, C, K. Toxicity is possible as these are stored in the liver and fat of the body

   Some examples relating to Australian wildlife:
   - Vitamin A toxicity is possible as most parrots recognise and use the pre-form of Vitamin A and cannot regulate formed Vitamin A.
   - Fruit bats (on other continents) cannot make vitamin C.
   - Thiamine B1 supplementation is required for animals being fed thawed frozen fish (McDonald).
   - Marsupials and birds can make their own Vitamin C, unlike primates and guinea pigs.

Table 2: Vitamin deficiencies in animals (Fowler, 2012)

Vitamin	Source	Deficiency probability	Signs of deficiency
A	Dark green leaf, liver	High – birds on all seed diet, carnivores on meat only diet	Changes to lining of gut, respiratory tract,
B1	Grains, greens	High on meat only diet, honey-water diet for insectivorous honeyeaters	Neurological signs
B6	Fish, grains, greens	Low	Poor immune system, neurological signs
B12	Meat, milk, seeds	High with chronic diarrhoea	Diarrhoea
C	Able to synthesise in body	Unlikely as marsupials and birds can make their own	N/a
D	Bones, liver, kidney	High on meat only diet in carnivorous birds	Folding fractures of bones
E	Liver, seeds	Possible in birds on seed only diets, marsupials grazing pasture	May have impaired immune system
K	Green leafy veges, liver	High in birds on seed only diet.	Unable to clot blood

6. **Minerals** are also required for cell function. As one mineral can compete with another, overdosing on one can lead to deficiencies in others. At least 20 minerals are considered to be essential. Calcium is the mineral where deficiency is seen most commonly, particularly in growing animals. Meat contains 1/20th of the calcium needed by animals.

   Macro-minerals include calcium, phosphorous, sodium, magnesium, potassium, chloride and sulphur (Hand & Novotny).

   Micro-minerals include iron, zinc, idodine, selenium, copper.

Table 3. Mineral deficiencies in animals (Fowler, 2012)

Mineral	Source	Deficiency probability	Clinical signs of deficiency
Magnesium	Milk, vegetables, meat	Low	Muscle cramps, restless – only seen on cattle on young pasture
Selenium	Australian soils are deficient	Moderate, avoided with supplementation e.g mac pellets, hand-rearing mix	Anaemia, poor coat. Reported in cattle.
Iron	Meat, dark green veges, fruits	Low, excess is more likely	Anaemia – reported in calves on milk
Zinc	Nuts, grain, meat, fish	Low	Dermatitis
Manganese	Grains, greens, meat	Low	Weight loss, slow growth
Calcium	Bones, dark green veges, leaf	High if feed meat only	Broken bones
Cobalt	Meat	Low	Cofactor for B12 - diarrhoea
Iodine	Meat, milk	Low,	Affects thyroid gland
Fluoride	plants	Toxicity is more likely	Enamel loss on teeth

Some examples relating to Australian wildlife:

- Tasmanian devil pups fed on meat only diets are highly susceptible to calcium deficiency and may develop broken bones. A suitable diet for this species is whole prey items.
- Fluorosis toxicosis has been seen in Eastern Grey Kangaroos in close proximity to aluminium smelters.
- Iron levels are low in most marsupials and Australian birds. Supplementation with human infant vitamins leads to liver failure from iron accumulation.
- Selenium levels are low in Australian soils. However, low levels of selenium were seen in Quokkas and associated with muscle disease.

Storing food items

Food that is stored starts to have a reduction in quality and nutrients lost over time. Some recommendations are summarised below:

- Store powders such as milks in an air-tight container, preferably that of the manufacturer. They should be stored in a dark, dry environment. Avoid contact with light and air.
- Reconstituted milk or hand-rearing formulae should be made up fresh each 24 hours and refrigerated. Only sufficient for the feed should be removed. Any excess is discarded, not returned to the remainder in the refrigerator.
- Food should be used well before the expiry date. This date should be recorded on the container.
- Vegetables should be stored in refrigeration, particularly if there is to be a delay in offering them. Fruits may be refrigerated or left at room temperature. No fruit or vegetable should be offered if it is not suitable for human consumption. Mouldy, soft or decaying food should not be fed.
- Small prey items should be frozen for no longer than three months.
- Insects should be frozen for no longer than three months.
- Large meat items can be stored for up to twelve months if kept at less than -23 ºC.
- Any meat item that is refrigerated is discarded if not fed after 24 hours. Thus all meat items are frozen in likely portion sizes.
- Meat, fish and prey items are thawed in the refrigerator at 4 ºC. Even thawing at a temperature of 10 ºC is sufficient to grow bacteria.
- Thawing in water is not recommended due to the loss of nutrients. If an emergency thaw is needed, the meat is placed in a sealed bag and placed into a water bath.

Fresh or frozen prey items should be selected by assessing the various factors tabled below. If you do not feel that the meat is acceptable, it should not be fed to the animal. At best, it may lack nutrients. At worst, it may contain harmful bacteria that result in gastroenteritis, sepsis or death.

Table 4: Factors considered when choosing meat (US Dept of Ag).

Factor	Acceptable	Inferior	Unacceptable
General	Meat – cherry red Prey- shine to skin, no bloat, or guts out	Meat – brown Prey – loss of shine	Meat – brown, slimy Prey – lustre gone Guts out of abdomen
Eyes	Prey – translucent, full, slight shrink	Prey – dull, cloudy, slight sunken	Prey – dull, sunken, white cornea
Odour	Fresh	Mild sour	Strong to putrid odour
Feel	Meat – firm, elastic Prey – firm, elastic, touch but indent not stay	Meat – soft Prey – soft, indent stay	Meat – slimy, soft, mushy Prey – soft, spongy, flabby, skin split when handled

Growing foods

There are a variety of foods that can be grown at home, and either fed fresh or frozen. These food items provide variety and environmental enrichment. However, as food items, they are only as good as the food that they are fed. A starved, chilled mealworm or cricket fed mouldy carrot, are not suitable food items to feed. These colonies should be maintained to provide food of a high quality.

- **Rats and mice** are housed in well-ventilated, wire cages. A substrate of sawdust or wood shavings is suitable. They should be offered rat/mouse cubes and not seed mixes (high in fat). Vegetables can be offered but cheese, breads should be avoided.
- **Mealworms** are housed at 25 – 30º C on bran or pollard. They are offered green leafy vegetables weekly. Mouldy, dried food items are discarded.
- Crickets are housed in a plastic tub at 25 – 30 ºC. Egg cartons provide a hide. Vermiculite can be used as a substrate. Offer green leafy vegetables twice weekly. They should be offered water. A suitable powdered food is Vetafarm Herpaboost powder or Wombaroo Insect booster. Dog kibble can be offered, but not if you are feeding frogs as it is too high in fat.

- Earthworms can be grown in a worm farm or compost bin. Worms are fed regularly with house-hold scraps, avoiding meat and bones.
- Growing fruits – in the tropics, mango, papaya and other fruit trees can be grown to feed wildlife.
- Planting trees and shrubs. Shrubs such as Grevillea, Callistemon and Hakeas can be grown for their flowers. Eucalypt, wattle and tea tree could also be grown if sufficient space is available.
- Natural harvesting of seasonal insects, such as moths, locusts and beetles can be done. Insects can also be harvested from the garden when gardening.
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Hygiene practices with food

It is imperative to wash hands prior to the preparation of foodstuffs for animals. Ideally, animal foods (such as frozen prey items) should not be kept in a fridge with food for human consumption. Chopping boards should be dedicated to meat/fish or fruit/vegetables. Uneaten food should be removed daily. Leaf in browse pots should be changed at least every second day and the water in the pots changed daily. Food bowls should be washed daily. They may be run through a dishwasher cycle, or hand-washed in hot water and detergent, and follow the disinfection procedure below.

Procedure for cleaning feeding utensils (Fowler, 2012)

1. **Rinse the utensils (bottle, teat) in cold water after use.**
   Reason: immediate rinse prevents milk sticking to plastic/glass. Cold water stops protein from setting.
2. **Wash in hot soapy water.**
   Reason: fat is only dissolved in hot water and detergent. Bacteria are killed in water over 60°C. Detergent can break down bacterial walls.
3. **Rinse clean.**
   Reason: Rinsing is needed as disinfectant does not work in presence of milk/protein/detergent.
4. **Make up correct strength disinfectant (e.g.: Miltons, F10) and soak for 10 minutes in cold water.**
   Reasons: correct strength - more is not better, it will not kill more. 1% bleach kills bacteria, viruses and yeast/fungi. It works on time in contact with surface.
5. **Rinse in boiling water.**
   Reason: bleach is inactivated in hot water and breaks down to its basic ingredients (chlorine, water, oxygen) which are rinsed away. There are no leftovers to 'harm' good bacteria. Remember that many good bacteria do not make it through the stomach anyway due to the acid there.

Conclusion

Feeding wildlife to meet their energy requirements is fundamental to successful rehabilitation. Provision of good quality protein, carbohydrates and fats is vital. Vitamins and minerals should be provided in the correct amounts as toxicity is as much of a problem as deficiency. However, storage of food is essential to prevent the loss of these nutrients.

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