Current Knowledge of Parrot Nutrition

Liz Koutsos, PhD

Liz.koutsos@mazuri.com

www.mazuri.com

Mazuri®
A World of Good Nutrition

NOTE: Data in this document have been presented from others' published works (with references) and should not be used elsewhere without proper referencing.

Wild Type Diets

- 1◦ plant based
  - fruits
  - seeds
  - nuts
  - some leaves
  - some flowers
- Some insects reported

Journal of Avian Medicine and Surgery 15(4):257–275, 2001

Review Article

Nutrition of Birds in the Order Psittaciformes: A Review

Elizabeth A. Koutsos, MS, Kevin D. Matson, MS, and Kirk C. Klasing, MS, PhD

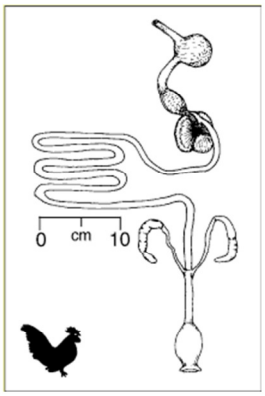
Table 1. Feeding strategies and common diet ingredients of wild birds in the order Psittaciformes.

Species name	Feeding strategy	Common diet ingredients[a]	Time spent feeding[b]	Refer
Blue and gold macaw (*Ara ararauna*)	florivore	seeds, fruits, nuts	NR	18
Kaka (*Nestor meridionalis septentrionalis*)	florivore	1° insects, seeds, nectar/pollen, fruit, sap	>50% of day foraging	23
Kakapo (*Strigops habroptilus*)	florivore	1° leaves, also mosses, rhizomes, roots, bark, fruit	NR	31
Military macaw (*Ara militaris*)	florivore	seeds, nuts, berries, fruits	NR	18
Buffon's macaw (*Ara ambigua*)	frugivore	fruits, flowers	NR	18
Golden parakeet (*Aratinga guarouba*)	frugivore	fruits, buds, flowers	NR	29
Green-winged macaw (*Ara chloroptera*)	frugivore	fruits (Hymenaea), palm nuts, seeds	NR	18
Orange-winged amazon (*Amazona amazonica*)	frugivore	fruit (85% from palm fruit)	NR	117
Red-bellied macaw (*Ara manilata*)	frugivore	fruit (96% from palm fruit, flowers, seed pods	NR	117
Budgerigar (*Melopsittacus undulatus*)	granivore	seeds	NR	26
Carnaby's cockatoo (*Calyptorhynchus funereus latirostris*)	granivore	seeds (especially from cones and nuts of Proteaceae)	NR	118
Cockatiel (*Nymphicus hollandicus*)	granivore	seeds (prefers soft, young over mature, hard seeds)	3 h/d	27
Forest red-tailed cockatoo (*Calyptorhynchus banksii naso*)	granivore	seeds of two native trees (*C calophylla* and *E marginata*)	10–12 h/d	34
Hooded parrot (*Psephotus dissimilis*)	omnivore	1° seeds (1° sesame), flowers, invertebrates	NR	30
Major Mitchell cockatoo (*Cacatua leadbeateri*)	omnivore	larvae, fruits, seeds	NR	118
Black cockatoo (*Calyptorhynchus* species)	omnivore	1° seeds, fruits, flowers, insects/larvae, pine cones	NR	119

NOTE: Data in this document have been presented from others' published works (with references) and should not be used elsewhere without proper referencing.

Diets for Captively Managed Parrots

- Nutrient reqts?
- Limited data in psittacines
- Baseline generally from poultry data



Chicken (*Gallus domesticus*)
digestive tract (Stevens & Hume 1995)

TABLE 2-1 Nutrient Requirements of Immature Leghorn-Type Chickens as Percentages or Units per Kilogram of Diet

Nutrient	Unit	White-Egg-Laying Strains				Brown-Egg-Laying Strains			
		0 to 6 Weeks, 450 g[a]	6 to 12 Weeks, 950 g[a]	12 to 18 Weeks, 1,375 g[a]	18 Weeks to First Egg, 1,475 g[a]	0 to 6 Weeks, 500 g[a]	6 to 12 Weeks, 1,100 g[a]	12 to 18 Weeks, 1,500 g[a]	18 Weeks to First Egg, 1,600 g[a]
		2,850[b]	2,850[b]	2,900[c]	2,900[c]	2,900[b]	2,900[c]	2,850[c]	2,850[c]
Protein and amino acids									
Crude protein[d]	%	18.00	16.00	15.00	17.00	***17.00***	15.00	14.00	***16.00***
Arginine	%	1.00	0.83	0.67	0.75	***0.94***	***0.78***	***0.62***	***0.72***
Glycine + serine	%	0.70	0.58	***0.47***	***0.53***	***0.66***	***0.54***	***0.44***	***0.50***
Histidine	%	0.26	0.22	0.17	0.20	***0.25***	***0.21***	***0.16***	***0.18***
Isoleucine	%	0.60	0.50	0.40	0.45	***0.57***	***0.47***	***0.37***	***0.42***
Leucine	%	1.10	0.85	0.70	0.80	***1.00***	***0.80***	***0.65***	***0.75***
Lysine	%	0.85	0.60	0.45	0.52	***0.80***	***0.56***	***0.42***	***0.49***
Methionine	%	0.30	0.25	0.20	0.22	***0.28***	***0.23***	***0.19***	***0.21***
Methionine + cystine	%	0.62	0.52	0.42	0.47	***0.59***	***0.49***	0.39	***0.44***
Phenylalanine	%	0.54	0.45	0.36	0.40	***0.51***	***0.42***	***0.34***	***0.38***
Phenylalanine + tyrosine	%	1.00	0.83	0.67	0.75	***0.94***	***0.78***	***0.63***	***0.70***
Threonine	%	0.68	0.57	0.37	0.47	***0.64***	***0.53***	***0.35***	***0.44***
Tryptophan	%	0.17	0.14	0.11	0.12	***0.16***	***0.13***	***0.10***	***0.11***
Valine	%	0.62	0.52	0.41	0.46	***0.59***	***0.49***	0.38	***0.43***
Fat									
Linoleic acid	%	1.00	***1.00***	***1.00***	***1.00***	***1.00***	***1.00***	***1.00***	***1.00***
Macrominerals									
Calcium[e]	%	0.90	0.80	0.80	2.00	***0.90***	***0.80***	***0.80***	***1.50***
Nonphytate phosphorus	%	0.40	0.35	0.30	0.32	0.40	0.35	0.30	0.35
Potassium	%	***0.25***	***0.25***	***0.25***	***0.25***	***0.25***	***0.25***	***0.25***	***0.25***
Sodium	%	0.15	0.15	0.15	0.15	***0.15***	***0.15***	***0.15***	***0.15***
Chlorine	%	0.15	***0.12***	***0.12***	***0.15***	***0.12***	***0.11***	***0.11***	***0.11***
Magnesium	mg	600.0	***500.0***	***400.0***	***400.0***	***570.0***	***470.0***	370.0	370.0
Trace minerals									
Manganese	mg	60.0	***30.0***	***30.0***	***30.0***	***56.0***	***28.0***	***28.0***	***28.0***
Zinc	mg	40.0	***35.0***	***35.0***	***35.0***	***38.0***	***33.0***	***33.0***	***33.0***
Iron	mg	80.0	***60.0***	***60.0***	***60.0***	***75.0***	***56.0***	***56.0***	***56.0***
Copper	mg	***5.0***	***4.0***	***4.0***	***4.0***	***5.0***	***4.0***	***4.0***	***4.0***
Iodine	mg	0.35	***0.35***	***0.35***	***0.35***	***0.33***	***0.33***	***0.33***	***0.33***
Selenium	mg	0.15	***0.10***	***0.10***	***0.10***	***0.14***	***0.10***	***0.10***	***0.10***
Fat soluble vitamins									
A	IU	1,500.0	1,500.0	1,500.0	1,500.0	***1,420.0***	***1,420.0***	***1,420.0***	***1,420.0***
D_3	ICU	200.0	200.0	200.0	300.0	***190.0***	***190.0***	***190.0***	***280.0***
E	IU	***10.0***	***5.0***	***5.0***	***5.0***	9.5	***4.7***	***4.7***	***4.7***
K	mg	0.5	***0.5***	***0.5***	***0.5***	***0.47***	***0.47***	***0.47***	***0.47***
Water soluble vitamins									
Riboflavin	mg	3.6	1.8	1.8	2.2	***3.4***	***1.7***	***1.7***	***1.7***
Pantothenic acid	mg	***10.0***	***10.0***	***10.0***	***10.0***	***9.4***	***9.4***	***9.4***	***9.4***
Niacin	mg	27.0	11.0	11.0	11.0	***26.0***	***10.3***	***10.3***	***10.3***
B_{12}	mg	0.009	0.002	0.003	0.004	***0.009***	***0.002***	***0.003***	***0.003***
Choline	mg	1,300.0	900.0	500.0	500.0	***1,225.0***	***850.0***	***470.0***	***470.0***
Biotin	mg	***0.15***	***0.10***	***0.10***	***0.10***	***0.14***	0.09	***0.09***	0.09
Folic acid	mg	***0.55***	***0.25***	***0.25***	***0.25***	***0.52***	***0.23***	***0.23***	***0.23***
Thiamin	mg	***1.0***	***1.0***	***0.8***	***0.8***	***1.0***	***1.0***	***0.8***	***0.8***
Pyridoxine	mg	3.0	***3.0***	***3.0***	***3.0***	***2.8***	***2.8***	***2.8***	***2.8***

NOTE: Where experimental data are lacking, values typeset in bold italics represent an estimate based on values obtained for other ages or related species.

[a] Final body weight.

[b] These are typical dietary energy concentrations for diets based mainly on corn and soybean meal, expressed in kcal ME_n/kg diet.

[c] Chickens do not have a requirement for crude protein per se. There, however, should be sufficient crude protein to ensure an adequate nitrogen supply for synthesis of nonessential amino acids. Suggested requirements for crude protein are typical of those derived with corn-soybean meal diets, and levels can be reduced somewhat when synthetic amino acids are used.

http://books.nap.edu/openbook/0309048923/gifmid/20.gif 6/08

NOTE: Data in this document have been presented from others' published works (with references) and should not be used elsewhere without proper referencing.

Kakapo.
From K. Klasing

NOTE: Data in this document have been presented from others' published works (with references) and should not be used elsewhere without proper referencing.

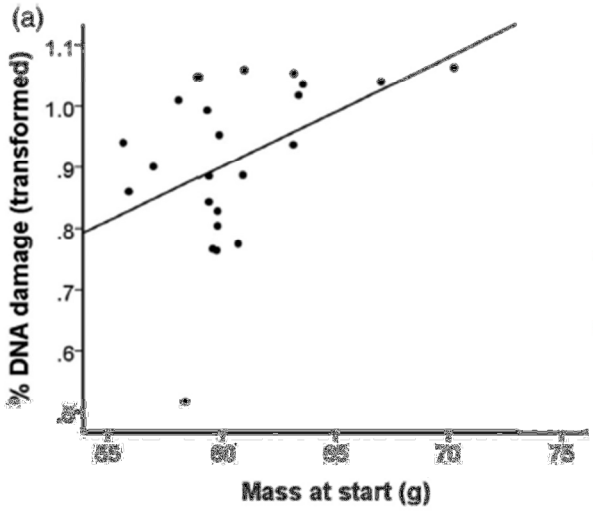
Diets for Captively Managed Parrots

- Need to account for different energy reqts vs wild birds

Management scenario	ME requirement (kcal/d)	g fresh fruit/d (2 kg bird)
Indoor cage	154.6 x (BW in kg)$^{0.73}$	360
Indoor aviary	176.6 x (BW in kg)$^{0.73}$	
Outdoor aviary in warm/hot environment	203.9 x (BW in kg)$^{0.73}$	
Outdoor aviary in cold environment	226.1 x (BW in kg)$^{0.73}$	
Free ranging	229.2 x (BW in kg)$^{0.73}$	542

NOTE: Data in this document have been presented from others' published works (with references) and should not be used elsewhere without proper referencing.

Impact of overweight/overconditioned birds



Conservation Physiology
Volume 3 • 2015
10.1093/conphys/cov045
SEB Society for Experimental Biology
Research article

Oxidative stress, activity behaviour and body mass in captive parrots

S. D. Larcombe[1], C. A. Tregaskes[2,†], J. Coffey[2], A. E. Stevenson[2], L. G. Alexander[2,‡] and K. E. Arnold[3,*]

NOTE: Data in this document have been presented from others' published works (with references) and should not be used elsewhere without proper referencing.

Diets for Captively Managed Parrots

NOTE: Data in this document have been presented from others' published works (with references) and should not be used elsewhere without proper referencing.

INSIGHTS ON PSITTACINE NUTRITION THROUGH THE STUDY OF

FREE-LIVING CHICKS

A Dissertation

by

JUAN CORNEJO

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

May 2012

NOTE: Data in this document have been presented from others' published works (with references) and should not be used elsewhere without proper referencing.

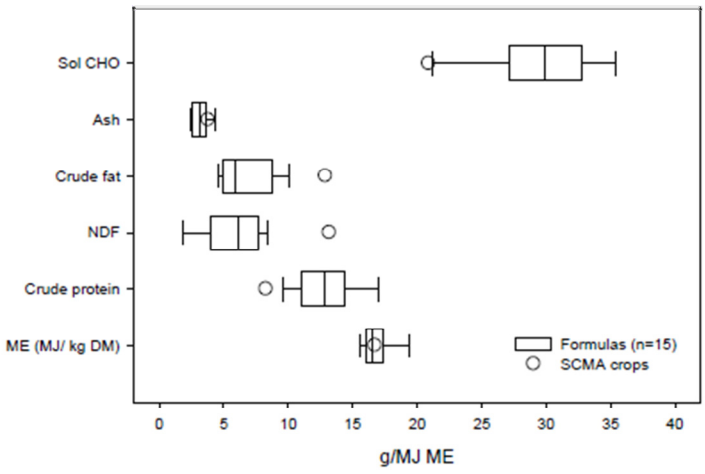
Diets for Captively Managed Parrots

- Handrearing challenges
  - particle size
  - separation

From Cornejo, 2012 PhD Thesis:
"Parrots feed their chicks a regurgitated coarse mix of foods."
"Largest food particles fed to… Scarlet macaw chicks in Peru averaged 9 x 4.5 mm, and there was little variation with chick age."

NOTE: Data in this document have been presented from others' published works (with references) and should not be used elsewhere without proper referencing.

Diets for Captively Managed Parrots



Cornejo, 2012, PhD Thesis

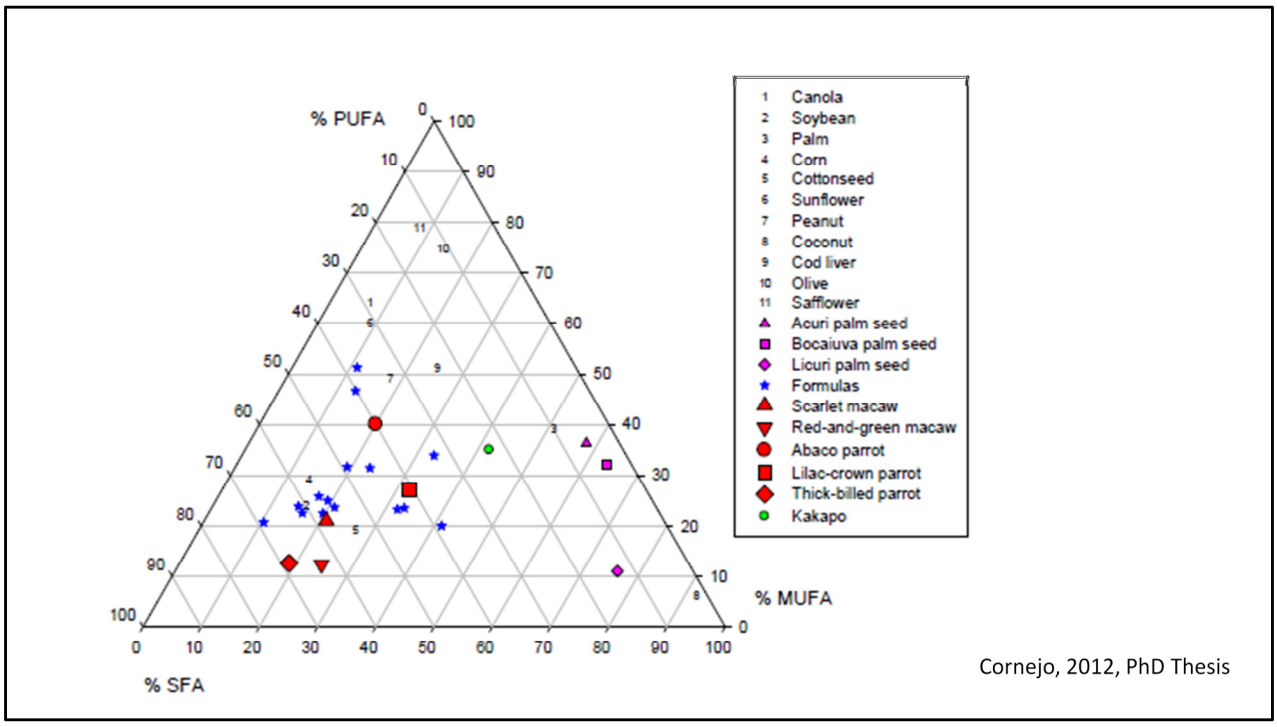
NOTE: Data in this document have been presented from others' published works (with references) and should not be used elsewhere without proper referencing.

Diets for Captively Managed Parrots

	Scarlet macaw (n = 14)	Red-and-green macaw (n = 5)	Cuban parrot (n = 5)	Lilac-crowned amazon (n = 6)	Thick-billed parrot (n = 2)	Kakapo (n = 2)	Commercial formulas (n = 15)	Acuri and Bocaiuva
Crude fat (%DM)	21.6 ± 6.42	37.7 ± 10.4	30.5 ± 1.46	33.8 ± 8.9	41.4 ± 1.56	-	11.6 ± 4.61	
	(9.53-29.42)	(24.1-36.8)	(29.2-32.5)	(22.5-47.5)	(40.3-42.5)		(7.34-23.6)	
Crude fat (g/MJ ME)	12.4 ± 3.10	18.6 ± 4.06	15.9 ± 0.57	15.3 ± 2.86	18.6 ± 4.06	-	6.73 ± 2.10	
	(6.34-17.7)	(13.0-23.8)	(15.2-16.5)	(11.5-19.4)	(13.0-23.8)		(4.55-11.5)	
Total FA (% DM)	15.0 ± 5.17	30.9 ± 5.51	19.0 ± 2.74	24.8 ± 4.22	31.8 ± 0.56	7.81 ± 0.11	10.4 ± 4.05	(60.7-
	(7.30-24.7)	(25.4-36.8)	(16.0-21.0)	(19.1-29.9)	(31.2-32.3)	(7.73-7.89)	(5.90-22.0)	66.4)
Total FA (g/MJ ME)	8.72 ± 3.07	15.3 ± 1.81	9.91 ± 1.40	11.3 ± 1.21	14.2 ± 0.24	10.2 ± 0.32	6.05 ± 1.92	
	(5.87-15.8)	(13.3-17.5)	(8.29-11.3)	(9.78-12.7)	(14.1-14.4)	(9.96-10.4)	(3.62-10.7)	

Cornejo, 2012, PhD Thesis

NOTE: Data in this document have been presented from others' published works (with references) and should not be used elsewhere without proper referencing.



Cornejo, 2012, PhD Thesis

NOTE: Data in this document have been presented from others' published works (with references) and should not be used elsewhere without proper referencing.

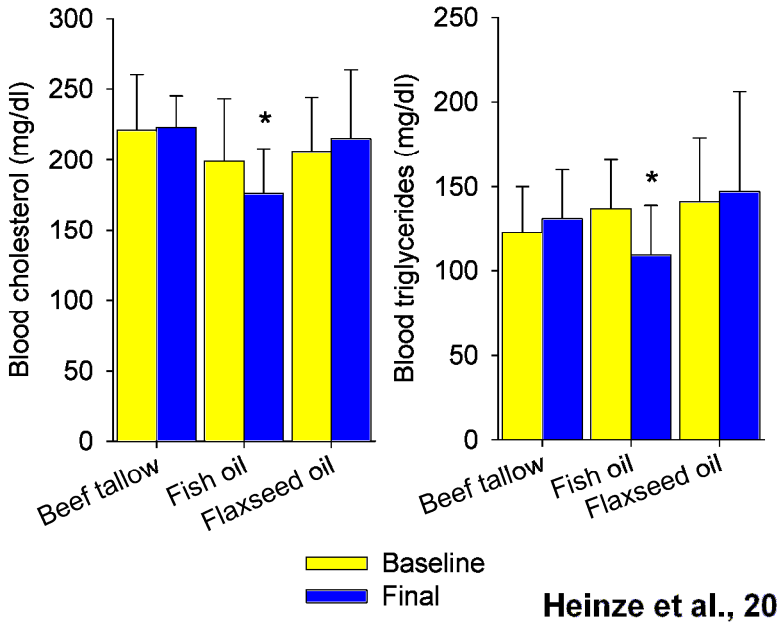
Need for more omega 3 in parrot diets?

	Scarlet macaw (n = 15)	Red-and-green macaw (n = 7)	Cuban parrot (n = 5)	Lilac-crowned amazon (n = 6)	Thick-billed parrot (n = 2)	Kakapo (n = 2)	Commercial formulas (n = 15)
C18:2n6	45.6 ± 13.6	56.0 ± 13.0	25.8 ± 7.81	31.9 ± 9.17	67.7 ± 1.53	6.93 ± 0.86	44.3 ± 9.87
LA	(22.8-64.9)	(25.9-66.5)	(16.5-36.5)	(19.9-43.5)	(66.2-69.3)	(6.3-7.5)	(29.0-68.2)
C18:3 n6	0.00 ± 0.00	0.00 ± 0.00	7.11 ± 3.81	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
GLA	(0.00-0.00)	(0.00-0.00)	(2.92-12.3)	(0.00-0.00)	(0.00-0.00)	(0.00-0.00)	(0.00-0.00
C18:3n3	11.4 ± 9.38	2.24 ±1.55	0.88 ± 0.46	8.70 ± 6.55	0.65 ± 0.14	15.9 ± 1.40	5.03 ± 3.45
ALA	(1.52-37.4)	(0.85-4.79)	(0.43-1.52)	(2.03-18.7)	(0.49-0.75)	(15.0-16.9)	(0.74-15.0)
C20:2n6 Eicosadienoic acid	1.23 ± 0.75 (0.18-2.40)	0.00 ± 0.00 (0.00-0.00)	0.55 ± 0.25 (0.30-0.93)	0.00 ± 0.00 (0.00-0.00)	0.00 ± 0.00 (0.00-0.00)	0.00 ± 0.00 (0.00-0.00	0.03 ± 0.11 (0.00-0.44)
C20:3n6	0.01 ± 0.02	0.00 ± 0.00	0.99 ± 0.57	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
DGLA	(0.00-0.08)	(0.00-0.00)	(0.38-1.85)	(0.00-0.00)	(0.00-0.00)	(0.00-0.00	(0.00-0.00
C20:4n6	0.01 ± 0.02	0.00 ± 0.00	0.80 ± 0.63	0.02 ± 0.04	0.00 ± 0.00	0.00 ± 0.00	0.08 ± 0.13
AA	(0.00-0.10)	(0.00-0.00)	(0.13-1.73)	(0.00-0.10)	(0.00-0.00)	(0.00-0.00	(0.00-0.39)
C20:5 n3	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.09 ± 0.31
EPA	(0.00-0.00)	(0.00-0.00)	(0.00-0.00	(0.00-0.00)	(0.00-0.00)	(0.00-0.00	(0.00-1.21)
C22:4n6	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.01 ± 0.04	0.00 ± 0.00	0.00 ± 0.00	0.03 ± 0.07
Adrenic acid	(0.00-0.00)	(0.00-0.00)	(0.00-0.00	(0.00-0.09)	(0.00-0.00)	(0.00-0.00	(0.00-0.24)
C22:6n3	0.04 ± 0.06	0.00 ± 0.00	2.40 ± 1.52	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.12 ± 0.24
DHA	(0.00-0.19)	(0.00-0.00)	(0.66-4.41)	(0.00-0.00)	(0.00-0.00)	(0.00-0.00	(0.00-0.78)

Cornejo, 2012, PhD Thesis

NOTE: Data in this document have been presented from others' published works (with references) and should not be used elsewhere without proper referencing.

Need for more omega 3 in parrot diets?



Heinze et al., 2012, Cockatiels

NOTE: Data in this document have been presented from others' published works (with references) and should not be used elsewhere without proper referencing.

Need for more omega 3 in parrot diets?

Work in quaker parakeets suggest flax = fish
(Petzinger et al., 2014, J. An. Phys. An. Nutr.)

Likely species differences in omega-3 needs

Need to consider palatability of omega-3 source

NOTE: Data in this document have been presented from others' published works (with references) and should not be used elsewhere without proper referencing.

Diets for Captively Managed Parrots

- Often based on offering multiple food items
  - variety contributes to welfare
  - unknown reqts
  - preference (birds and managers)
- Challenges
  - Sorting/selection of preferred food items

Ullrey DE, Allen ME, Baer DJ. Formulated diets versus seed mixtures for psittacines. *J Nutr.* 1991;121: S193–S205.

Fledging success based on diet offered	Seed Blend	Extruded Diet
Yellow headed Amazon	75	100
Forstens Lorikeet	62	100
Goldie's Lorikeet	45	83
Blue & Gold Macaw	62	80
Scarlet Macaw	62	100
Ring-necked parakeet	80	100
Rock Peplar Parakeet	88	80
Blue crowned hanging parrot	50	75
Average	66	90

NOTE: Data in this document have been presented from others' published works (with references) and should not be used elsewhere without proper referencing.

Diets for Captively Managed Parrots

- Challenges
  - Diet items are not nutritionally complete

	Whole corn	Proso millet	Flax seed	Milo	Saff-lower	Sun-flower	NRC quail reqs	= energy
Dry matter	86	88	90	87	93	95		
Crude Protein (%)	9.5	12.5	25.0	10.56	17.5	24.0	18	36
Met (%)	0.26	0.34	0.56	0.21			0.30	0.60
Lys (%)	0.29	0.28	0.78	0.23			0.80	1.60
Lipid (%)	4.3	5.5	37.8	3.1	35.0	52.2		
Ca (%)	0.04	0.02	0.40	0.03	0.26	0.13	0.53	1.06
P (%,)	0.30	0.34	1.00	0.28	0.67	0.75	0.45	0.90
Niacin (mg/kg)	27	3	56	30			40	80

Seed based diets offer a lot of variety to the bird. But, also come with problems including nutrient deficiencies. All numbers in red are deficient vs known requirements.

NOTE: Data in this document have been presented from others' published works (with references) and should not be used elsewhere without proper referencing.

Diets for Captively Managed Parrots

Table 5. Nutrient concentrations by dry weight of diets consumed by 7 captive Amazon parrots offered a mix of seed, produce, and formulated diet compared with published recommendations for large parrots. Consumed diet measurements (mean ± SD) followed by asterisks differ significantly from the mean recommendation. Recommendations columns give the lowest and highest values from the cited literature, the mean of which was used for statistical analysis. The column "N references" shows the total number of references used for calculating the mean followed by the reference citations.

		Recommendations			
Nutrient	Consumed diet	Lowest	Mean	Highest	N references
Energy, kJ/g	18.6 ± 0.44		12.6		1[9]
Protein, %	15.5 ± 0.3	12	16	24	5[3,9,13,37,38]
Total lipids, %	20.6 ± 3.9***	4	5	7	4[9,13,37,38]
Ca, %	0.34 ± 0.13*	0.50	0.69	1.10	5[3,9,13,37,38]
Mg, %	0.22 ± 0.02**	0.06	0.12	0.15	3[3,9,38]
P, %	0.53 ± 0.02	0.40	0.54	0.80	5[3,9,13,37,3]
K, %	0.74 ± 0.02	0.40	0.60	0.70	3[3,9,38]
Na, %	0.06 ± 0.02***	0.15	0.18	0.20	4[3,9,13,38]
Ca:P ratio	0.64 ± 0.02***	1.0	1.3	1.4	5[3,9,13,37,3]
Fe, ppm	70.5 ± 11.3***	80	110	150	3[3,9,38]
Zn, ppm	49.2 ± 6.4	45	72	120	3[3,9,38]
Cu, ppm	12.4 ± 0.7	8	12	20	3[3,9,38]
Vitamin A, IU/g	11.1 ± 8.4	3	5	8	3[3,9,38]
Tryptophan, %	0.22 ± 0.01***		0.12		1[9]
Threonine, %	0.59 ± 0.01***		0.40		1[9]
Lysine, %	0.85 ± 0.09	0.60	0.88	1.15	2[9,38]
Methionine, %	0.36 ± 0.03*		0.25		1[9]
Arginine, %	1.44 ± 0.10***		0.60		1[9]

Abbreviations: Ca indicates calcium; Mg, magnesium; P, phosphorus; K, potassium; Na, sodium; Fe, iron; Zn, zinc; Cu, copper.
*$P < .05$.
**$P < .01$.
***$P < .001$.

Journal of Avian Medicine and Surgery 26(3):149–160, 2012

Nutritional Levels of Diets Fed to Captive Amazon Parrots: Does Mixing Seed, Produce, and Pellets Provide a Healthy Diet?

Donald J. Brightsmith, MS, PhD

NOTE: Data in this document have been presented from others' published works (with references) and should not be used elsewhere without proper referencing.

Effect of physical form?

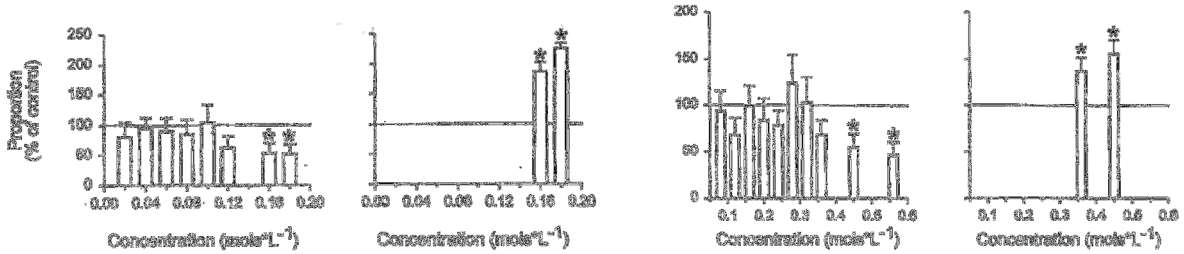
6% of day feeding/foraging

26% of day feeding/foraging

Rozek et al., 2010

NOTE: Data in this document have been presented from others' published works (with references) and should not be used elsewhere without proper referencing.

Sense of taste?



At high concentrations, salt (left panel) and sucrose (right panel) are avoided

ELSEVIER
Applied Animal Behaviour Science 69 (2000) 313–326
APPLIED ANIMAL BEHAVIOUR SCIENCE
www.elsevier.com/locate/applanim

Taste threshold determination and side-preference in captive cockatiels (*Nymphicus hollandicus*)

Kevin D. Matson, James R. Millam, Kirk C. Klasing *

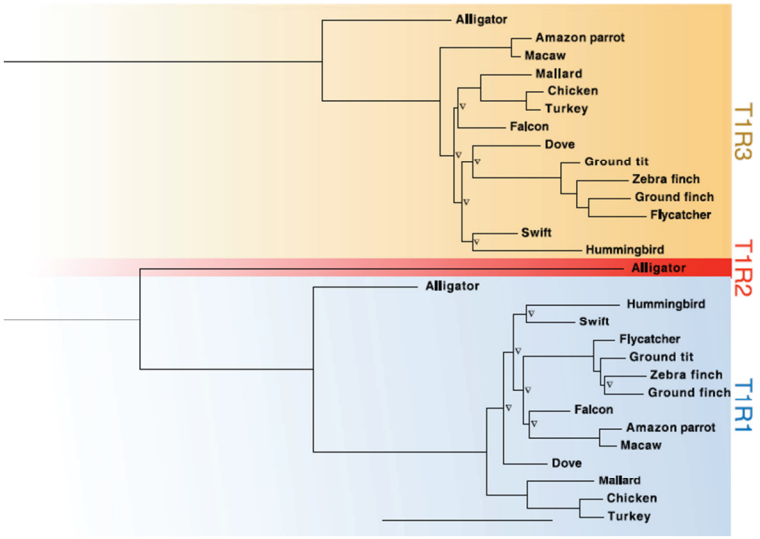
NOTE: Data in this document have been presented from others' published works (with references) and should not be used elsewhere without proper referencing.

Sense of taste?

Evolution of sweet taste perception in hummingbirds by transformation of the ancestral umami receptor

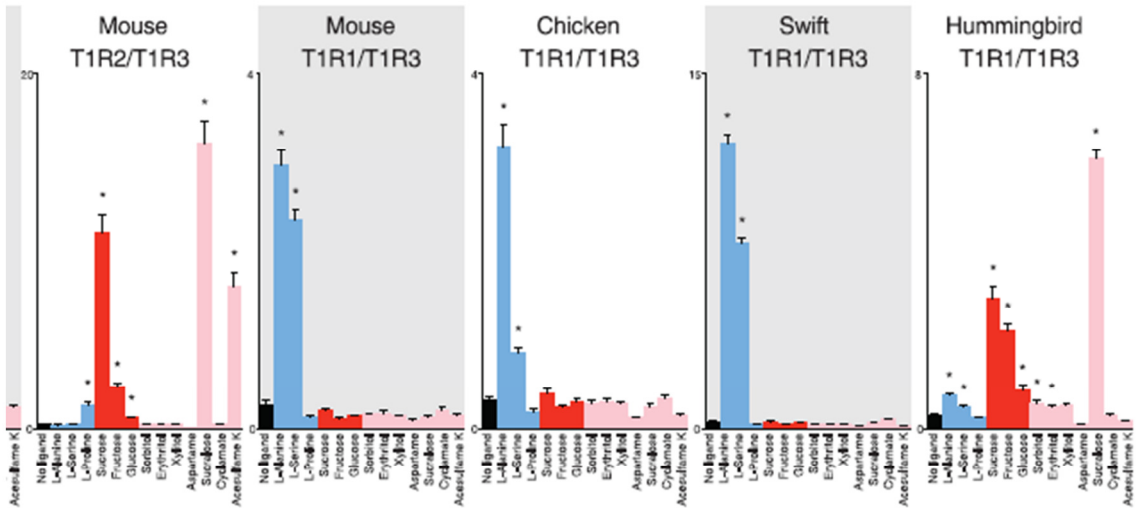
Maude W. Baldwin *et al.*
Science **345**, 929 (2014);
DOI: 10.1126/science.1255097

- T1R1, T1R2 and T1R3 sense umami (amino acids/savory) and sweet
- T1R1-T1R3 combination for umami
- T1R2-T1R3 for sweet



NOTE: Data in this document have been presented from others' published works (with references) and should not be used elsewhere without proper referencing.

Evolution of sweet taste perception in hummingbirds by transformation of the ancestral umami receptor
Maude W. Baldwin *et al.*
Science **345**, 929 (2014);
DOI: 10.1126/science.1255097



NOTE: Data in this document have been presented from others' published works (with references) and should not be used elsewhere without proper referencing.

Summary

- Absence of empirically determined reqt's for parrots
  - Poultry data
  - Experience and success stories
  - Field data
  - Known pathology
- More work needed to optimize handfeeding diets
  - Differences in wild type diets yet produce similar nutrition
  - Fat? Omega-3?
- Known sorting of mixed food items
  - Optimization of blends to ensure full consumption?
  - Improve palatability of less preferred food item