Captive diet of New Zealand black stilt held at Twizel

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1. Introduction

In the New Zealand black stilt held at Twizel there has been a problem with fertility which could be related to inadequacies in the diet. The aim of the present study was to describe the composition in terms of nutrient content and digestibility of nutrients of the diet fed to NZ black stilt held at Twizel, and to relate this to the fertility problem. Also as iodine was added to the diet (in the form of iodised salt) in 1998, a further aim was to ensure that the birds were not ingesting excess iodine.

2. Material and methods

The animal experimentation was conducted atTwizel from Monday 27 March to Saturday 1 April 2000. Chemical analyses of the diet and faeces as well as calculation of the results were conducted by Massey University, Palmerston North.

Ten black stilts were selected and assigned to one of six brooders, with brooders 1, 3, 5 and 6 containing a pair of birds and brooders 2 and 4 each containing one male. Weights of these birds were taken at the start and end of the study, and ranged from 177 g to 229 g. The brooders were a fibreglass tub (1.2 m width x 1.1 m length x 1.0 m depth) with the floor lined with plastic sheets. Lights (one standard light bulb per brooder) were on during the day and turned off at night, with no heating in the room. The birds had *ad libitum* access to fresh water, presented in trays (25 cm x 20 cm x 4 cm depth). A mixed diet was provided *ad libitum* at 9 am and 4 pm each day, starting on Monday. Table 1 presents the diet as eaten by the ten birds. Faeces, collected on the weighed plastic sheets, were collected twice a day at 4 pm and 9 am. Faecal collection involved moving the birds to an adjacent brooder, removing the top plastic sheet from the brooder, weighing the sheet and collecting the faeces into a plastic bag (care was taken not to include any spilled food). Food intakes and faecal outputs were recorded twice a day. Samples of the mixed diet, mealworms, and faeces were frozen and transported to Massey University for analyses.

The diet eaten by the black stilts (oxheart mix + mealworms) and the faeces (bulked over the 5-day collection period and over the six brooders) were freeze-dried, ground, and analysed for dry matter (DM), crude protein, lipid, amino acids, fatty acids, and ash. The diet was also analysed for minerals. Dry matter was determined by oven drying at 105 °C while ash was determined by heating the sample to 550 °C for 16 h. Crude protein was determined by multiplying nitrogen by 6.25 with nitrogen determined by the Kjeldahl technique. Lipid was analysed using petroleum ether extraction, and amino acids were determined by high-performance liquid chromatography. Fatty acids were analysed using gas chromatography, with mineral determination carried out by plasma emission spectrophotometer.

3. Results

As there were different numbers of birds in the brooders, the intakes were adjusted to a per bird basis. Each bird consumed an average of 4.2 g of mealworms and 36.3 g of ox-heart mix (ox heart, kiwi pre-mix and iodised table salt) per day. The amount of daily diet eaten by the birds in each brooder is presented in Table 2.

The nutritional composition of the diet consumed by the black stilt birds is presented inTables 3-6. The gross nutrient composition is presented inTable 3, the dietary amino acid profile in Table 4, the dietary fatty acid profile in Table 5, and the mineral content of the diet in Table 6. The concentrations of several minerals were below the detection limits of the machine and therefore not included in this report. Selenium content of the diet was 0.80 Mg/g diet DM and iodine was 0.59 Mg/g diet DM.

The average daily amount of faeces produced by the birds in the six brooders is shown in Table 7. Of the total amount of faeces produced, an average of 62% was recovered from the plastic sheets. This was due to the faeces being spread over a wide area of the plastic sheet and being very difficult to collect. The birds in all brooders produced similar amounts of faeces (approximately 6.5 g per bird per day).

Tables 8-10 present the apparent faecal digestibility of gross nutrients (Table 8), amino acids (Table 9) and fatty acids (Table 10). The lipid component of the diet (18% on a dry matter basis) was highly digestible, with 97% of the crude fat being digested. Crude protein made up 73% of the diet, with approximately 92% digested (based on amino acid nitrogen digestibility). Organic matter was less digestible, making up 94% of the diet but only 69% being digested. The majority of amino acids had high digestibility values, with lower digestibility values found for glycine (69%) and cysteine (86%). The majority of the fatty acids had high digestibility values, with the apparent faecal digestibility ranging from 92 to 99%.

4. Discussion

In general the results indicate that the protein (amino acid nitrogen) and fatty acid fractions of the diet fed to NZ black stilt held at Twizel were highly digestible (in general >92%). Lower digestibility values were obtained for dry matter, organic matter, glycine and cysteine. Due to a very low carbohydrate component of the diet (3%) it was not possible to obtain an accurate digestibility value for carbohydrates. The low carbohydrate content of the diet is as expected from an insectivore, which would normally not ingest a diet rich in carbohydrates in the wild. Insects mainly consist of protein, lipids and chitin.

On first sight, the dry matter digestibility (67%) is low compared with those of crude fat (97%), fatty acids (>92%) and amino acid (most >92%). This can be explained by the high faecal uric acid levels. In the faeces of these birds, 92% of the nitrogen in the dry matter originated from uric acid, with the nitrogen content of the faeces being 22% on a dry matter basis. This is extremely high compared to poultry species, where the expected nitrogen content of faeces is approximately 8%.

The low apparent digestibility of cysteine can be explained by the presence of feathers in the faeces. The collected faecal samples contained feathers and, although care was taken to remove the majority of them, some still remained in the sample. As feathers are high in cysteine, this is lowering the apparent digestibility of dietary cysteine. The low apparent faecal digestibility of glycine is an artefact of the presence of uric acid in the faecal samples, as uric acid is spontaneously converted to glycine in faeces.

Birds excrete high levels of uric acid, which is mixed with the faecal material during excretion. This results in an incorrect estimate for the digestibility of crude protein and for this reason this has not been calculated. The combined urine/faeces also masks the mineral digestibility, so faecal mineral excretion was not analysed and dietary mineral availability could not be calculated.

There are adequate levels of most fatty acids in the diet when compared to other avian species, except for arachidonic acid. Arachidonic acid can be synthesised by many animal species from linoleic acid. However, true carnivores such as the cat, mink and ferret have lost/not developed this ability and consequently require arachidonic acid in their diet. Insectivores ingest a diet similar to carnivores, as both contain protein and fat and no carbohydrates. Arachidonic acid is synthesised in vivo from linoleic acid and involves several enzymes. In true carnivores such as the cat, the A' desaturase enzyme activity is low or completely absent, thereby limiting the synthesis of arachidonic acid. It is unknown whether the black stilt is able to synthesise arachidonic acid from linoleic acid. Some effects of essential fatty acid (i.e. linoleic and arachidonic acid) deficiency in mammals are altered visual function, reduced growth rate, scaly dermatitis, increased susceptibility to infection, and impaired reproduction (male animals refuse to mate, females frequently reabsorb foetuses, there are frequent stillbirths and neonatal deaths).

The diet has a good balance and content of most minerals. One result which should be highlighted is the low calcium content and low calcium to phosphorus ratio of the diet. For normal breeding and growing birds the expected ratio would be between 2:1 and 3:1. This diet has a Ca:P ratio of only 0.54:1. The total amount of calcium (5.2 mg/g diet DM) in the diet is also low. No data are available on calcium requirements of the black stilt, but diets for broilers (poultry) contain approximately 1.2 g Ca per 100 g dry matter. For the NZ black stilt the calcium should be increased (ratio Ca:P approximately 2:1) by addition of more to the diet to allow egg shell formation and bone development.

The concentration of selenium in the diet was 0.80 mg/kg dry matter. Normal levels of selenium in the diets for poultry and other production animals are 0.1 mg/kg dry matter, so the stilt diet is likely to have an excess of sele-

nium. However, no toxicity symptoms have been observed in the black stilt at Twizel, and this may indicate that, like the domestic cat (carnivorous), the black stilt (insectivorous) can tolerate high levels of selenium. The diet contained 0.59 mg/kg dry matter of iodine. The actual intake of selenium (per bird per day) was 8.85 Mg and iodine 6.55 Mg.

5. Conclusions

The diet fed to NZ black stilt at Twizel is highly digestible and generally provides a good balance of nutrient to the birds. The calcium levels, however, appear low and the calcium to phosphorus ratio is low. Therefore it is recommended that calcium be added to the diet.

There is an absence of arachidonic acid in the diet and, although the birds may synthesise this from linoleic acid, until data becomes available on arachidonic acid synthesis in the black stilt, this fatty acid should be added to the diet.

The amount of uric acid in the faeces is of concern, as it is very high in comparison with poultry species. High uric acid levels can cause gout, which is often attributed to high protein levels in the diet (black stilt diet is 73%, from the high proportion of oxheart). Although no problems have been seen with the black stilt at Twizel it is recommended that the protein level of the diet be reduced.

6. Recommendations

Increase the calcium levels of the diet. Add 14 mg/g diet dry matter. This equates to adding 10.9 g calcium carbonate supplement to 782 g of oxheart mix, or 13.9 g to a mix using 1 kg of oxheart (see Appendix 4).

Add arachidonic acid to the diet. Suggest adding 200 mg/kg diet dry matter. As arachidonic acid is expensive, a good way to supplement the diet would be to substitute 10% of the oxheart for 10% cat biscuit/water mixture (see Appendix 4).

Lower the uric acid level in the faeces by lowering the amount of protein in the diet (replacing protein with carbohydrate). This, too, achieved by substituting 10% of the oxheart for a 10% cat biscuit/water mixture in the diet (see Appendix 4).

Suggested new diet for the NZ black stilt at Twizel (see Appendix 4 for suggested formulation method):

Ingredient	Per kg	Using 1 kg oxheart
Oxheart	782.4 g	1000 g
Dry cat biscuits [a]	56.5 g	72 g
Water	43.5 g	56 g
Kiwi premix [b]	4.3 g	5.5 g
Iodised salt [b]	2.5 g	3.2 g
Mealworms [b]	100 g	128 g
Ca supplement	10.9 g	13.9 g

[a] Go-Cat (dry cat food) chicken, beef, calcium and vegetable flavour, from Friskies Pet Care, 1 Broadway, Newmarket, Auckland.
[b] Amount unchanged from present diet.

7. Disclaimer

The Monogastric Research Centre, Massey University, has taken every care to ensure that the contents of this report provide a correct reflection of its current understanding of these results and that the information presented is accurate. The Monogastric Research Centre cannot, however, accept responsibility for any inaccuracies or errors in the information presented. Similarly, no responsibility is accepted for any interpretations made from the information provided.

Appendix 1. Tables of results.

Table 1. Diet formulation eaten by captive NZ black stilt

Ingredient	Amount (%)
Ox-heart mince	89.1
Mealworms [a]	10.3
Kiwi Pre-Mix [b]	0.4
Iodised salt	0.2

[a] Mealworms (*Tenebrio molitor)* Biosuppliers live insects, 201 Eskdale Rd, Birkenhead, Auckland
[b] Kiwi Premix, Carlyle Veterinary Clinic, Napier (for composition see Appendix 3)

Table 2. Daily amount of ox-heart mix and mealworms eaten by captive NZ black stilt over the 5 day collection period

	Ox-heart mix intake (g)					
	Brooder 1	Brooder 2	Brooder 3	Brooder 4	Brooder 5	Brooder 6
Monday	6.3	14.3	15.9	12.5	15.7	25.6
Tuesday	38.3	36.1	44.7	30.1	19.6	50.1
Wednesday	30.1	43.1	37.3	45.6	20.4	48.1
Thursday	41.9	46.9	39.0	57.9	34.0	50.0
Friday	43.4	49.2	40.1	59.5	43.9	49.6
Average	**32.0**	**37.9**	**35.4**	**41.1**	**26.7**	**44.7**
	Daily intake (g)					
Monday	10.7	19.9	18.5	13.4	20.2	29.9
Tuesday	43.2	42.4	49.1	35.7	24.2	54.6
Wednesday	35.1	48.5	42.0	51.2	24.4	51.6
Thursday	45.7	52.9	42.3	58.3	38.7	53.9
Friday	47.9	54.8	44.5	59.5	47.8	54.0
Average	**36.5**	**43.7**	**39.3**	**43.6**	**31.1**	**48.8**

Table 3. Gross nutrient composition of the daily diet eaten by captive NZ black stilt

Component	Amount (%)
Dry matter, DM	27
Crude protein (DM basis)	73
Lipid (DM basis)	18
Ash (DM basis)	6
Carbohydrates	3

Table 4. Amino acid profile of the daily diet eaten by captive NZ black stilt (g/100 g diet DM)

Amino acid	Amount	Amino acid	Amount
Aspartic acid	5.7	Leucine	5.6
Threonine	2.9	Tyrosine	2.4
Serine	2.6	Phenylalanine	2.7
Glutamic acid	8.8	Histidine	1.8
Proline	2.8	Lysine	5.0
Glycine	3.1	Arginine	4.3
Alanine	4.1	Cysteine	0.7
Valine	3.5	Methionine	2.0
Isoleucine	3.0		

Table 5. Fatty acid profile of the daily diet eaten by captive NZ black stilt

Fatty acid	Amount (mg/g diet DM)
Myristic acid (C14:0)	4.8
Palmitic acid (C16:0)	31.3
Palmitoleic acid (C16:1)	5.0
Margaric acid (C17:0)	0.0
Stearic acid (C18:0)	27.4
Oleic acid (C18:1)	65.1
Linoleic acid (C18:2)	30.3
Linolenic acid (C18:3)	2.1
Arachidonic acid (C20:4)	0.0
total unsaturated fatty acids	102.5
total saturated fatty acids	63.5

Table 6. Mineral content of the daily diet of captive NZ black stilt

Mineral	Amount (mg/g diet DM)	Mineral	Amount (Mg/g diet DM)
Calcium (Ca)	5.2	Zinc (Zn)	118.5
Phosphorus (P)	9.6	Manganese (Mn)	48.2
Potassium (K)	10.0	Copper (Cu)	18.0
Sulphur (S)	7.2	Selenium (Se)	0.8
Magnesium (Mg)	1.3	Iodine (I)	0.6
Iron (Fe)	0.2		

Table 7. Amount of faeces produced (g as is)[a] by the captive NZ black stilt over the 5 day collection period

	Brooder					
Day	1	2	3	4	5	6
Monday	6.8	3.5	7.6	9.2	5.4	4.5
Tuesday	10.4	5.3	9.2	5.2	5.8	8.7
Wednesday	6.7	6.1	6.8	5.8	3.3	6.5
Thursday	7.6	7.0	7.8	6.1	4.6	6.4
Friday	7.4	6.1	5.8	6.6	6.5	6.0
Average daily faeces:	**7.8**	**5.6**	**7.4**	**6.6**	**5.1**	**6.4**

[a] Expressed as average faeces produced on a per bird basis.

Table 8. Apparent faecal digestibility of various nutrients in the diet consumed by captive NZ black stilt

Component	Apparent digestibility (%)
Dry Matter	67
Organic matter	69
Fat	97
Amino acid nitrogen	92

Table 9. Apparent faecal digestibility of amino acids in the diet consumed by captive NZ black stilt

Amino acid	Apparent digestibility (%)	Amino acid	Apparent digestibility (%)
Aspartic acid	94	Leucine	94
Threonine	92	Tyrosine	94
Senne	91	Phenylalanine	95
Glutamic acid	94	Histidine	92
Proline	92	Lysine	95
Glycine	69	Arginine	96
Alanine	94	Cysteine	86
Valine	93	Methionine	95
Isoleucine	94		

Table 10 Apparent faecal digestibility of fatty acids in the diet consumed by captive NZ black stilt

Fatty acid	Apparent digestibility (%)
Myristic acid (C14:0)	99
Palmitic acid (C16:0)	97
Palmitoleic acid (C16:1)	-
Margaric acid (C17:0)	-
Stearic acid (C18:0)	97
Oleic acid (C18:1)	98
Linoleic acid (C18:2)	98
Linolenic acid (18:3)	92
Arachidonic acid (20:4)	-

Appendix 2.
Current diet formulation method for NZ black stilt

Ingredients

- Frozen minced oxheart.
- Kiwi Premix (see Appendix 3 for analysis) from Carlyle Veterinary Clinic, Napier.
- Mealworms *(Tenebrio molitor)* Biosuppliers Live Insects (Telephone/ Fax 09 418-2352).
- Iodised table salt.

Ox-heart mix

1. Defrost and weigh 1 kg ox-heart mince.
2. Sprinkle over 2 level '/2 tsp (approx. 4.28 g) Kiwi Premix and 2 level '/4 tsp (approx. 2.46 g) iodised table salt (dissolved in a little hot water).
3. Mix thoroughly by hand and keep in refrigerator for maximum of over-night.

Presentation

Place ox-heart mix on plastic plate, flatten and make a small dip in which to place the mealworms.

Appendix 3.
Analysis of Kiwi Premix

Breakdown of Kiwi Premix from Suppliers
This table presents the daily dose per black stilt based on 0.16 g per bird per day.

Active Ingredient	Daily dose per stilt	Units	Source Material
Calcium (Ca)	46.3	mg	Calcium carbonate
Vitamin A	123.5	iu	Rovimix A 500
Vitamin D3	9.3	iu	Rovimix D3 400
Vitamin B12	0.0004	mg	Vit B12 conc.
Vitamin E25	0.93	iu	Rovimix E25
Thiamine	0.068	mg	Thiamine hydrochloride
Riboflavin	0.046	mg	Riboflavin
Ferrous iron (Fe^{2+})	0.386	mg	Ferrous fumerate
Vitamin C	0.772	mg	Ascorbic acid
Vitamin K	0.062	mg	Menadione sodium bisulphate
Vitamin H	0.003	mg	Biotin 1 % (Vit H%)
Zinc (Zn)	0.39	mg	Zn oxide
Manganese (Mn)	0.39	mg	Manganese sulphate
Copper (Cu)	0.039	mg	Cu carbonate
Iodine (I)	0.0039	mg	Potassium iodate
Selenium (Se)	0.0023	mg	Selenium stock conc
Cobalt (Co)	0.004	mg	Co carbonate
Pyridoxine	0.039	mg	Pyridoxine hydrochloride
Nicotinic acid	0.309	mg	Nicotinic acid
Pantothenic acid	0.232	mg	calcium D-pantothenate 80%
Choline	5.79	mg	Choline chloride 50%
Folic acid	0.015	mg	Folic acid
Inositol	0.154	mg	Inositol
BHT	0.15436	mg	Butylated hydroxy toluene

Appendix 4.
Suggested new diet formulation method for NZ black stilt

Ingredients

- Frozen minced ox-heart.
- Kiwi Premix (see Appendix 3 for analysis) from Carlyle Veterinary Clinic, Napier.
- Mealworms *(Tenebrio molitor)* Biosuppliers Live Insects (Telephone/ Fax 09 418-2352).
- Iodised table salt.
- Calcium supplement (calcium carbonate).
- Friskies Go-Cat (dry cat food) chicken, beef, calcium and vegetable flavour Friskies Pet Care, 1 Broadway, Newmarket, AuckIand.

Catfood/supplement mix

1. Blend 72 g Friskies Go-Cat in food processor until finely ground.
2. Add approx. 5.5 g Kiwi Premix (2'/2 level '/2 tsp).
3. Add approx. 3.2g (2'/2 level '/4 tsp) iodised salt.
4. Add 13.9 g calcium carbonate.
5. Mix powders thoroughly.
6. Add 56 g water.
7. Mix thoroughly and leave to soak overnight.

Ox-heart mix

1. Defrost and weigh 1 kg ox-heart mince.
2. Add the catfood/supplement mix.
3. Mix thoroughly by hand and keep in refrigerator for maximum of overnight.

Presentation

Place ox-heart mix on plastic plate, flatten and make a small dip in which to place the mealworms. Offer the same amount of ox-heart mix and add the same amount of mealworms as in the current diet.