Improvements in health and productivity of large psittacines fed formulated diets composed of organic ingredients.

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Abstract

Health and productivity of eight psittacine species (*Psittacus erithacus*, *Amazona* spp, *Cacatua galerita, C. moluccensis, C. galerita triton*, *Eclectus roratus*, *Ara* and *Anodorhynchus* spp) were evaluated at a commercial aviary in the USA following conversion from formulated diets composed of nonorganic ingredients (NOFD) to formulated diets composed of organic ingredients (OFD). Breeding success of psittacines maintained on a variety of NOFDs increased from 0.87 chicks per pair (n=150 breeding pairs) to in excess of 3 chicks per pair when birds were transferred to the OFDs, with improvements in health of both chicks and adults. The organic products provided lower levels of vitamin A (0.63-5.68 IU g^{-1} vs. 8.33-17 IU g^{-1}) copper (6-10 mg kg^{-1} vs. 10-17 mg kg^{-1}), iron (121-132 mg kg^{-1} vs. 140-233 mg kg^{-1}) and zinc (43-85 mg kg^{-1} vs. 128-130 mg kg^{-1}), with higher levels of fat (11-18% vs. 6.7-8%) and selenium (0.6-0.8 mg kg^{-1} vs. 0.3 mg kg^{-1}). Nutritional implications for the health and breeding success of these birds are discussed.

Introduction

Inadequate nutrition compromises the health and productivity of birds, with traditional seed-based diets not conducive to the production of large clutches or healthy offspring. Chronic illness and poor productivity associated with birds maintained on these diets (Angel, 1995) and vitamin toxicities from oversupplementation (Bourke, 1996; Schoemaker et al, 1997) has lead to an increased reliance on the use of formulated diets. However, despite improvements in fertility and productivity of birds fed certain extruded products (Howard et al, 1991; Meade, 1998; Stoodley, 1998), scepticism associated with formulated diets (Green 2001; Cravens 2002) is not without foundation (Carpino 1997). Many poorly formulated products are still correlated with high rates of infertility, poor hatching, weak, non-thriving chicks with crop emptying problems and high chick mortality (Harrison and McDonald, 2003).

While excesses of fat-soluble vitamins are implicated in a number of these problems, the use of nonorganic ingredients has also been questioned, with improvements in health of chicks and adults correlated with the use of organic extruded diets (Meade, 1998; Stoodley, 1998). Pesticides have been implicated in the modification of endocrine systems (McArthur, 1983) and behavioural abnormalities such as: reduction in courtship behaviour (Newton, 1976; Newton et al, 1978), incorporating a reluctance of females to take food from males (Snyder et al, 1973) and changes of activity patterns in males (Grue and Shipley, 1981); reduced levels of nest defence (Fox et al, 1978; Fyfe et al, 1976); alterations of incubation behaviour (White et al, 1983) and decreased parental attentiveness resulting in increased embryonic mortality (Peakall and Peakall, 1973; Fox et al, 1978); decreased time feeding young; fewer sorties to feed young and increased time away from nests (Grue et al, 1982).

While there is evidence of improvements in flock health and productivity when fed formulated diets composed of organic ingredients, it is unclear whether these changes are correlated with superior nutrient composition or the organic nature of the ingredients. This study provides a nutrient comparison among a range of formulated products to determine if there are any key nutritional differences or if the diminished exposure to pesticides can be implicated.

Methods

Data were evaluated from management records obtained from a commercial aviary in the USA, where birds were housed outdoors in suspended aviaries. The study group consisted of 150 breeding pairs comprising eight psittacine species (listed in Table 1) that were maintained on a variety of commercial bird pellets composed of nonorganic ingredients (Mazuri Parrot Maintenance, Pretty Bird African Special and Kaytee Exact Rainbow Breeder) for a period exceeding 15 years, before being transferred to organic formulated diets (HBD Adult Lifetime Coarse and HBD High Potency Coarse) with changes in health and productivity recorded. Housing conditions, pairing of breeders, feeding schedules and placement of nestboxes were not altered following conversion to the OFDs.

Nutrient composition of commercial products was evaluated from manufacturers' data reported at the time of the study with values reported for the organic products confirmed from independent laboratory analyses (Midwest Laboratories). Proportions of fruit, seeds and nuts outlined in Table 1 remained constant, with hyacinth macaws maintained on breeding diets all year round once transferred to the organic products (HBD High Potency Coarse).

Results

Breeding success increased from an average of 0.87 chicks per pair to in excess of three chicks per pair (n=150 pairs), when transferred from NOFDs to OFDs, with a reduction in embryonic death, poor chick development and adult aggression, and improvement in parental care, eliminating the need to hand-rear chicks. The high incidence of gram negative bacteria and budding yeast were all but eliminated in adults and chicks once transferred to the OFDs. Comparisons of nutrient composition of the formulated products are summarised in Table 2. The OFDs were higher in fat and selenium with the organic breeding diet having the highest value for vitamin E. In contrast, copper, iron, zinc and vitamin A concentrations were higher in the NOFDs.

Discussion

Dietary pesticide contamination has been correlated with a number of behavioural abnormalities, some of which were observed in this study. Parental aggression was prevalent in many breeders maintained on the NOFDs, forcing the removal and intensive hand-rearing of chicks. This negative behaviour was reduced when transferred to the OFDs, increasing the number of chicks that were parent reared until at least 10-12 weeks of age (Meade, 1998). While pesticide contamination may be implicated, the high concentrations of vitamin A in the NOFDs are also of concern as these may influence vocalisation patterns of chicks and thus parental response to begging behaviour (Koutsos et al, 2001).

While vitamin A is necessary for reproduction, dietary excesses can result in hyperkeratosis, weakening cellular membranes of reproductive epithelial tissue and increasing access to pathogens and infections. Vitamin A content of all NOFDs exceeded recommendations for cockatiels (Koutsos and Klasing, 2002) and may also have antagonised uptake of vitamin E, despite apparently adequate concentrations in most of the products. Deficiencies of vitamin E can increase susceptibility of spermatozoa to lipid peroxidation (Surai et al, 1998; Surai et al, 2001), impacting on fertility, which was significantly improved once birds were transferred to the OFDs.

The low vitamin A and high vitamin E content of the OFDs may have been enhanced by the higher selenium content of these products. Selenium (Se) is a key component of the enzyme *glutathione peroxidase* (GSH-Px) and Se supplementation of hens stimulates GSH-Px activity, improving the efficacy of the antioxidant system throughout embryonic development and early postnatal development of offspring (Surai, 2000). Increasing levels of GSH-Px in the seminal plasma of spermatozoa, testes and liver along with higher levels of α-tocopherol (as seen in the organic breeding diet), improve the antioxidant systems of spermatozoa (Surai et al, 1997; Surai et al, 1998), which are particularly susceptible to peroxidation due the nature of their fatty acid profiles (Surai et al 1998). It is possible that the higher selenium content of the organic diets enhanced sperm viability and fertility due to increased GSH-Px activity. Problems with hatchling susceptibility to infection were all but eliminated once adults were transferred to the OFDs and may be attributed to improved antioxidant status of hatchlings.

While dietary zinc requirements have not been established for psittacines, these birds are particularly susceptible to excesses of zinc (Doneley, 1992) and concentrations in the NOFDs all exceeded poultry recommendations (40 mg kg^{-1}; NRC, 1994). High levels of zinc can impair enteric absorption and/or transport of vitamin E as a consequence of zinc-induced pancreatic insufficiency, a major cause of reduced tissue concentrations of α-tocopherol (Lü and Combs, Jr, 1988), with lower levels of plasma tocopherol correlated with high levels of zinc (100-200 mg zinc kg^{-1}), equating to levels identified in some of the NOFDs. It is possible that high levels of zinc in the NOFDs diminished availability of vitamin E, impacting on fertility and compromising the immune systems of hatchlings.

Conclusion

In the absence of controlled experimentation, the data presented here is not adequate to conclude whether the improvements in health and productivity recorded in this study are a consequence of the organic nature of the ingredients or the nutritional formulation. Behavioural abnormalities normally associated with pesticides were diminished with the introduction of the OFDs but excesses of vitamin A may also be implicated. Increased fertility and production may be attributed to improvements in the antioxidant system from the higher selenium and vitamin E and lower vitamin A and zinc content of the OFDs. The increased quantity and quality of offspring, decreased time required to hand-rear chicks, increased longevity of breeding pairs and decreased veterinary expenditure, all increase the economic viability of using the OFDs, with chicks produced in this study attracting an additional 10% premium in recognition of the exceptional health of the babies. While it is unclear whether the organic nature of the products or superior nutritional quality support higher production and greater health in psittacines, it is evident that the provision of nutritionally balanced formulated diets can improve health and productivity of aviary birds.

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Species	**African Grey *(Psittacus erithacus)***	**Amazon (*Amazona spp*)**	**Cockatoo (*Cacatua galerita*)**	**Cockatoo (*C. moluccensis/ C. galerita triton*)**	**Eclectus (*Eclectus roratus*)**	**Macaw (*Ara spp*)**	**Macaw (*Anodorhynchus spp*)**
Pellets	40 (69)	40 (74)	45 (76)	70 (83)	35 (60)	40 (58)	40 (54)
Seeds	10 (17)	6 (11)	6 (10)	6 (7)	15 (26)	15 (22)	15 (20)
Almonds	0.5 (0.9)	0.5 (0.9)	0.5 (0.9)	0.5 (0.6)	0.5 (0.9)	0.5 (0.7)	3 (4)
Peanuts	0.5 (0.9)	0.5 (0.9)	0.5 (0.9)	0.5 (0.6)	0.5 (0.9)	0.5 (0.7)	3 (4)
Fruits	3.5 (6)	3.5 (7)	3.5 (6)	3.5 (4)	3.5 (6)	6.5 (9)	6.5 (9)
Vegetables	3.5 (6)	3.5 (7)	3.5 (6)	3.5 (4)	3.5 (6)	6.5 (9)	6.5 (9)
Total (g)	58	54	59	84	58	69	74

Table 1. Composition of diets fed to psittacines at aviary 2. All quantities are expressed in g (as fed) with figures in parentheses indicating percent total diet (as fed).

Table 2. Nutrient composition of various commercial parrot foods. ¯ indicates no data available.