Nutritional Research with Budgerigars

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Concepts in Formulating a Diet

We asked the Research Committee of the American Federation of Aviculture if they were interested in supporting a research project with budgerigars *(Melopsittacus undulatus).* They were very interested in our proposed project to determine the protein requirements and utilization of dietary ingredients in a balanced diet based on other than seeds, which have been the basic dietary ingredients that most bird owners feed. The proposal was the research requirements for a Masters Degree in Avian Nutrition at the Department of Animal Science, Michigan State University by Mr. Michael Underwood. This report will summarize some of the interesting findings in that research endeavor.

As we pointed out to the AFA committee, seed mixes are most often deficient in vitamins, minerals, and certain essential amino acids. Furthermore, the birds dehull the seeds, thereby tossing away fiber, an important part of the diet and B vitamins that reside in the seed hull. These are items that the bird owner must supplement in the diet if they expect to approach a balanced nutrition. One other important aspect of seeds is that those with high protein concentrations are usually the ones with high fat content so that, when consumed as the major part of the diet, they result in fatty kidneys, livers and an accumulation of fat in blood vessels, deposits that often result in obesity and damage to those important organs. Exotic birds in captivity just do not live as long as they should; everyone recognizes this and the lack of proper nutrition has been a major cause for this premature mortality. A need for better diets is obvious. We had thought of formulating a diet from seeds but, with the birds throwing away the hulls, an undetermined quantity of the diet, we gave up on that idea. We just could not see us sitting down with a pile of seeds, taking each hull off the seed and doing enough of these to obtain an exact weighing of what proportion the hulls weight for each type of seed. Then the other problem was how do you add the proper concentrations of vitamins, minerals, and essential amino acids to the diet and be certain that the correct proportion of all nutrients are consumed by each bird. We are very aware of attempts to coat seed hulls with vitamins but penetration of the hulls is impossible to accomplish. Remember, the hull is nature's way of protecting the germ inside that seed. There is no scientific evidence to show that such coatings with vitamins penetrate. Then you are back to the problem of the hull being discarded. So, our research was the first to try and develop a diet for budgies from ingredients most popularly used in pet foods for dogs, cats, fish, quail and pigeons. Pelleting would have been the ideal approach to the diet. But, because very small amounts were to be made for each experiment, we decided to chance the feeding of the diet as a mixture of the ingredients as they are purchased from the mills.

We had to make certain assumptions to study the requirement for protein and assume certain detailed considerations for the need of the ten essential amino acids that most birds are known to require. This is unlike mammals that only require the ten essential amino acids during their early growth. After that, the requirements shift to a lesser number of amino acids and it depends on the species as to which amino acid is no longer required. That is one reason why feeding cat, dog, monkey, or rodent chow to birds is a no-no. Long term feeding problems from improper nutrition do occur. We also had to assume that mineral and vitamin requirements would be similar to that of certain animals including other birds. We used our knowledge from the research that has been performed with farm animals to derive a diet that would be optimum in all respects except for the particular nutritional item that we desired to vary and, in this case, that was the protein concentration. In addition, we had to assume certain energy requirements. As a result of changing only the protein and maintaining the energy concentration constant we had wide shifts in the protein to energy ratio, a very important consideration when formulating diets. *This is of utmost importance as the energy concentration of the diet is a major determinant for controlling food intake.* This meant that in the future we would have to research the protein energy ratios that are optimum for the budgie. Another consideration was the make-up of the calories that are part of the energy constituency. These are very important because of feedback mechanisms that control how the liver functions for regulating fat metabolism. With all of these as unknowns for budgies, one would suspect that it would be difficult to arrive at a diet that would work. Actually, with sufficient nutritional knowledge gained from other animals, the formulation of such a diet is not difficult for a professional nutritionist knowledgeable in the area of bioenergetics to arrive at what would be a close approximation of what the budgie requires. In some situations, we could provide an excess to be certain that the nutrient would be available yet know that no harm would come to the animal. Certain nutrients have a wide margin of safety so they could be present in excess, but one has to be careful not to overdo this as nutrient interaction can make other nutrients unavailable. There is basic nutritional information applicable to most animals that would allow some very good guesses on what the budgies would require nutritionally. What we wanted to do was to establish with better certainty what those requirements actually were. One must also remember that environmental conditions will influence dietary considerations so we had to make certain assumptions in regard to what these would be. That part was easy because we controlled

the environment to a considerable extent.

The diets that we decided to use were varied in the following protein concentrations: 12%, 17%, 22% and 27%. For comparison, we included in the experiment a seed-type diet that was indicated to be used for feeding budgies that we purchased at a local store. It contained 11% crude protein.

Converting the Budgies from Seed Eaters to Eaters of Formulated Diet

Now that you have an idea of how we started out on the dietary concept, we then had to develop the technique to have the budgies eat the diets we would formulate. Our sources of budgies were commercial breeders who could supply us with an adequate number of birds (mixed sexes) to do the study. These suppliers feed seeds to their birds. So, we had to train the budgies to eat the formulated diets that we prepared because only through such diets of known ingredients and nutritional composition could we hope to determine certain nutritional requirements.

All budgies in these trials were converted to a commercial budgie crumbled diet of 20% crude protein from the commercial seed mix of 11% protein. At first they were given a mixture of 50% seeds and 50% crumbled diet, the latter mixed with enough (5%) vegetable (corn) oil to make it appear moist. This mix was fed to the birds in quantities small enough so that they could not pick out as many seeds as they would normally eat. Over several weeks, the percentage of seeds was slowly reduced, and finally eliminated. Also, the amount of vegetable oil was slowly reduced over this time with the non-coated diet added to replace the percentage reduction in seeds and oil-coated diet. As indicated in Table 1, eventually the commercial crumbled diet for budgies was the only food being fed. If an individual bird appeared sick at any time during the conversion, it was separated and fed only seeds until it recovered. Then conversion for that bird was attempted again. In Table 1 are listed our experiences in converting budgies from seed type diets to formulated diets. In our first experience, we had substantial mortality from starvation. You will note several items that form a pattern. First of all, some mortality occurred in the shipments soon after the birds were received. We attributed that to the stress of shipping. We fed seeds to the budgies as soon as they came in and for several days, so they were not stressed from any attempt to convert to the mash diets. Next, you will note that our greatest mortality occurred in our first attempt for conversion. Experience with the conversion procedure indicated that if the conversion was rushed, mortality would result from starvation of the budgies. The last item to note is that most of the mortality occurred after we thought the budgies were converted to the diets. What we noted during the first experience was that budgies would fly to the feed troughs to eat and look as if they were eating. Actually, careful observation of some revealed that all they were doing was picking at the feed. Those that died late in the conversion process lost considerable weight, and it was that clue that made us note their feeding behavior. In the second and third set of budgies we converted, we took successively longer periods of time to convert them from seeds to mashes. Our survival rates were 70, 98 and 90% for each of the three attempts to convert 63, 99, and 97 birds, respectively.

Experimental Data

Once the budgies were converted to the crumble diet, they were fed this diet for several weeks before the birds were used in the experiments. In our first experience with some budgies that were trained to eat formulated diets, we used wheat bran in the diet; the wheat bran was selected to supply a goodly portion of the fiber that is needed in the diet, besides supplying some other nutrients. The budgies would have no part of that. They selected out the other ingredients and refused to eat the bran. We surmised that the bran looked so much like hulls that they avoided it. We could not use that diet, so back to the computer to see what we could do. The diets that we subsequently formulated were eaten in their entirety.

During the experiment that lasted four weeks for some birds and eight weeks for others, the budgies were weighed every seven days. Those that were fed for four weeks were euthanized for carcass analysis of lipid, protein and ash. At the end of the eight weeks for the experiment, the remaining birds were euthanized and

Table 1

Conversion of Budgies from Seed to Crumble Diet

First Attempt: 63 birds	Day of Experiment	Procedure
	1	Fed seeds in colony cages
	5	Fed 50% seeds/50% oil-coated crumble diet*
	6	1 dead
	7	1 dead
	11-23	Reduced seed and oil-coated diet gradually, adding non-coated diet
	24	Moved birds from colony cages to 3 per cage
	24	Fed dry crumble diet only
	24-44	Fed only dry crumble diet, 17 dead
	Summary:	**Alive 44, Dead 19, Survival Rate 70%**
Second Attempt: 99 birds	**Day of Experiment**	**Procedure**
	1	Fed seeds in colony cages
	5	Fed 50% seeds/50% crumble diet*
	6	1 dead
	8	1 dead
	12-31	Reduced percentage of seed and oil-coated diet gradually, add non-coated diet
	32	Feed dry crumble diet only
	51	Moved birds from colony cages to smaller cages, 3 per cage
	Summary:	**Alive 97, Dead 2, Survival Rate 98%**
Third Attempt: 97 birds	**Day of Experiment**	**Procedure**
	1	Fed seeds in colony cages
	10	Fed 66% seeds/33% crumble diet*
	14	1 dead
	19	Fed 50% seeds/50% crumble diet*
	22	3 dead
	23	1 dead
	28	1 dead
	29	1 dead
	38	Fed 25% seeds/75% crumbles diet of which 50% is non-oily
	63	Fed dry crumbles only
	65	1 dead
	67	1 dead
	69	1 dead
	Summary:	**Alive 87, Dead 10, Survival Rate 90%**

* Crumble diet has 5% corn oil

Table 2

Weight Gains and Body Fat Concentrations of Budgies Fed Various Diets

Dietary Treatment	Start Wt., grams	Average Wt. Gain, 8 Weeks	Based on % Dry Weight	
			Carcass Fat	Carcass Protein
Seed diet	28.7	4.9	28.7	63.7
CP at 14.8%	30.5	1.0	29.1	66.6
CP at 17.8%	28.6	1.3	21.4	72.4
CP at 23.8%	29.7	2.4	27.8	66.4
CP at 30.7%	29.9	2.8	23.6	60.0

their carcasses analyzed for the same constituents. Feed intake and body weights were monitored weekly. In addition, the formulated diets and their excreta (droppings) were analyzed for moisture, crude protein and the caloric (energy) value. Thus we were able to obtain measurements on the retained energy and retention of the crude protein, as well as the digestibility of the diet. These latter measurements were not possible for the seed diet because of the undetermined loss of the hulls and their contamination into the excreta.

The 24 budgies fed the seed mix consumed on the average for the eight weeks of the experiment 7.6 grams per day. Those fed the diets with varying protein ate 6.5, 5.8, 6.1, and 5.9 grams per bird per day for the diets with protein concentrations of 12, 17, 22 and 27% respectively. This intake represented 20 to 21% of the starting weight of the budgies, a value representative of the caloric needs of these small birds with such a high heat output. They digested the diets to the extent of 69 to 80%, with the 27% protein diet having the lowest digestibiltiy. The 12% protein diet was digested to the extent of 78%, while the 17% diet had the highest value of 80%. There was a significant statistical effect for the digestibility to decrease as the protein concentration of the diet increased above 17%. The highest value for energy retention (83%) was also associated with the 17% protein diet, with the energy of the 12% protein diet retained to the extent of 81%. The other two diets analyzed at 78 and 76% retention of energy.

Based on the National Research Council (NRC) table of feed ingredient values, the budgies retained about 14% more energy from the diets than one would expect from chickens eating the same diet. This was consistent for all of the formulated diets. Incidentally, the crude protein analysis of the diet revealed they actually contained crude protein concentrations of 14.8, 17.8, 23.8, and 30.7%, values that can be compared to the estimated values cited above that are based on tables of nutrient composition. This can vary depending on where the feed ingredients are grown or purchased, so some variability is the rule, not the exception. That is why diets need to be analyzed to be assured that they contain what they are supposed to contain.

Crude protein (CP) retention amounted to 44.5, 47.9, 40.3, and 42.5% for each of the diets with analyzed values of 14.8, 17.8, 23.8, and 30.7%. What this means is that 44.5% of the 14.8% CP diet was actually retained for use by the budgies, and that 47.9% of the 17.8% CP diet was retained, etc. Another way to evaluate the data is to calculate how much of the protein that the budgie eats daily is retained in the bird. Récall that the feed intake per day averaged about 5.8 grams for the diet that contained 17.8% crude protein. So, the daily intake of CP was 1.03 grams. Of that amount, 0.5 grams of CP is retained. Similarly, one could calculate the retained protein for the other diets. One can measure the cost effectiveness of the diet from a nutritional point of view if that is a consideration. However, body composition to be expected from feeding the diet is a more important aspect for a pet animal.

The budgies used in the experiments were full grown so growth criteria were not available. However, the impact of the diet on body composition is an important aspect of feeding. One item we desire to avoid is obesity, and nutritionists have known for a long time that high protein diets force the body to use much energy for digestibility and are excellent for keeping the fat content of the body at a lower concentration. (We refer to this phenomenon as heat increment or specific dynamic effect or heat of nutrient metabolism.) This picture was reflected in these short term experiments, and is a major consideration for establishing where one wants to target the nutrient composition of the diet. The carcass compositions give us a clue as to what is happening. Remember these budgies were fed a commercial formulated diet of 20% protein before they went on the experiment. So, one would not expect much change if the diets they were then fed in the experiment were close to that level of CP.

Feeding the seed diet resulted in average body weight gains of 4.9 grams for the eight weeks of data collection, as compared to weight gains of 1 to 2.8 grams for the formulated diets. The other item to note is the rapidity at which body fat is deposited from feeding the seed diet or the diet with 14.8% analyzed CP. There was some variability in the carcass fat, but generally CP concentrations greater than 14.8% resulted in less carcass fat.

The other aspect to consider is the protein concentration of the carcass. The data indicate that the budgies with the highest protein concentration were those from the diet with 17.8% CP. Not involved in this experiment were the protein to calorie ratios that could have an impact on carcass composition. Note that the seed diet and the formulated diet with 30.7% CP (the two extremes) produced the lowest carcass protein in the budgies. These budgies had been defeathered before they were analyzed so the feathers are not a factor in these data. Also there were eight to ten birds comprising the data for each diet, a sufficient number to determine the trends for any change in carcass composition.

In conclusion, feeding budgies a commercial seed diet resulted in rapid weight gain mostly as fat in the carcass. A formulated diet with CP of 17.8% CP appeared to produce the carcass with the lowest fat and the highest protein concentrations. It also resulted in the highest digestibility and energy retention. Based on the trends of the various data, one could conclude that the optimum concentration of CP for maintenance is somewhere between 17.8 and 23.8% CP with an energy concentration of 3.03 kcal/g diet (based on NRC tables of nutrient composition). Budgies assimilated about 14% more of the dietary energy than expected from data based on the tables of nutrient composition.

There was another aspect of the research that dealt with the specific utilization of certain feedstuffs and this will be discussed in a separate article.

About the Authors

Dr. Donald Polin is professor of avian nutrition and toxicology at Michigan State University. He has over 80 refereed publications in scientific journals and a total of about 140 papers and abstracts. He received the American Feed Manufacturer's award for his research in 1984, and is a member of many scientific organizations including the American Institute of Nutrition. He has served on Committees for the National Academy of Sciences — National Research Council, and has served as consultant to projects overseas and in the United States.

Mr. Underwood is president of Avi-Sci, Inc., producers of Dr. D's feeds, and consultant to the U.S. Endangered Parrot Species project in Puerto Rico. Mr. Underwood has raised exotic birds most of his life and is currently Michigan Coordinator for the American Federation of Aviculture (AFA). He is involved in preventing legislation in Michigan that would severely limit ownership of exotic birds. ●

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