COLUMBIFORM CROP MILK AND CROP MILK REPLACERS

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Introduction

Altricial chicks undergo an intense period of growth in the first few weeks of life. These chicks' huge needs for nutrients are usually met by their parents feeding them high protein food items such as insects, other invertebrates, or vertebrate prey. Columbiformes (doves and pigeons) have conquered this nutritional obstacle a different way, by manufacturing the perfect food for their chicks themselves. This "crop milk" is fed to chicks exclusively for approximately the first 3 days of life and then a gradually increasing portion of adult diet is mixed into the food as the chick matures. When captive rearing is necessary, it can sometimes be very frustrating for caregivers to successfully reproduce the fledging rates and weight gains seen in parent-reared birds, and a major contributing factor of this frustration has been dietary issues and finding an effective crop milk replacer.

What is crop milk anyway?

Crop "milk" is similar to mammalian milk in that it is a high energy substance produced by the parent that supports the rapid development of the newborn. However, crop milk differs from mammalian milk in several notable ways. It is produced in the crop rather than in mammary glands, is produced by both male and female parents, is a *holocrine* secretion rather than a *merocrine* and *apocrine* secretion, and lacks significant amounts of carbohydrates. In a mammary gland, the constituents of milk are manufactured by cells lining the gland and vacuoles (membrane-lined packages) of these products are extruded from gland cells into the branched collection ducts by merocrine (large vacuoles) or apocrine (small vacuoles) secretion. Consequently, normal mammalian milk has few to no whole mammary cells present in it, instead consisting of a liquid stew of nutrients. In the crop, however, the cells of the crop lining swell up with fat and other crop milk constituents, and then whole cells that have been packed with nutrients slough off to form a thick holocrine secretion. Thus, since crop milk is directly made from whole crop cells, chemically speaking, crop milk closely resembles avian muscle tissue, with extra fat added to raise the caloric content.

What is crop milk made of?

Crop milk consists of protein and fat with very low levels of carbohydrates, with several additional beneficial compounds. Typical analysis shows the macronutrients to be 9-13% protein, 9-11% fat, and 0.9-1.5% carbohydrates by wet weight. By dry weight, these values are 33.8-66% protein, 33.8-55.8% fat and 3.4-5.6% carbohydrates.[4] For comparison, whole cow's milk is 3.2% protein, 3.3% fat and 5.3% carbohydrate by wet weight and 27.6% protein, 27.8% fat and 45.0% carbohydrate by dry weight.[11] The wet weight numbers show how much denser crop milk is than cow's milk: 19-26% solids vs. 11.8% solids in whole cow's milk. Crop milk has less moisture in it than canned cat food, and as such is a thick, cheesy material.

Protein: The protein in crop milk is of course of animal origin, being composed of sloughed cells of the parent's crop. It closely resembles muscle tissue nutritionally, and has approximately 17% free amino acids as well.[5] Chicken meat and egg white are good approximations when formulating hand feeding diets.[4,11] Vegetable sources of protein typically have very different amino acid profiles, consequently plant origin foodstuffs are not likely to provide adequate nutrients to the youngest columbids. By the second week of life, however, columbid chicks are physiologically ready to start being introduced to these plant materials they will depend upon as adults. Chicks do not start producing the enzymes for digesting these foods until the second to third week of life.

Fats: The fat content of crop milk is quite high, in the neighborhood of marine mammal milk. There are substantial amounts of saturated fat, essential fatty acids, and other miscellaneous lipids associated with cell membranes such as phosphatidyl choline, cholesterol, and others. The majority of the fatty acids are oleic (50.9%), linoleic (22.6%), palmitic (11.0%), and stearic (8.3%) acids.[8]

Carbohydrates: Carbohydrates are present in crop milk in very small amounts, and may just be stray bits of parent food found in study samples. It is unknown whether this quantity of carbohydrates is important or incidental.

Minerals: Crop milk has a lot of phosphorus compared to calcium for the first few days, but this drops to more typical levels for growing chicks by the 5th day.[9] The rehabilitation community typically supplements columbid chicks of all ages at a ratio of 2:1 elemental calcium to phosphorus by weight. No problems have been noted with this level of supplementation in thousands of chicks of North American species raised by the author. Wild columbid chicks sometimes present for care with metabolic bone disease. Crop milk is also rich in iron, zinc and copper for the first few days.

Other important things in crop milk

Immunoglobulins: IgA is an immunoglobulin that provides general localized immunity by binding to pathogens within the gut and preventing them from invading the body. There is also some evidence that pigeon squabs directly absorb parentally derived IgA by taking it in whole across their gut walls.[3] These compounds serve to protect the chick from infection while its own immune system matures. Raw or dried egg products may help provide some of this, as IgA is present in eggs as well. IgA is denatured by cooking.

Beneficial gut flora: Like the GI tract of other animals, the crops of columbid parents contain a beneficial population of normal gut bacteria, and as the chick is fed it becomes inoculated with these species of flora. In domestic pigeons, these bacteria are almost exclusively gram positive streptococci and lactobacilli.[10] Other species of bacteria have been isolated from rock pigeons, but have limited relevance here since study birds were not healthy.[1] There is some evidence that crop flora assists in breakdown of cellulose as the chick begins to consume adult diet. The most readily available source of normal flora is a fresh speck of feces from a healthy adult conspecific. However, this does, of course, carry the risk of pathogen transfer. An alternative is to use diet

recipes with live Lactobacillus cultures and/or supplement the diet with commercial avian probiotics.

So, what to feed hatchlings?

MacDiet, developed by Janine Perlman and Astrid MacLeod, is an excellent choice, as it closely matches the composition of natural crop milk. Subsequent to the publication of the below article, the authors have modified the diet slightly by using raw egg yolk rather than boiled. The raw egg may carry a higher probability of bacterial contamination and require greater attention to freshness of the formula, but raw egg yolk provides an excellent source of IgA. This diet recipe is available online at http://www.iwrc-online.org/journal/journal4-17.pdf. Pages 9-14 of the pdf contain the article. This article also discusses the use of pancreatic enzymes to pre-digest crop milk replacers for extremely young chicks. Some rehabilitators are turned off by this diet's seemingly complicated supplements and sometimes drop ingredients without thinking about the consequences of missing nutrients. Every ingredient is important and must be included.

Another crop milk replacer is recommended in Chapter 20 Pigeons and Doves in *Hand Rearing Birds.*[6] This diet has a higher protein/fat ratio than crop milk (58.3% protein, 21.7% fat, and 14.9% carbohydrate by dry weight), but has been used successfully on several hundred hatchling mourning doves and rock pigeons over the course of several years.[2] Since the book went to press, however, it has been revised to be as follows: 1 jar Beechnut Chicken and Gravy baby food (71g), 1 tbsp plain low-fat yogurt (15ml), 2 tbsp dried egg yolk (8g), 1/8 tsp Avi-Era avian vitamins (LaFeber), 250 mg elemental calcium from 625 mg CaCO3. The newer version of the diet provides 50% protein, 36% fat and 1.6% carbohydrate by dry weight.

San Diego Zoo hatchling columbiform protocol feeds chicks whole raw chicken egg mixed 50:50 with Pedialyte.[12] This provides 47.2% protein, 37.7% fat and 12.3% carbohydrates by dry weight. This protocol also calls for hatchlings to receive a daily dose of Nystatin against yeast infections. If this diet were made with water instead of Pedialyte, the ratios would be even closer to natural crop milk: protein 59.5%, fat 47.0%, and carbohydrates 3.6% by dry weight.

Disney's Animal Kingdom Columbiforms Handrearing Techniques video recommends feeding soaked Mazuri Parrot Breeder pellets. This diet provides 20.5% protein, 8.3% fat and 60.5% carbohydrates (by difference) mostly from corn and soy. Kaytee Exact, another psittacine hand feeding formula, provides 24.4% protein, 10% fat and 54% carbs. Psittacine diets do not provide enough protein or fat for columbid chicks during their first week of life. Kaytee Exact, however, has beneficial bacteria and digestive enzymes already mixed into the diet.

Roudybush makes a powdered Squab Diet that some wildlife rehabilitators have recently reported excellent results with. This diet merits further investigation, but this author cannot currently comment on its suitability or efficacy.

Potential problems of chicks

Chicks hatched in a brooder are more likely to be in good condition when hand rearing commences. Hatchlings ejected from nests for whatever reason are often chilled and may be

significantly dehydrated. These chicks should be warmed to normal body temperature prior to being given anything, then hydrated until the chick has passed droppings and any parent food has passed from the crop before starting hand feeding. It is important to start care of debilitated chicks by following a "warmth, fluids, THEN food" order of operations.

Many aspects of housing and diets can lead to crop problems in columbid chicks, such as inadequate warmth or humidity. During rehabilitation of wild species, Rehabilitators commonly raise chicks that have been caught by cats (or other predators) and may have crop lacerations or other injuries such as broken bones. Wild chicks also present with crop infections, such as with *Trichomonas gallinae* or Candida (yeast). These infections can cause crop stasis or the presence of palpable crop masses. A crop swab should be evaluated on any chick having crop motility problems. Microscopic evluation of a fresh wet mount from a crop swab can differentiate these problems. Probiotics are recommended if chicks require antibiotic treatment. Extremely young hatchlings having problems emptying their crop should have their food treated with digestive enzymes prior to feeding, as discussed in MacLeod and Perlman.[7]

Wildlife rehabilitation centers face several challenges probably not seen as frequently in zoo aviculture: 1) too many chicks to feed at once and 2) a need for birds to remain as wild as possible behaviorally. The first issue is often dealt with by tube feeding instead of allowing the birds to swallow their meals drop by drop, which is very time consuming. We typically feed 10% of body weight as often as the crop empties (or near-empties in some species), for at least 12 hours a day, usually every 2 hours for very young chicks, to every 3-4 hr for older birds. Tube feeding is less messy when dealing with volunteer caregivers of variable skill levels, as growing feathers must stay clean. Tube feeding also helps rehabilitators deal with issue #2, as tube feeding is fast and does not involve a lot of interaction with chicks. Chicks are always raised with conspecific companions. During the height of the busy season, the author's local wildlife center has up to 350 birds being hand fed at a time, of mixed species with a variety of health problems, mostly passerines and columbiformes.

When raising columbids for wild release, each young bird's plumage must be of as high quality as its wild counterparts. In the author's experience, columbids raised on lower protein or plant protein diets during hatchling-hood develop much poorer quality plumage. The high animal protein crop milk replacers grow chicks of much higher plumage quality. This is less of an issue if the bird will be remaining in captivity.

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