EARLY NUTRITION AND IMMUNE DEVELOPMENT

Julia Dibner and Chris Knight
Novus International, Inc
20 Research Park Drive
St. Charles, Missouri 63304

Introduction

Hatchling birds, including poultry, are very susceptible to early stress and mortality from a variety of causes. The birds tend to get a slow start and often do not immediately begin to eat and drink on their own. Lightweight hatchlings are especially vulnerable. If there is a delay in the intake of feed and water, consequences include poor response to vaccination, slow gastrointestinal and immune development, poor disease resistance, and also poor long-term growth performance. Composition of the feed also affects development of digestive and immune systems. These tissues use glucose and glutamine as preferred energy substrates (Watford et al, 1979), and since the residual yolk has no remaining glycogen, if feed is not provided the bird must degrade protein for the amino acids used as substrate for gluconeogenesis. Glucogenic amino acids include glutamine, arginine and even limiting amino acids such as methionine. Thus, the nutrient profile of feed for the immediate post hatch period should be rich in highly available carbohydrates. The availability of substrate will affect development of the gut, which in turn will determine future nutrient availability and influence resistance to disease.

The bird is particularly susceptible to disease in the early post hatch period, in part due to immaturity of its immune system (Lillehoj and Chung, 1992). In the hatchling, all humoral immunity must be provided by maternal immunoglobulin from the residual yolk. Perhaps the most important source of pathogens in the hatchling is the gut, which is virtually unprotected in the neonate (Dibner et al, 1998). Optimally, establishment of a stable gut microflora should take place at this time, and the nutrient composition of the early feed can influence the species available and selected for colonization. Thus, inclusion of antimicrobial substances such as organic acids can help establish a microflora high in acid tolerant microorganisms (Cherrington et al, 1991). Such a microflora will tend to reduce the numbers of opportunistic pathogens such as Clostridium and Salmonella (Hinton and Linton, 1988).

Source of Early Nutrition

Oasis® hatchling supplement has been designed to be a complete source of feed and water to the hatchling. The dry matter is about half carbohydrate, in a particularly available form, and half

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protein. The moisture content of the Oasis formulation as sold is 30%, but this can be doubled easily by the addition of water. A moisture content of 30% is adequate for the first day of life, when the balance of water that might be needed can be absorbed from the residual yolk, which usually contains about 3 g of water at hatch. It is important to add water when Oasis is used as the sole source of nutrition and water for more than 24 hr, as in bird shipment. Addition of water also allows the producer to include other soluble compounds that may benefit the hatchling.

Another important aspect of the Oasis formulation is that it includes organic acids. The Oasis formulation contains three organic acids: citric, sorbic and propionic at a final total of about 3%. All of these have shown antimicrobial activity that can contribute to the establishment of an acid tolerant microflora (Izat et al, 1990; Roth and Kirchgeshner, 1997). Feeding organic acids has been associated with benefits beyond those associated with microbial control, such as enhanced nutrient digestibility through increased pancreatic secretion (Harada and Kato, 1983).

Our own studies confirm these beneficial effects of proper early nutrition.

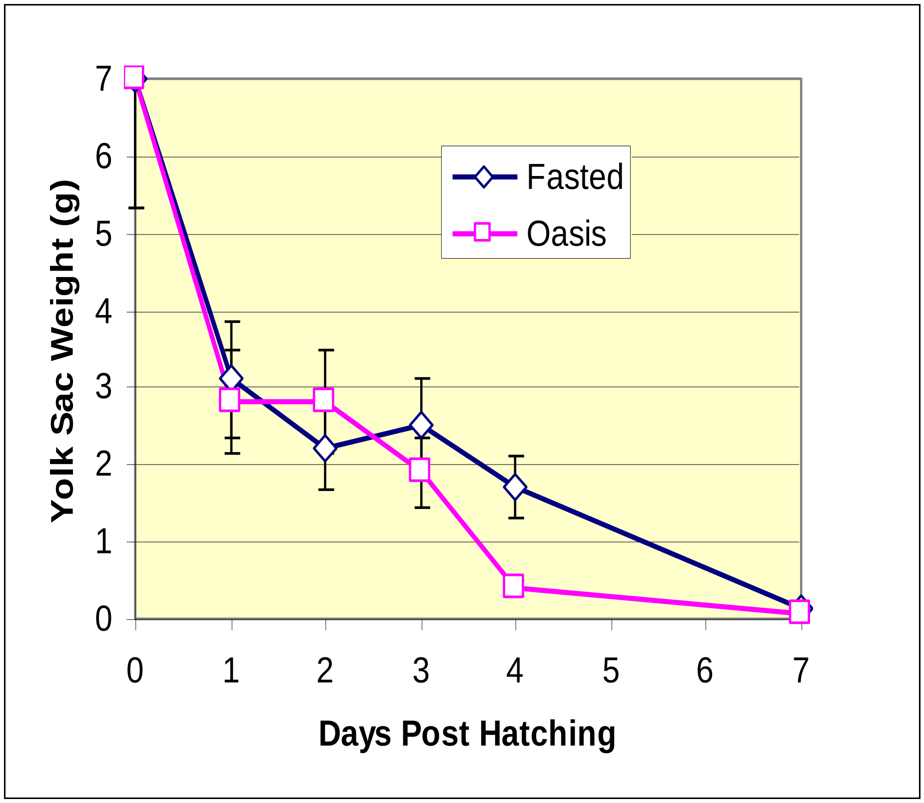

Figure 1 Effect of Fasting or Feeding Oasis on use of residual yolk by hatchling turkey poults.

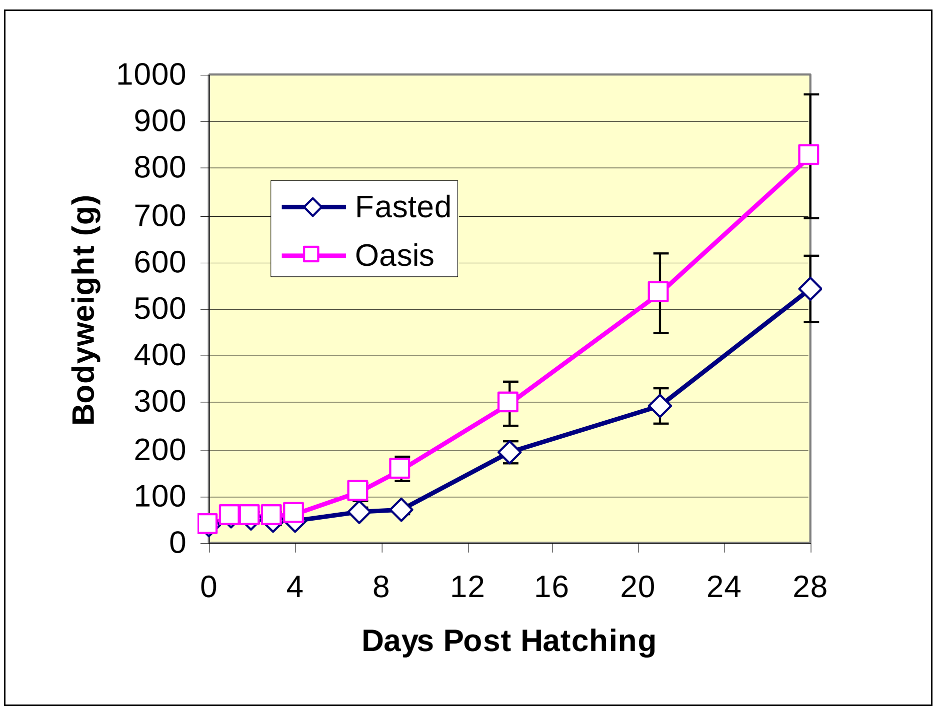

Figure 2 Feeding Oasis was associated with a long term body weight advantage.

Figure 1 shows the effect on yolk sac weight when hatchling turkey poults are not fed immediately. These birds were fed Oasis® Feed Supplement or were fasted in the early post hatch period (days 0-2). In terms of body weight, fasted poults lost 1.12 g and fed birds gained 1.0 g over the treatment period, but fasting did not change the rate of yolk utilization. Absolute weight of yolk sacs confirmed that fasted birds do not show accelerated use of their residual yolk as a way to compensate for a lack of feed. Figure 2 shows that body weights in the fasted poults were significantly lower than those fed Oasis. The presence of organic acids may play a role in the trophic effect of Oasis on the pancreas (Figure 3). The stimulation of pancreas secretion by dietary organic acids has been well documented in swine and ruminants(Harada and Kato, 1983; Roth and Kirchgeshner, 1997).

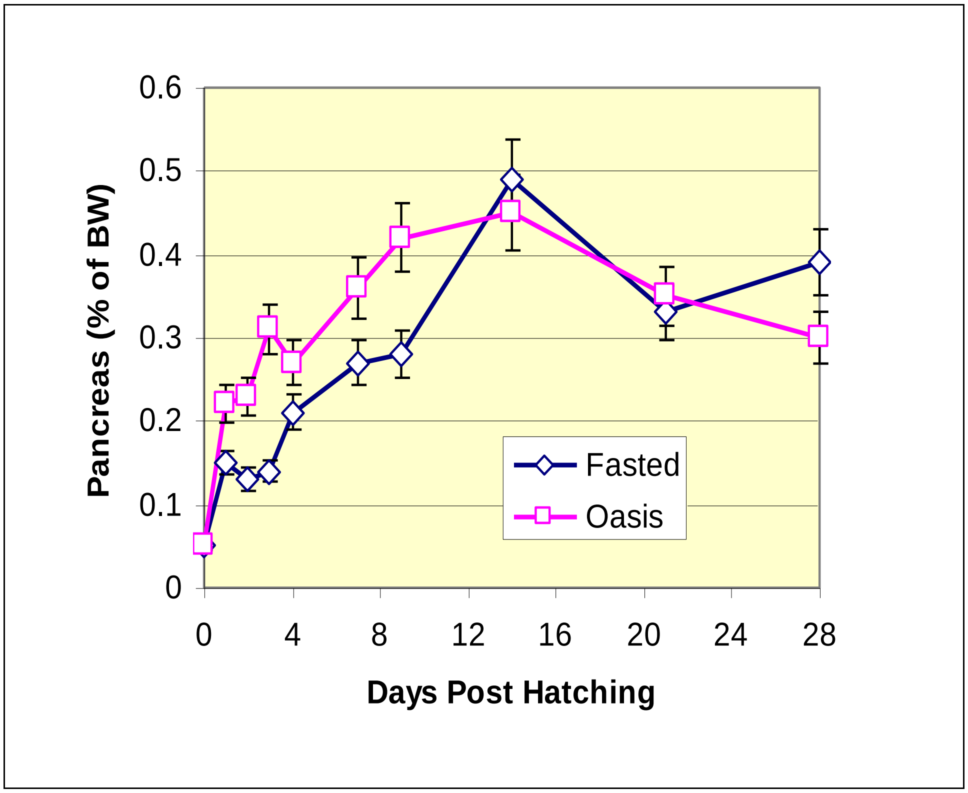

Figure 3 The trophic effect of Oasis on the pancreas may be due to the presence of organic acids in the formulation.

Early Nutrition & Gastrointestinal Function

Early nutrition and initiation of feeding seem to be essential to optimum performance, as numerous reports in the literature demonstrate the impact of delays in feeding on growth and livability (Fanguy et al, 1980; Moran, 1990; Pinchasov and Noy, 1994). Delayed feeding has been shown to retard maturation of systems that begin developing in the hatchling only after the availability of feed. This is particularly marked in the gastrointestinal system, including effects on liver and pancreas (Sell et al, 1991).

Gut development - not only villus growth but also enterocyte differentiation - depends in part on oral intake (Baranyiova, 1972; Baranyiova and Holman, 1976). Intestinal motility, nutrient transport systems, pancreatic enzyme secretion and bile salt synthesis are all examples of systems which are partly developed at hatch but whose development to adult levels requires oral intake (Nir et al, 1988; Noy and Sklan, 1995; Palo et al, 1995; Uni et al, 1998).

Noy and Sklan (2001) reported that after an initial growth reduction, the weight of the small intestine increases more rapidly in relation to body weight than other organs of both chickens and turkeys. They stated that this enhanced growth is at its maximum in poults at 4-6 days after hatch and then decreases. Microscopic examination of the intestinal mucosa showed that the villi increased rapidly in size, and hence surface area. However the rates differ in the different segments of the small intestine. They believe these changes in the gastrointestinal tract are required in order to facilitate the change-over from yolk dependence to feed.

Noy and Sklan (2001) also reported that delayed provision of nutrients for 48 hr affected the growth of the organs of the gastrointestinal tract. This was found for the crop, small intestine, and large intestine in both poults and chicks. Morphological examination of the gastrointestinal tract from birds held with no access to feed or water for 48 hours showed decreased villus growth at 48 hr post hatch; further, the major reduction in villus size and enterocytes per villus was apparent some 5 to 6 days later. This could lead to a depression in intestinal function due to a reduction in absorption capability, and this may be an explanation for the long-term reduced growth described.

Early Nutrition & Immune Function

Another system requiring oral intake for full and rapid development is the immune system, particularly the mucosal immune system. Provision of substrates is essential for the growth and development of all secondary lymphoid organs, which are not present or are not mature at hatch. Beyond the need for substrate, fasting interferes with immune development in other ways. Fasting (and the stress of handling) stimulates secretion of corticosteroids which are powerful inhibitors of immune cell proliferation, including that required for the hatchling to respond to a vaccine (Constantin et al, 1977; Nir et al, 1996).

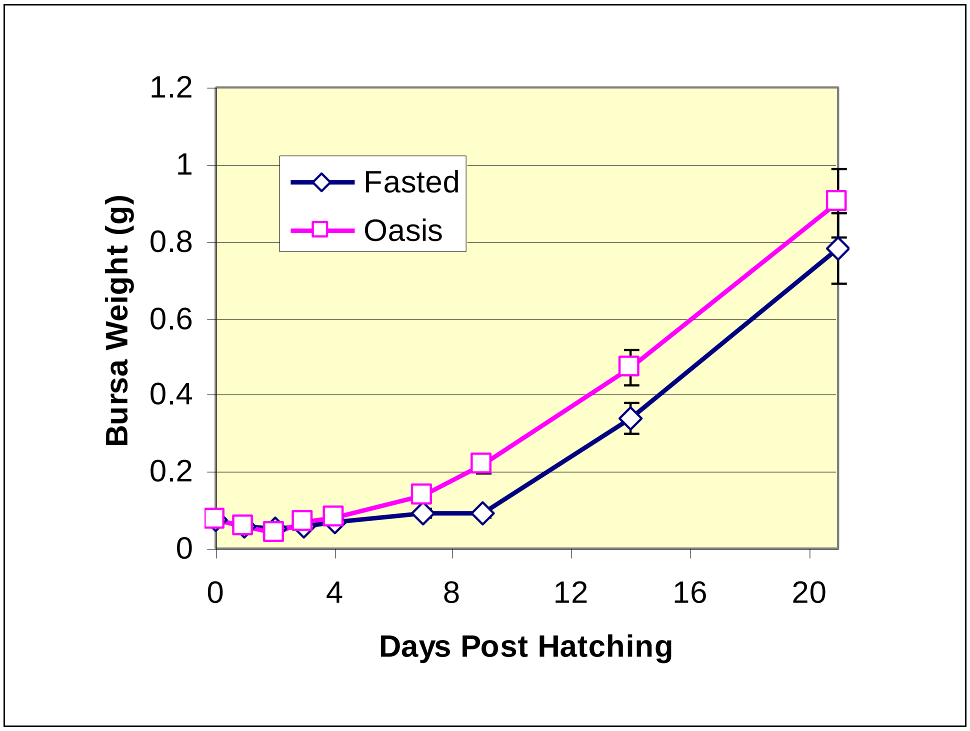

Figure 4 Birds fed Oasis had heavier bursas – an indication of more rapid immune development.

In the hatchling, the humoral immune system consists of only IgM bearing lymphocytes, primarily found in the bursa itself. The further development of antibody diversity is dependent on the exposure of the lymphocytes to foreign antigens. Preventing contact between the bursal lymphocytes and environmental antigens can seriously retard the development of immune memory. In fact, in the absence of oral intake and in gnotobiotic (germ-free) birds, lymphocytes fail to colonize mucosal sites such as the cecal tonsils (Honjo et al, 1993). These are secondary immune organs critical for the protection of the enteric and respiratory mucosa, the sites of entry of many infections.

Results of the study of Oasis feeding in turkey hatchlings indicated that the bursa of early fed poults remained heavier than those of the fasted group (Figure 4). Availability of nutrients, hormone responses to fasting, or oral antigen deprivation appear to have affected the primary and secondary immune organs on a long-term basis. This could affect disease resistance over the lifetime of the bird.

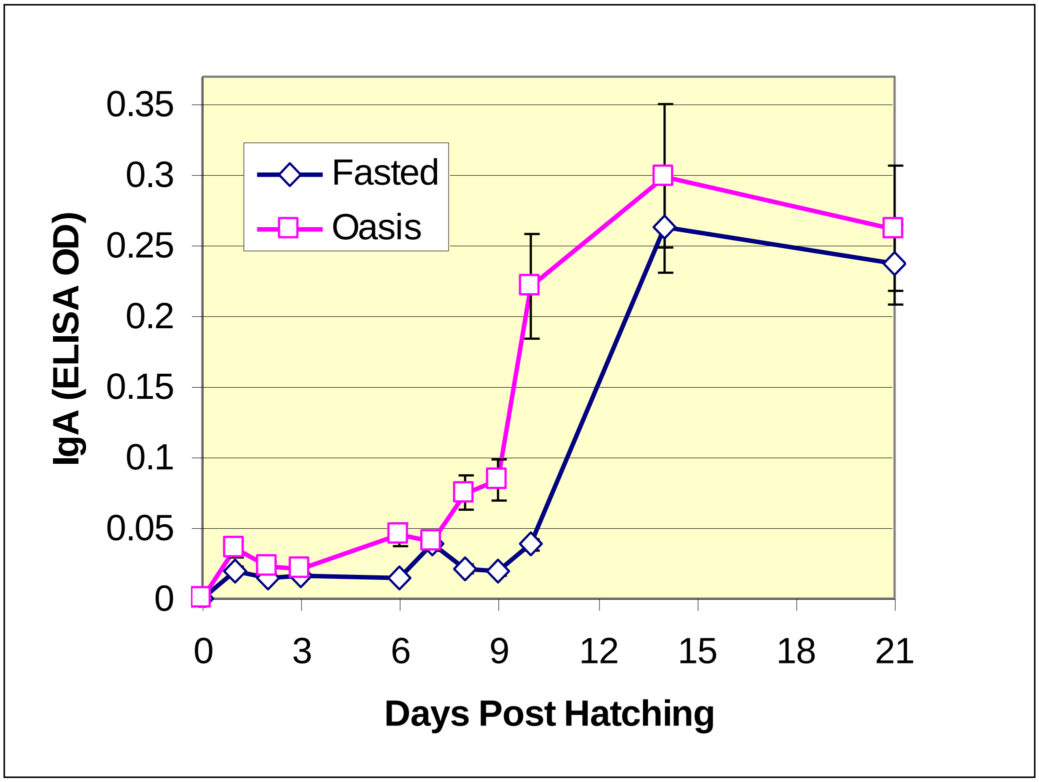

Figure 5 The increase in biliary IgA with age is faster when birds are fed, indicating readiness to respond to vaccines or pathogens.

The demonstration that early feeding increases bursa weight and the amount of bursal lymphocyte proliferation does not prove that this results in an improvement in development of immunocompetence. Other observations, however, suggest that there may be long term consequences of early feed and water deprivation. Figure 5 shows the effect of early feeding on the appearance and levels of biliary IgA. This immunoglobulin is a part of the mucosal immune system and is critical for disease resistance in the gastrointestinal and respiratory systems.

Summary

The time from hatching to the onset of feeding is obviously a critical period in the development of hatchling poultry. It is clear that failure to provide feed to the birds immediately after hatch may squander an important opportunity for future health and production. The impact of providing feed early is more than simply giving birds a head start over those for whom feeding is delayed. What is consumed in the first days following hatching can play a definitive role in the establishment of a beneficial microflora, and in the development of the immune system and gut. These factors will determine the health and growth of the hatchling into a mature bird. The ability of Oasis to encourage early feeding results in the presence of organic acids in the gut before coliforms and pathogens have a chance to colonize. These advantages will result in the bird achieving its genetic potential of the bird for body growth, immune competence and disease resistance.

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