Early Feeding and Nutritional Programming in Hatchling Poultry

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A "Good Start" is Crucial For Good Performance

When it comes to starting day old poultry, there is a common understanding that a good start results in a better bird, a more uniform and problem free flock with more marketable product at the end of the production cycle. The high correlation between broiler bodyweight in the first 6 days with final bodyweight at 6-7 weeks gives strong evidence of the importance of a good start to good overall performance in commercial broilers (Nir, 1995). Achieving the maximum potential of poults in the brood period has been reported to account for as much as 70% of final turkey performance (Smith, 1998), and every pound lost in the brooder house results in 4 pounds lower final bodyweight. Greater body weight at 5 weeks of age for commercial pullets has even been shown to positively correlate with the onset and duration of lay, livability during lay and total eggs/hen housed (Peters, 1997).

Early growth rate clearly indicates subsequent production in poultry, even though there are numerous pitfalls along the way that can cause major setbacks in performance. While a good start is accepted as important, the question still remains: What is actually occurring in the neonatal period that plays such an important role in the bird's future production.

Early Nutrition & Feeding Are Key to a Good Start

Early nutrition and initiation of feeding are common themes when discussing what constitutes a "good start." There are a variety of reports in the literature that demonstrate the impact of delays in feeding on growth and livability (Fanguy et al., 1980; Wyatt et al., 1985). Delayed feeding has been shown to retard maturation of systems that begin developing in the hatchling only after the addition of nutrients. This is particularly marked in the gastrointestinal system, including effects on liver and pancreas. Can that short delay in growth result in lifelong changes in how the bird grows and reproduces? There is a growing body of data that indicates that postnatal nutrition actually programs how an animal will metabolize, grow and reproduce as an adult, that could explain some of the long term effects of delayed feeding in hatchlings.

Nutritional Programming and Early Feeding

The concept of nutritional programming is simply that, what is fed or not fed during critical or sensitive periods of development may "program" the lifelong structure or function of the animal. This was examined at length in a recent symposium in which experimental models to study nutritional programming were described (Lucas, 1998). The programming period is generally during fetal life or in the early neonatal period. A classic example of programming is found in experiments showing that a reduction of intake in suckling rats soon after birth caused a slower growth rate that continued to diverge after the restriction period and ultimately resulted in lower body weight for the entire life-time (McCance, 1962). However, if this restriction occurred a few weeks later, the restricted rats easily caught up with the non-restricted ones. Subsequent work determined that lifetime effects on body size were influenced by postnatal nutrition but not prenatal nutrition of the mother (Snoek et al., 1990) - more evidence of the importance of early feeding.

The time from hatching to initiation of feeding in commercial poultry offers an excellent model to determine if nutritional programming occurs during this period. It is particularly interesting as significant numbers of commercial hatchlings are held for as long as 3 days prior to the initiation of feeding with the only source of nutrition being that supplied by the residual yolk. While many feel that residual yolk contains what hatchling requires for the first couple days of life, it is clear from a growth perspective that this is definitely not the case.

During the process of studying early nutritional needs of hatchling poultry we have repeatedly observed that the time from hatching to the onset of feeding plays a critical role in achieving the genetic potential of the hatchling for growth. We have also found that supplying the specific nutritional needs of the hatchling in the form of a hydrated nutritional supplement (Oasis® Hatchling Supplement)[1] can substantially improve post-hatching performance of birds not immediately provided dry feed, and that growth benefits can be observed through market weight. These findings indicate that nutritional programming exists for hatchling poultry and may play a significant role in production and profitability.

With Nutritional Programming Timing is Everything

Just as the classical rat pup restriction studies showed, the age that a nutrient restriction is imposed will determine the overall impact on the neonate. A large body of data exists for both turkeys and broilers that demonstrates substantial benefits for feed efficiency and carcass fat when nutrient intake was restricted to maintenance levels for periods of 1 week starting from 7 days of age or later (Plavnik & Hurwitz, 1988a & b). While bodyweight following the restriction was reduced, compensatory growth rates allowed for equal or better bodyweights at marketing with better feed conversion and less carcass fat.

We conducted a trial in which hatchling poults were either fed Oasis or fasted from day 0-3 and growth rates of the entire body and individual organ systems were measured through 28 days of age. The 3 day fast resulted in a 30% slower growth rate for bodyweight (Figure 1) and, unlike results of restriction later in life (Plavnik & Hurwitz, 1988b), there was no indication of catching up in the 28 day timeframe of the experiment. Thus, as with the rat pups, timing and possibly the severity of nutrient restriction for hatchling poults will determine the impact on subsequent growth.

At the onset of feeding small intestine, liver and pancreas, these organs grow 2-5 times faster than the rest of the body and play a key role in supplying nutrients for growth of muscle

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[1] Oasis® hatchling supplement is a commercially available hydrated nutritional supplement and a trademark of Novus International, Inc, St. Louis, MO.

and other demand tissues. Absolute weight of each organ system was lower for fasted than for Oasis-fed poults throughout the 28 days. Growth rate relative to bodyweight was affected differently among these supply organs.

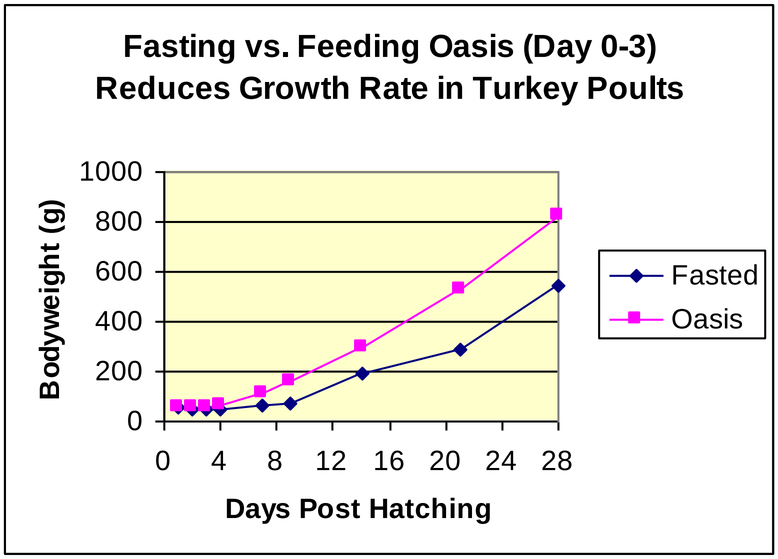

FIGURE 1

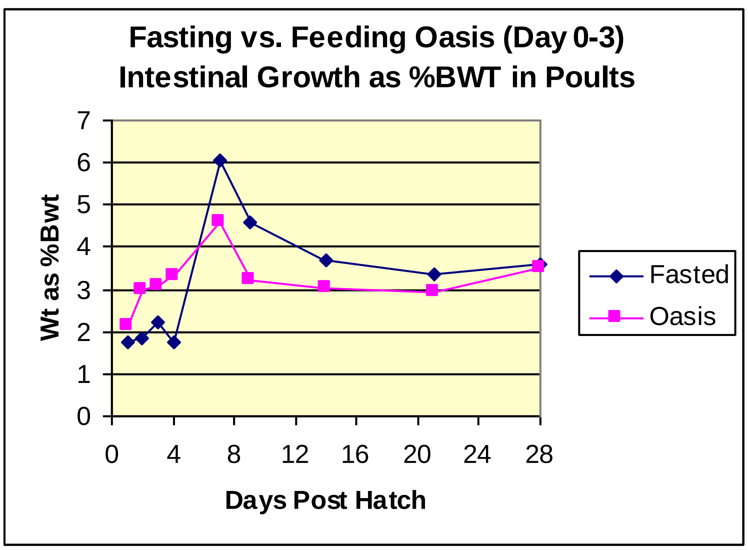

FIGURE 2

Relative growth rate of all 3 organs was greater during Oasis feeding than fasting. Once all poults were allowed ad libitum consumption of dry feed, relative growth rates of small intestine (Figure 2) and liver for fasted poults exceeded that for Oasis-fed poults (Treatment X Day $P<.01$). The increase in growth between days 4 and 8 for fasted poults was approximately 200% for liver and 300% for intestine. However, only a 30% increase was noted for pancreas growth during the same timeframe and it never exceeded that for the Oasis treatment (Figure 3). Consequently, the relative growth rate of pancreas over the 28-day period was lower for fasted than fed poults while relative growth of liver and small intestine did not differ. Thus, it appears that pancreas growth is more negatively impacted by delayed feeding than the other supply organs, and this difference could play a significant role in continued poor performance following commencement of ad libitum feeding.

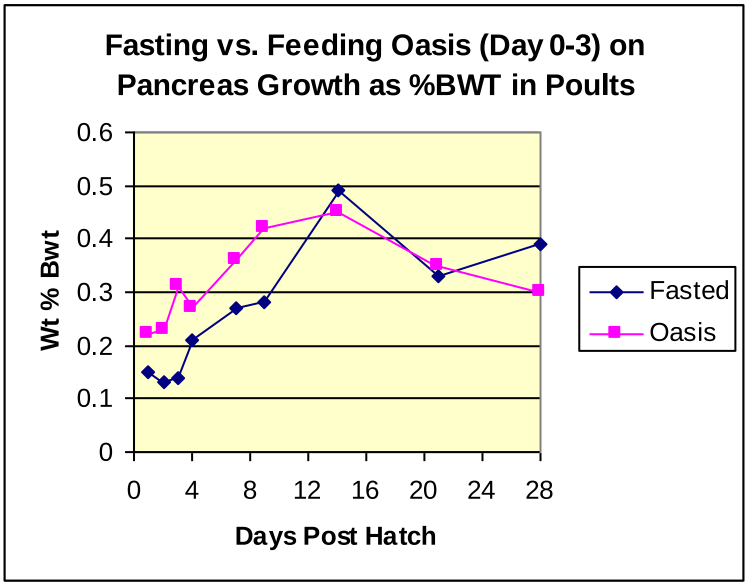

FIGURE 3

Long Term Effects on Cell Populations and Muscle Growth

Some effects of nutritional programming may be immediate, such as a failure to fuel growth of brain cells during early life that results in long term effects on the animal over its lifetime. But there is also evidence that the programming effects may be more complex. Lucas (1998) suggested that nutrients might be critical signals acting directly or indirectly on sensitive tissues and affecting which of a variety of stem cells and cell populations proliferate, thereby permanently affecting the quantity or proportion of cell populations in a tissue. Low protein diets in pregnant rats resulted in offspring with a greater proportion of liver cells that produced an important enzyme for gluconeogenesis (Desai et al., 1995). This was shown to result in a permanent 4-fold increase in the rate of glucose formation in these animals.

The effects of feeding versus a 34 or 48 hr fast from the time of clearing the shell was reported for broilers and turkey poults, respectively (Noy and Sklan, 1998). In these studies, fed birds experienced peak body weight growth over controls from 4-8 days post-hatch. Providing water alone resulted in a transient 7-10d body weight response that was no longer different from controls beyond that time. The magnitude of the body weight response to early feeding gradually became lower as a percentage of controls through 39 days for broilers and 140 days for turkeys. However, for broilers and turkeys alike, there were increases in breast yield of approximately 10% over controls, substantially greater than the absolute difference in body weight. The mechanism of this reproducible effect is under study; the authors have hypothesized that it is a specific effect of nutrients on factors controlling post-hatch satellite cell development that affects subsequent growth of muscle. The economic benefits of greater muscle development resulting from early feeding are obvious.

Nutritional Programming and Immune Development

Another system requiring oral nutrition for rapid full 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 processing) stimulates secretion of corticosteroids which are powerful inhibitors of immune cell proliferation, including that required for the hatchling to respond to a vaccine.

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 depends 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. These secondary immune organs are critical for the protection of the enteric and respiratory mucosa, the sites of entry of many infections. Results from Novus research have demonstrated that the bursa and spleen of early fed poults remained heavier than those fasted from 0-3 days for the entire four-week study. Availability of nutrients, hormone responses to fasting, or oral antigen deprivation appear to affect the primary and secondary immune organs on a long-term basis. This would affect disease resistance over the lifetime of the bird and would be a particular problem in breeders, where hyperimmunization is used to enhance maternal immunity to specific diseases. The immune system effect may well be an example of nutritional programming.

To study the effect of Oasis on muscle growth under conditions of immune stress, a study was run comparing the performance of birds immunized against coccidiosis (*Eimeria maxima*) and either fasted or given Oasis for the first 24 hours after hatch. In addition, birds were either challenged with *Eimeria maxima* (40,000 oocysts/bird) or not on day 22 of the study. There were 8 treatments with 6 pen replicates of males and 6 of females per treatment. Two 48-pen battery rooms were used and there were 8 Ross Arbor Acres bird per pen. Breast yield was determined by dissecting the pectoralis major only. The study was run at the Novus International Research Farm in O'Fallon, MO. Table 1 below shows the treatments for this study.

Treatment	Oasis	Immunization	Challenge

1	No	None	No
2	Yes	None	No
3	No	E. maxima	No
4	Yes	E. maxima	No
5	No	None	Yes
6	Yes	None	Yes
7	No	E. maxima	Yes
8	Yes	E. maxima	Yes

TABLE 1

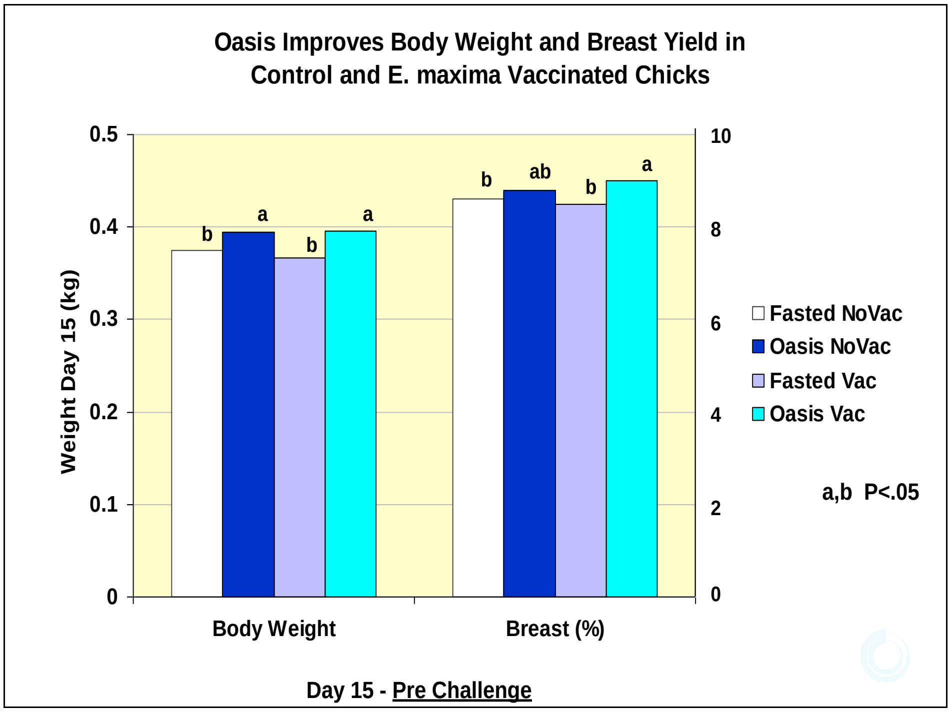

FIGURE 4

Figure 4 shows the prechallenge performance. For this data set, treatments were combined across challenge because that part of the treatment had not yet been given. There was a significant benefit for Oasis treatment as opposed to the birds fasted for 24 hr. This was true whether the birds were immunized or not. There was no performance decline associated with the vaccine. This is common when only one species of *Eimeria* is used. For breast yield, however, vaccination resulted in a significant difference between the fasted and Oasis treatments. Thus, the immune response associated with vaccination did place additional nutrient demands on the birds.

Birds were challenged on day 22 with *E. maxima*. There was a significant challenge effect in lesion scores (data not shown). Oasis feeding was associated with improved post-challenge period performance. Figure 5 shows the day 42-body weights. Clearly, the benefit of Oasis carried through to the end of the study. The best performance – and the most noticeable Oasis effect - was seen in birds that were vaccinated but not challenged (trt 3 vs 4).

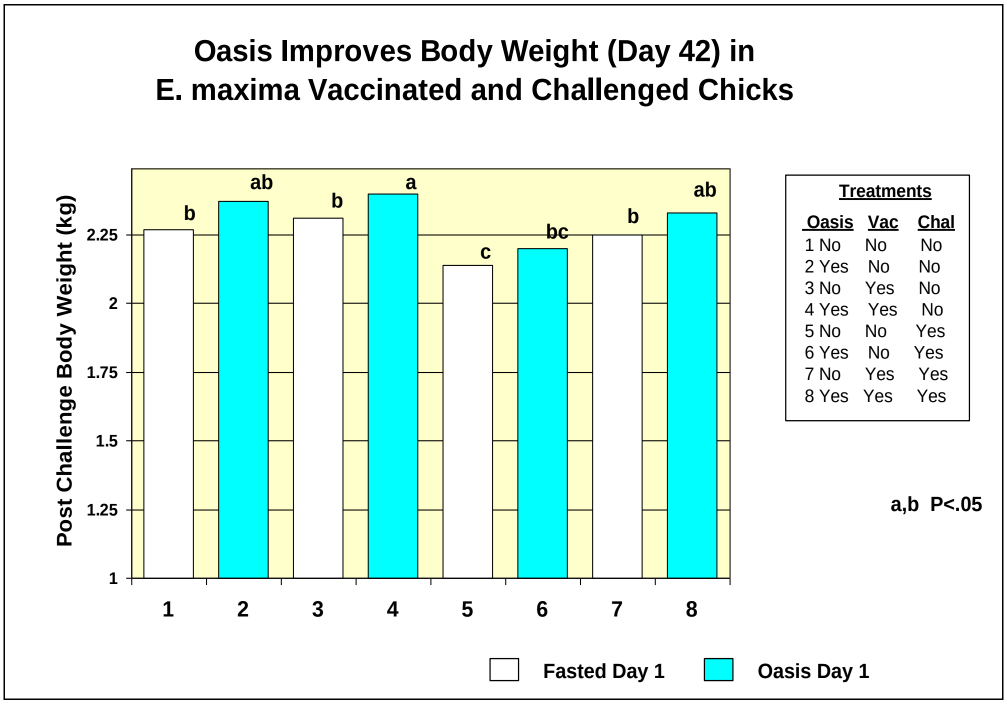

FIGURE 5

Figure 6 shows the breast yield results at the end of the study. There was a significant improvement in final breast yield associated with Oasis feeding for most treatment pairs (trt 1 vs 2, 5 vs 6 and 7 vs 8) except for the pair of treatments in which birds were not vaccinated but were challenged. This makes sense: When a non-immune animal experiences an acute disease stress of this magnitude it uses amino acids from muscle to generate glucose to fight the infection. This results in a reduction in breast yield. In these birds, early feeding did not provide an advantage because the acute challenge had to be met using breast muscle amino acids.

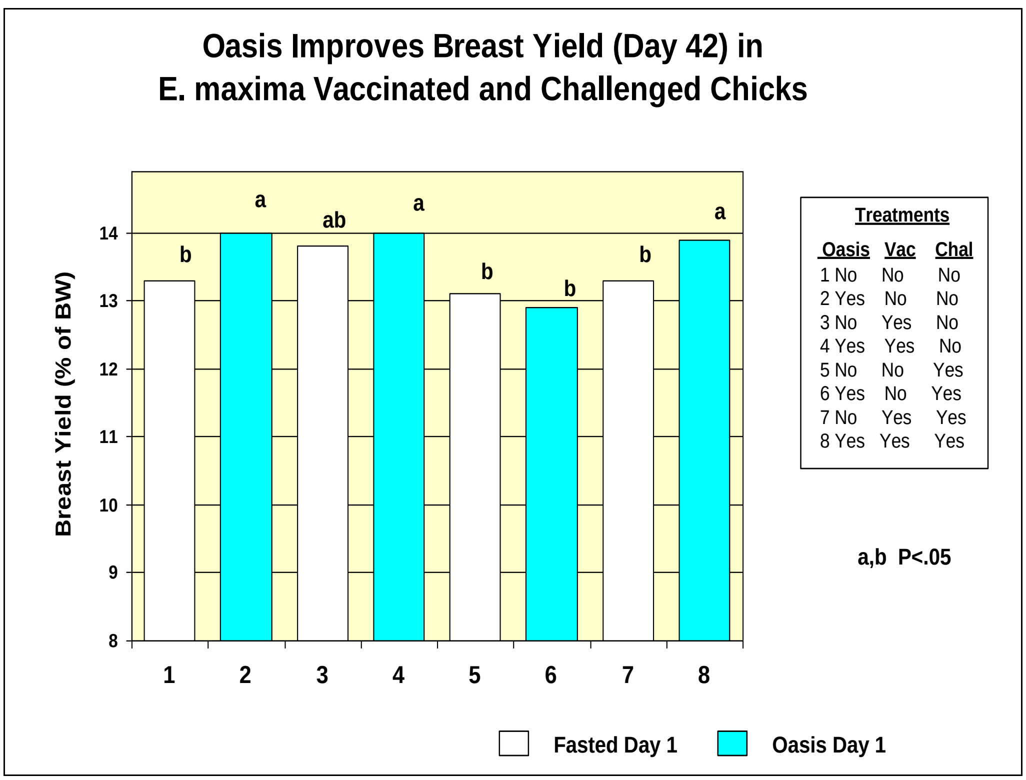

FIGURE 6

Post-Hatch Feeding Does Program Future Production

The time from hatching to the onset of feeding is a critical period in the development of hatchling poultry. It is clear that merely keeping birds alive the first several days after hatching may squander an important opportunity for future healthy growth. The benefit of early feeding is more than simply giving birds a head start over those whose feeding is delayed for a day or two. What is consumed in the first days following hatching plays a definitive role in achieving the genetic potential of the bird for body weight, muscle yield and immune competence. Supplying early nutrition in the form of a hydrated nutritional supplement allows initiation of feeding at the hatchery, thereby preventing the often unavoidable delays in feeding that occur in all forms of commercial poultry.

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