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Technical Bulletin

AUGUST 2011

Early chick nutrition— An approach for enhanced poultry production

The dramatic increase in poultry production and efficiency during the last 50 years is attributable to a number of factors including ongoing development in poultry genetic makeup and its application in Nutrition. To continue the same progress in productivity and feed efficiency of chicken in coming years, scientists and industry experts have short listed two new areas:

- **Early chick nutrition and**
- **Understanding and improving the efficiency of small intestine**

Body weight of chicks increases by approximately 50 times within 40 days of hatching. This includes an adaptation period, from utilizing embryonic yolk to exogenous carbohydrate rich feed.

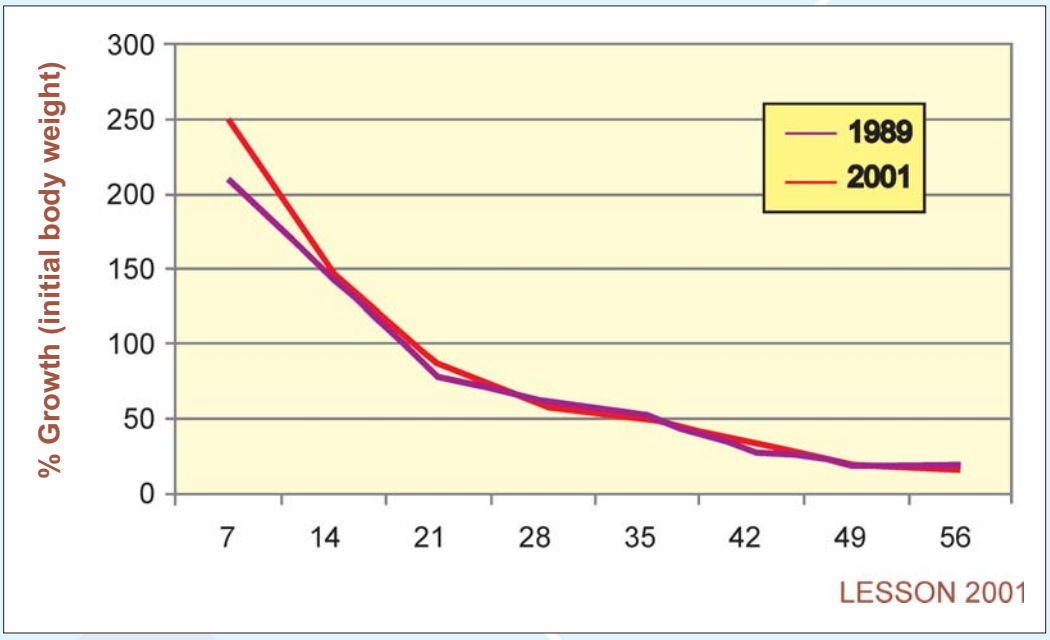


FIG 1: Increasing emphasis on first week body weight in boilers

Chicks are precocial and on hatching will forage for feed and then begin to grow, whereas holding chick without feed for 24 hrs, which results in loss of live weight. Access to nutrients initiates' growth, some 24 hrs post ingestion. Early access to feed results in more rapid intestinal development immediately after hatch. In practice eggs within a single tray will hatch over a 24-36 hrs window during this time the chicks which has pipped early are without feed. Hatchery treatments and transport to the farm involve a further holding period and the consequence is that chicks may be severely dehydrated and stressed on arrival which leads to increased transit mortality and early chick mortality, lack of vitality, compromised immuno-competence and therefore increased disease vulnerability, poor feed and water intake and consequently poor economic performance. During the period of withholding feed i.e. 48 hrs, chicks decrease in weight at an approximate rate of 4 g per 24 hrs due to moisture loss to body as well as yolk utilization. Effects of holding on villus surface area are region dependent, but generally both villus height and width are decreased. Both number of cells per crypt and the number of crypts per villus are initially decreased by lack of access to feed.

Early feeding has a great effect in triggering the right momentum of growth in chicks. It not only utilizes the residual yolk faster but also increases body weight gain and enhances the gastrointestinal tract development in chicks.

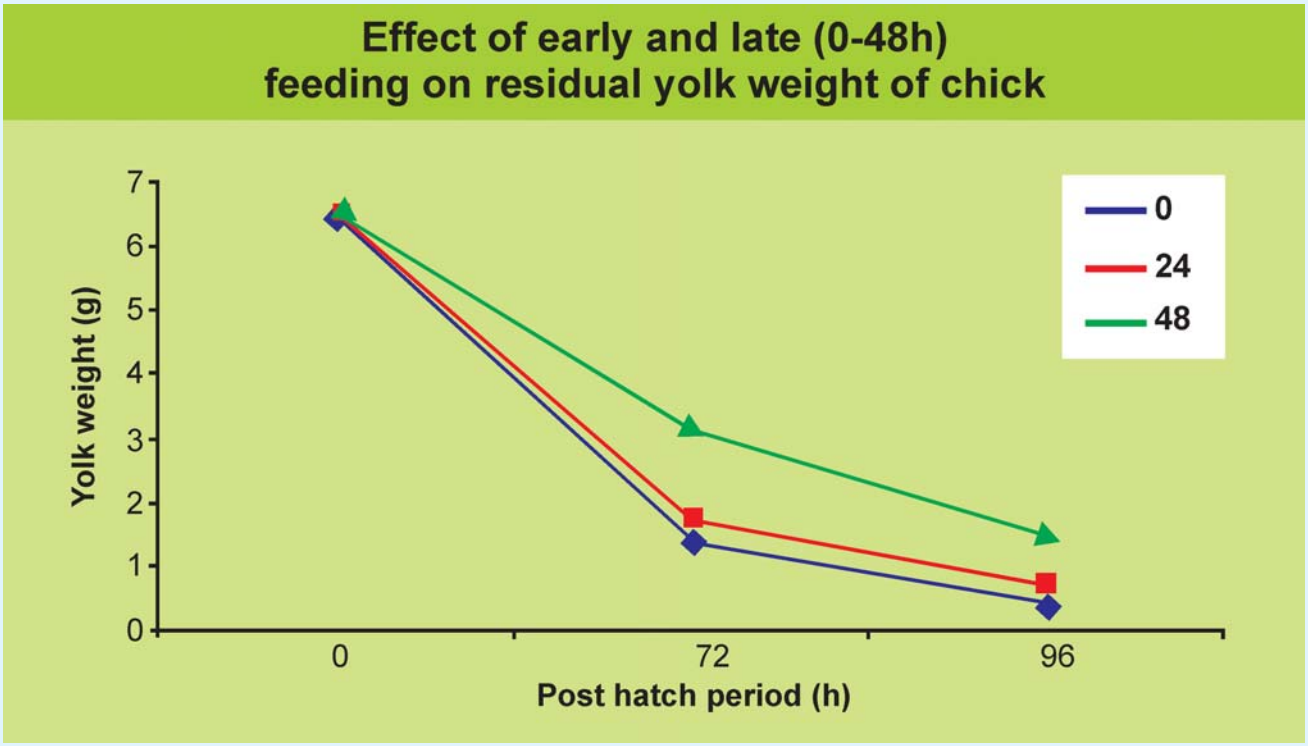
Importance of first day feed in chicks life

The post-hatch period is critical for the digestive tract because the system is switching itself from **'off'** to **'on'**. The first day after hatch is critical for the development of body systems in the chicken and certain types of manipulation must occur during the first days after hatch in order to achieve long-term effects. The GIT which is sterile at the time of birth undergoes exposure to different antigens through the passage of feed. The earlier the food passes through the tract the sooner the proliferating stem cells will meet an environmental antigen, which helps to create a wider antibody repertoire. At the time of hatching bursal ducts also open. Transport of environmental antigens into bursal lumen and further into the lymphoid follicles begins with unique and sucking movements.

Intestine is the primary nutrient supply organ, the sooner it develops its functional capacity, the faster the young chick can utilize dietary nutrients and grow to its genetic potential and resist infectious and metabolic diseases. Early access to feed and water is desirable in order to encourage better growth and performance. A good start can help to ensure higher body weight, and there is a positive relationship between first week weight and final body weight.

Importance of yolk in chick's life

During incubation the chick is totally dependent on a fat and protein diet, fat as a major source of energy. A hatchling depends on yolk for energy and protein till it is housed and fed, which may take 24 to 36 hrs. Although the protein fraction is partly albumen, a large fraction of the egg protein in the hatchling comprises of antibodies. Under normal circumstances, maternal antibody is not digested during the incubation process, leaving these immunoglobulins intact and fully functional at the time of hatch, indicating that the protein in the yolk sac is to be used for the passive immunity of the chicks and not as a source of amino acids. Similarly, the residual yolk lipid should be used for growth and not as an energy source for maintenance as some fatty acids in the yolk lipid may influence the pace of development of certain organ systems (Dibner et al, 1998). It was found that the maintenance energy required for 24 hrs post hatch for a broiler chick has been estimated at approx 25 Kcal while the yolk total energy potential calculated is only 20 Kcal (Hurwitz et al, 1980). Yolk utilization via circulation also remains



functional during the first 24 hrs post hatch after which transfers begins to decrease. In chicks with access to feed the rate of yolk utilization is faster, due to increased intestinal mechanical (antiperistalatic) activity.

Early feeding utilizes the residual yolk faster

The residual yolk is usually absorbed and utilized by the chick within four days of hatching. Recent studies indicate that the residual yolk is absorbed more quickly by chicks that have access to feed immediately after hatching than those fasted for 48 hrs. This is because the anti-peristaltic movement that transfers the yolk from yolk stalk to the duodenum appears to be stimulated by the presence of feed in the gut.

Early nutrition and functional developments

1. Early nutrition and gastrointestinal development

At hatch, the types of enterocytes present begin to change the source of absorption of nutrients

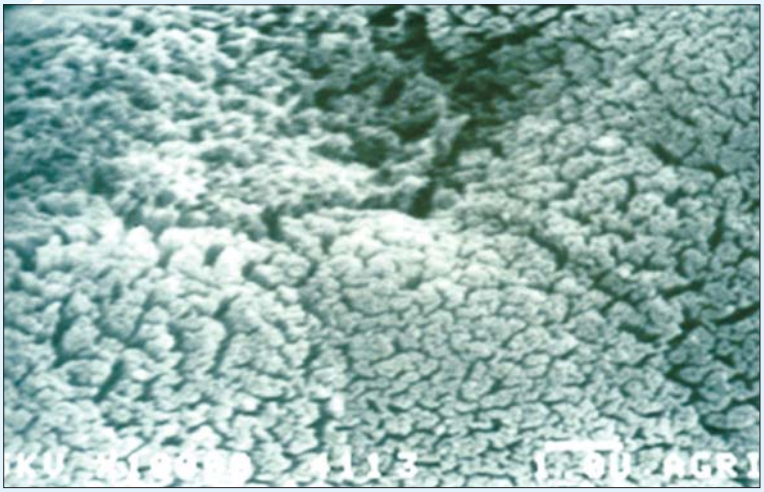
1st day Physiological facts
Trypsin activity in chick is 10x less than at 30 days
Amylase activity is 3-6 times less than at 21 days
Methionine absorption is poor (20-35%) in immediate post hatch chick
Proportionate weight of intestine is 0.02% on 1st day and 0.08% on 8th day
Protein digestion is 78% at 4th day whist upto 90% at 21st day

Effect of post-hatch feed deprivation on weight of certain organs (% Body weight) at four days of age

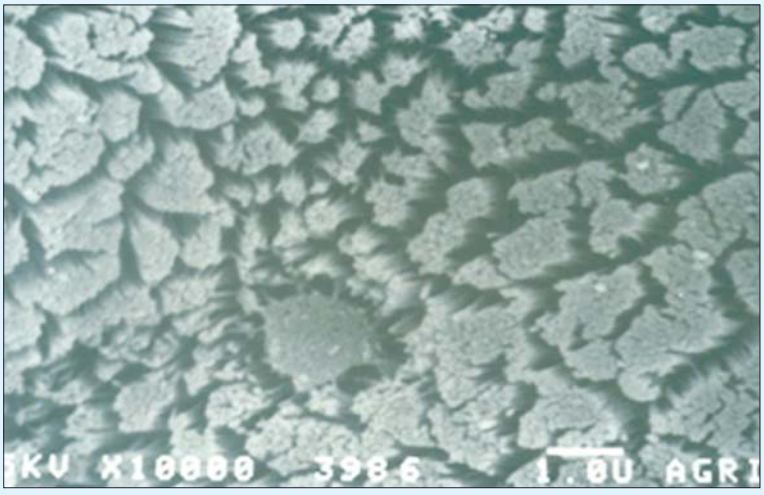
Post-hatch feed deprivation (h)	Liver	Proventiculus with gizzard	Pancreas	Duodenum	Jejunum	Ileum
0h	3.76[a]	7.91	0.38[a]	2.94	2.82[a]	2.12[a]
24h	3.71[a]	8.03	0.36[a]	2.89	2.85[a]	2.07[a]
48h	3.24[b]	7.80	0.20[b]	2.78	2.39[b]	1.65[b]

[a, b]*means with different superscript in a column differ significantly (P<0.05)*

from the internal environment of the egg to the nutrients from the feed. After hatch, chicks have a anatomically complete but physiologically incompetent gut resulting in inefficient feed utilization, reduced enzymatic (amylase & trypsin) activity & shorter villi length. Time from hatching to onset of receiving nutrition is critical given the high mortality; **approx. 2 to 5% of hatchlings do not survive** during post hatch period. Many of those who survive in this critical post-hatch period exhibit stunted growth, poor feed conversion, reduced disease resistance and poor meat yield in the long term. New research shows excellent results of early nourishment (neonatal supplement) as soon as possible after hatch. The supplemented energy helps to operate



Ingut Microvillii, 48h post hatch: with an early feed



Ingut Microvillii, 48h post hatch: without feed

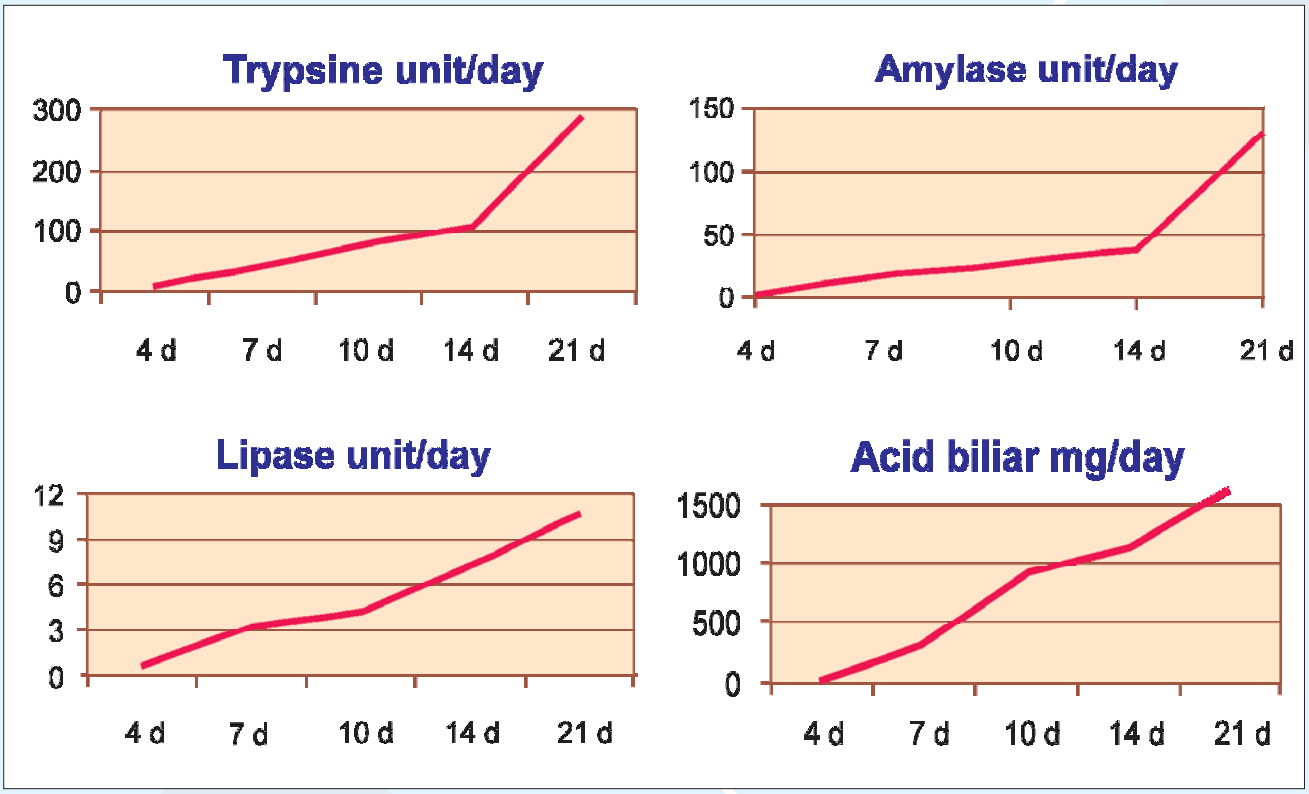
the digestive system and stimulates development of all other body systems.

Post-hatch changes are more pronounced in the intestine of the chicks compared to other parts. The proportional weight of the intestine compared to the whole body mass steeply increases from **0.02% on day 1 to 0.08% on day 8** (Sklan, 2001). The pace of development of the intestines is in tune with the concept of **supply organs developing in advance of demand organs** (Brake, 2001). At the time of hatching the villi of the small intestine are undeveloped and the crypts in the intervillus spaces are not detectable. The crypts begin to form in the first few hours and become defined within 72 hrs.This process continues and the villi are well defined by 336 hrs (within 14 days) after hatch. The total villi surface area in the jejunum increases from about 50 sq cm at hatch to about 550 sq cm on the 10th day (Sklan, 2001).

The development of the intestine though is rapid during the first 72 hrs and continues up to the 10th day indicating the importance of neonatal supplementation in chicks. Enzyme secretion is insufficient in quantities, but the development of the gut even though faster compared to other organs may be the bottle neck in the utilization of the nutrients. The rate of passage of the ingesta influences the utilization of the nutrients in the intestines. Slower rate of passage improves nutrient absorption by increased time of contact with absorptive cells and increases the digestibility of fiber by allowing more time for microbial fermentation (Washburn, 1991).

2. Early nutrition and pancreatic secretions

Carbohydrates, lipids and proteins reaching the intestine must be hydrolyzed before uptake. During late embryonic development and at hatch, pancreatic enzyme activities are found in the small intestine (Marchaim and Kulka, 1967). In fed birds intestinal pancreatic enzymatic activities were correlated both with body weight and intestinal weight (Sklan and Noy, 2000; Sklan, 2001). These findings suggest that feed intake triggers secretion of pancreatic enzymes, which are then secreted at relatively constant amounts per feed intake as the chick grows. Supplementation of lipase during early life is very critical for digestion of fat as secretion of lipase during this period is insufficient.



3. Early nutrition and immune system development

The immune system of the bird is partly developed at hatch and its further development depends on several factors. Gut associated lymphoid tissue (GALT), a component of the gut immune system, evolves to provide protection against pathogens found in feed and the environment. Many changes occur in the GALT, including changes in T and B lymphocyte count, innate immune cells, enlargement of the bursa, appearance of caecal tonsils and Payer's Patches. Many research reports have suggested chick in the first week post-hatch lack adequate immune responsiveness and are therefore are highly susceptible to infections. Consequently, nutritional strategy should be aimed not only at the development of the immune system, but also at adequate immune response. Hence the critical factors are intake of feed and nutrients. Insufficient nutrient intake can result in impaired immune system development hence nutrients are most essential to the development of immune system. However, the nutrients found in the remnants of the yolk in the post-hatch chick are not sufficient for proper immune development.

Nutrition is a critical determinant of immune responses which can affect the magnitude as well as the nature of the immune response. There are three ways in which early nutrition can affect immune development.

1) Nutrients provide substrates for cell proliferation and differentiation.

2) Nutrients can be immunomodulators themselves or can affect their endogenous synthesis.

3) Oral intake provides many of the antigens that drive both the development of isotypes and the generation of immunoglobulin diversity in the bursa.

In order for the immune system to develop properly, there must be exposure to antigens. Antigens can come from various sources but are usually ingested shortly after hatch. Feed intake is key to providing early antigen exposure to the chick. Once antigens are present, the immune system begins to develop. If the bird has decreased intake during early stages or the diet is lacking in certain nutrients prior to exposure of severe pathogen challenges, the immune system may not be adequate to handle the challenge properly and may either over react to the challenge or not result in a sufficient response.

4. Early nutrition and muscle development

Early nutrition is very important for the meat and muscle production or increased body weight. Muscle cells are multi-nucleated, hence each individual nucleus controls an area of cytoplasm within each cell. So muscle mass can increase in one of the two ways: either increase in number of nuclei or increased amount of cytoplasm. However, there is a limited time period early in life when the ability exists to donate nuclei into an existing cell. Therefore, there is limited time to impact muscle potential by increasing the number of nuclei within the cell. This occurs by activated satellite cells that can donate nuclei to the muscle. Once this period of donation ends, the main method for increasing muscle mass that remains only through increased cytoplasm.

Early nutrition correlates very closely to satellite cell activity. The longer the limitation of feed exists in the young bird, the fewer the number of nuclei are donated to the muscle due to decreased satellite cell activity. This creates a decreased potential for muscle development in the mature bird. Nutrients can enhance this brief period for creating improved muscle potential by activating satellite cells.

Fate of chicks at the hatchery

At the hatchery fertile eggs are transferred from the setter to hatcher on completion of 18 days. In the hatchers chicks start hatching soon after the transfer. In ideal conditions 25% of the eggs should have hatched 24 hrs before the hatch is

pulled, and 75% of the eggs should have hatched 13 hours before the hatch is pulled. This implies that at the time of pulling the hatch there are chicks that are 1-1.5 days old or may be even older.

These are results in ideal conditions. In reality the hatch window is far wider due to multi-stage incubation and inefficient husbandry, hatchery practices as well as the use of dated hatching technology.

At hatchery several processes must be completed i.e. grading, vaccination, sexing, and packing before finally transporting the chicks to the farms. The consequence is that chicks may be severely dehydrated and stressed on arrival. This leads to increased transit mortality and early chick mortality, lack of vitality, compromised immuno-competence and therefore increased vulnerability, poor feed and water intake and consequently poor economic performance.

Alleviating stress

In modern poultry production systems birds are inevitably exposed to considerable stress. The gastrointestinal tract of the newly hatched chick is immature and sterile and only begins to develop its function and its micro flora when it begins to ingest feed. Feed inevitably contains micro-organisms and other components which may be toxic, and this puts additional stress on the bird either through diseases or activation of the immune system. Minimizing stress through nutritional manipulation at this stage is clearly important.

Conclusion

- Early feeding helps in overall development of the chick organs and helps in further improvement in terms of mortality, stimulation of immune system and also building stronger immune system with less mortality post-hatch.
- There may be an opportunity to improve chick development through the use of neonatal supplements that balance the immune system and can enhance the development of the intestine.
- It is important to select a specialized supplement that can improve the development of the immune system so that the bird can respond more efficiently to an immune challenge early in life.
- A neonatal supplement that can aid in the proper development of the intestinal tract is also beneficial due to the rapid growth of the intestine early in life. If the intestinal tract develops more efficiently the bird will be better able to absorb nutrients which can impact feed efficiency and muscle development in the long run.

References are available with author and can be made available on request.

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