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Hatchling Quality–How to Measure It and Improve It to Ensure a Great Start

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What Is Hatchling Quality?

If you were to ask a service person, grower, or hatchery manager, you would get a completely different answer as to what the distinguishing attribute or essential character was for a good or bad 'quality' hatchling. Quite often, live production personnel define hatchling quality by two week mortality. However, this does not account for changes in morbidity and the long-term growth potential of the remaining flock. Some define quality as the relative uniformity of the flock (Figure 1). Morbidity after hatching greatly affects this uniformity and becomes progressively worse as the flock ages. For the purposes of this publication, factors affecting "hatchling quality" will be further defined such that optimal growth potential of the flock can be obtained.

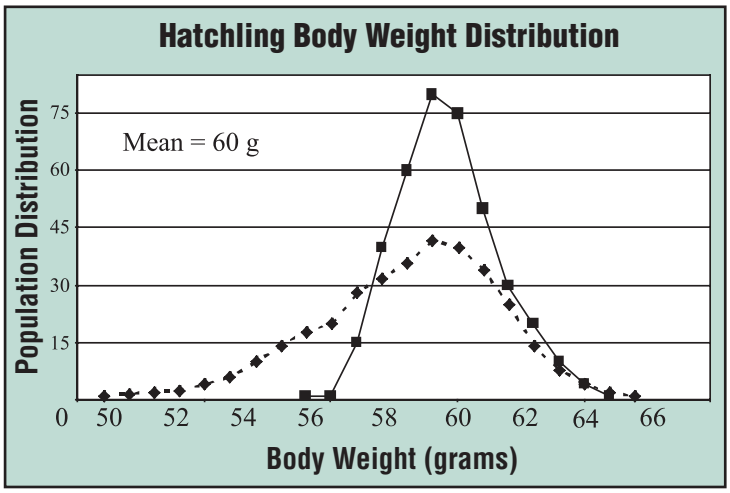


Figure 1. Hatching body weight distribution. Solid line represents a more uniform flock as compared with the dashed line.

"Stressors" that the bird encounters during the first few days of life (such as toe trimming, vaccination, desnooding, and beak trimming) often have been blamed for reducing poult thriftiness and quality. Often times, however, we are left asking ourselves, "What is a stressor, and how do you measure its impact on the potential for morbidity of the hatchling?" The word stress is often used inappropriately to describe evolutionary events that animals have adapted to. For example, the hatching event requires an extraordinary amount of energy and renders the hatchling nearly deplete of glycogen reserves in the liver. Yet the hatchling derives most of this energy from lipid precursors found within yolk sac reserves and liver stores (Romanoff, 1960; Freeman and Vince, 1974), thereby sparing muscle protein (Moran and Reinhart, 1980). Indeed the hatching event is energy intensive, but the bird is left with enough energy reserves for transport to the farm — arguably not a long-term stressor on the animal.

Factors Contributing to Hatchling Quality:

Hatchery Processing. In addition to hatching, other stressors, however, are typically imposed and can include a number of factors, such as: variability in hatching times, vaccination, sexing, toe trimming, desnooding, beak trimming, and prolonged transport times to external growers. At the time of hatching, the hatchling is nearly deplete of liver glycogen (Roseborough et al., 1979) and has a body composition containing nearly 25 to 30 percent lipid (dry matter basis, Noble and Cocchi, 1990). The hatchling is in a gluconeogenic state (deriving energy from body reserves) and will remain so until it consumes dietary nutrients (Romanoff, 1960). These hatchery processing steps, combined with metabolic changes associated with acclimation to external nutrient sources, may contribute to peaks of early hatchling mortality beginning at approximately four days of age (Phelps et al., 1987a).

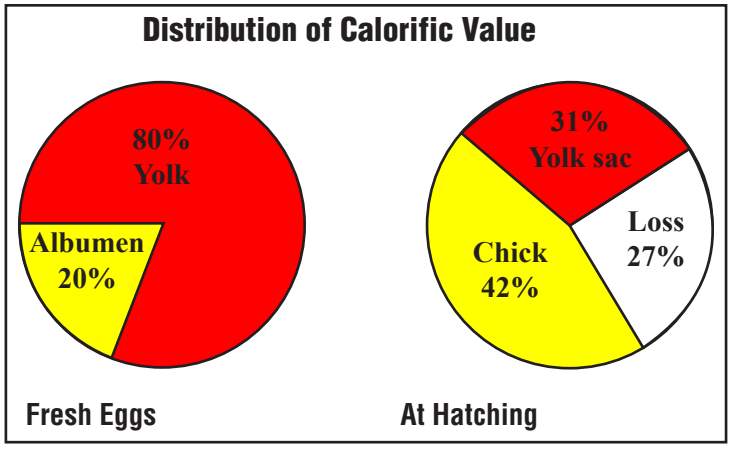
Metabolic Shift. A hatchling's shift in metabolism does not occur immediately upon feeding, but can only occur with the access to feed or water. The activity of certain enzymes such as glucose-6-phosphatase (a liver enzyme needed for production of glucose during fasting) is reduced within two hours of feeding, while others take nearly eight hours to demonstrate substantial shifts (Donaldson and Liou, 1976). However, the metabolic system continues

to fluctuate outside of normal ranges during the first five days after hatching. For example, Latour et al., (1995) concluded that the homeostatic mechanisms of metabolism in the chick were incomplete after observing fluctuations in daily plasma concentrations of corticosterone (+ 8 ng/mL), triglyceride (+ 100 mg/dL) and glucose (+ 220 mg/dL). In addition, Goodridge (1968) noted fluctuations in liver glycogen stores until 12 days of age.

Researchers in the past have tried to facilitate, or expedite, this shift in metabolism through administration of glucose or metabolic derivatives at the hatchery. Administration of these compounds will temporarily shift the hatchling from a gluconeogenic and ketogenic metabolic (reliant on energy from lipid and body stores) condition toward a glycolytic state (reliant on energy from feed). This shift, however, is exacerbated if feed and water are not immediately available after the initial glucose surge (Moran, 1989; 1990). In other words, if the hatchling doesn't have feed and water after the initial shift in metabolism, it has a tendency to crash.

Considerable controversy currently exists as to whether this metabolic shift should be expedited (through carbohydrate feeding) or slowed (through feeding of easily digestible lipid sources). The old adage that the hatchling is reliant on the yolk after hatching for its energy stores has circulated for years. During the course of incubation, the embryo derives more than 80 percent of its energy needs from lipid (fat) in the yolk (Figure 2). However, upon hatching, the yolk of the poult contains between 0.6 and 2.5 g of lipid (1200 mg of triglyceride), which only supplies 8 to 9 kcal of energy to the poult (Lilburn, 1998). As the poult has been deriving the majority of the energy needs from lipid during incubation, an easily digestible fat sources can ease this metabolic transition and improve two week body weights (Turner et al., 1999a). Poults that experienced delay in placement and are fed a highly available carbohydrate diet, however, are able to regulate plasma glucose concentrations after a glucose challenge during the first week after hatching (Turner et al., 1999a). Therefore, it is relatively uncertain whether a primarily carbohydrate or easily digestible fat-based diet is best for starting young birds.

Breeder Hen Age. We have observed long-term impacts of the age of the hen on the hatchlings ability to make this metabolic transition. Applegate and Lilburn (1999a) subjected four-day-old poults from young hens (just entering egg production) and poults from older hens to a glucose tolerance test. Poults from the young hens (particularly those from 75-80 gram eggs) continued to have higher glucose concentrations 60 minutes after a glucose injection, suggesting an early impairment in glucose regulation. However, intestinal growth (weight, length, or microscopic development) was unaffected (Applegate and Lilburn, 1999b). In other words, even though a hatchling from the younger hens might be able to digest and absorb nutrients from the diet, their body can take longer to process them. This difference may be contributing to reports of mortality during the first week after hatching in flocks from young hens. Therefore, in ideal situations, only turkey eggs above 75 grams should be used for incubation from hens after their 6-8 week of egg production.

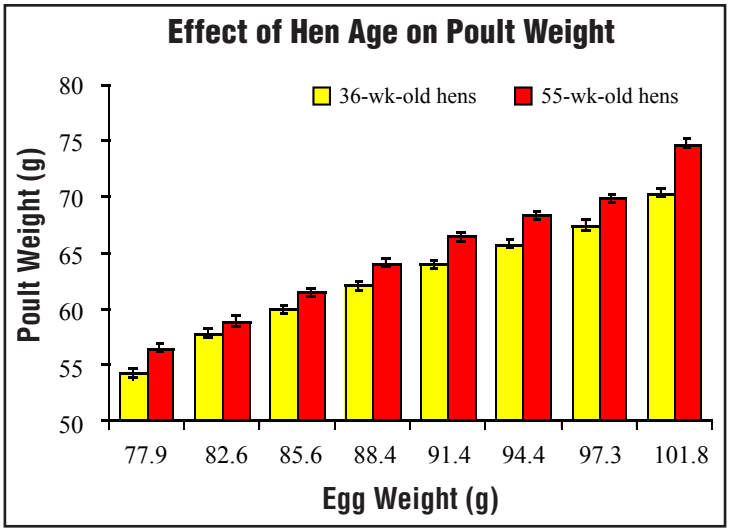


Applegate & Lilburn, 1996, 1998, 1999

Figure 2. Distribution of calories in the fresh egg vs. that in the egg at hatching.

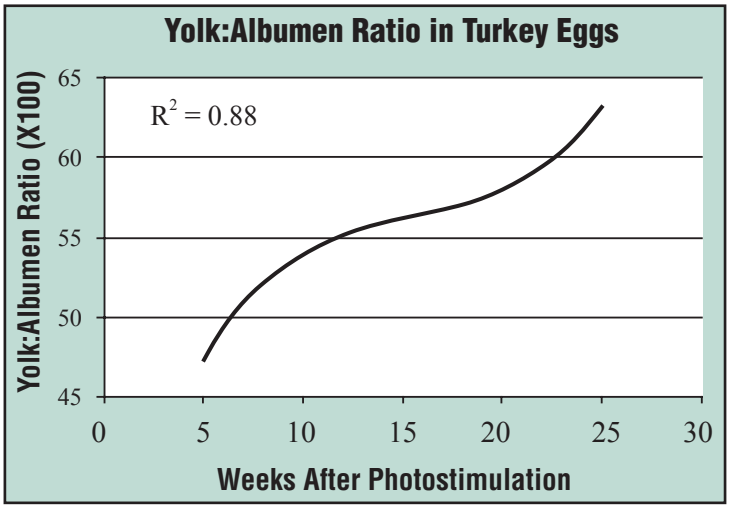
Other physiologic systems are also relatively undeveloped at hatching, and their development is largely dependant on energy/nutrient allocation. For example, during the first week after hatching, there is a tremendous energetic allocation to the growth of the gastro-intestinal tract (GIT) at the expense of most other body parts (Konarzawski et al., 1990). If a greater proportion of hatchlings from older hens develop more completely in ovo and/or hatch fractionally earlier, they could have a more completely developed GIT when given access to feed and water. This might minimize the aforementioned metabolic effects encountered within the first days of life.

Of course these factors greatly rely on egg size and egg composition. Egg size effects due to hen age will have considerable impact on the weight of the hatchling. If egg size is considerably variable, so too will be the range of hatchling body weights and subsequent flock growth (Figure 1). Additionally, Applegate and Lilburn (1996) noted that hatchling weight, regardless of egg size, is heavier from an older hen (Figure 3). Much of this difference can be attributable to differences in egg composition, particularly the yolk. As the hen ages, she incorporates proportionately more yolk into the egg (Figure 4). This additional yolk then contributes to a greater



Romanoff (1967)

Figure 3. Effect of turkey breeder hen age on poult body weight across egg weight classes (Applegate and Lilburn, 1996).



Applegate & Lilburn, 1996

Figure 4. Relative distribution of yolk and albumen in the egg as a turkey hen ages (Applegate and Lilburn, 1996, 1998, 1999).

energy reserve which drives differences in body weights during the final week of incubation (Figure 3). If flocks of different ages are incubated together, there may be a tendency for greater variability in body weights at hatching that may influence uniformity later in life (Figure 1).

Diet Composition. Diet composition can also have a profound effect on how the hatchling transcends to its new metabolic state. For example, when Turner et al., (1999a) fed diets containing a high proportion of energy from either corn (carbohydrate) or animal-vegetable fat they noted that 30 to 50 percent of poults fed the carbohydrate-based diet had plasma glucose concentrations above 500 mg/dL at 2 days after feeding (which is over twice the normal concentration). Traditional perception by the industry has also held that fat supplementation should be minimized for starting hatchlings. From a digestibility standpoint, research with feeding of animal fats and A/V fat blends has demonstrated that young hatchlings do not digest saturated fatty acids efficiently (Turner et al., 1999b; 27 to 53 percent from 3 to 11 days of age). However, the unsaturated fatty acids were highly digestible, 80 to 85 percent, during this same time period (Turner et al., 1999b). These reports suggest that supplemental fat sources (especially a source containing an appreciable amount of unsaturated fatty acids such as corn, soy, or other vegetable oil) may ease the metabolic shift after hatching. Caution should be used, however, as unsaturated fats typically are easily oxidized, rendering the fat rancid.

In addition, Adolph and Kao (1934) reported that soybean meal, which contains a high proportion of non-starch polysaccharides, is very poorly digested. Therefore, prestarter or starter diets containing a high proportion of soybean meal may not provide the amount of calculated energy and may suppress early growth. In the case of the turkey poult, the initial diet should contain less than 40 percent crude protein to minimize dietary inclusion of soybean meal. Typically formulation will need to include approximately 10 percent of fish and/or meat and bone meal.

Time of Placement. Holding time prior to placement can also have prolonged effects on the status or quality of hatchlings. For example, when Turner et al., (1999a) withheld feed and water for 48 hours, poults continued to have higher plasma glucose concentrations than those that were fed immediately after hatching. This failure of poults that had been held longer was noted four days after feeding had commenced, but not seven days after feeding. Holding time can have prolonged effects on overall growth (to 28 d, Corless and Sell, 1999). Part of this reduction in growth may be partly due to prolonged effects on intestinal structure. Delayed access to feed is followed by microvilli clumping (within 24 hours) and delayed jejunal mucosal development and crypt structure up to nine days after hatching (Uni et al., 1998).

Other factors, such as short-term exposure to low temperatures (21 C; Donaldson and Christensen, 1991) or excessive carbon dioxide (0.4% or greater; Donaldson et al., 1995) can also bring about fluctuations in plasma glucose concentrations and alter the ability of the hatchling to make its metabolic shift. Similarly, other factors including maternal health status, maternal antigen transfer, hatching time, and dehydration can greatly impact the long-term growth and health of the hatching flock (Rajcic-Spasojevic, 1998).

Hatcheries often will supply up to an additional four percent of hatchlings to growers to compensate for early mortality, especially if they were from a young flock or if the initial egg size was particularly small. If we were able to better assess why this mortality occurs, this margin could be greatly reduced, thereby passing savings from the breeder to the hatchery and along to the grower. In addition, most companies typically do not have a measure of hatchling morbidity and have no idea of what impact it is having over the life of the flock.

How Do I Categorize Hatchling Quality?

A hatchling quality assessment form is attached that was very kindly provided by Drs. A. Rahn and R.M. Fulton from Michigan State University (2001). This form is an example of factors that may be considered upon placement. Each company's situation can vary and the form should be optimized accordingly.

What Are Some of the Benefits of Categorizing Hatchling Quality at Placement?

Producer – knowledge of the type of flock

Field Service person – knowledge of what type of flock has been placed – no more excuses for poor performance if a good flock was received

Live Production Management – index and record of what product (hatchlings) quality is from your suppliers

Hatchery Management – quantification of hatchery problems for trouble-shooting

Breeder Management – tracking of maternal influences (antigen transfer, nutritional status, etc.)

Summary

Does a poor-quality hatchling necessarily mean you'll have poor growth, morbidity, and mortality? Quite simply NO. For example, Applegate & Lilburn (1999) reported that when hatchlings from young vs. older hens from the same commercial flock were reared in the same environment, that growth was not significantly different through three weeks of age. The old adage that hen age has long lasting effects on hatchling growth was not the case in this instance. As such, hatchlings from both hen ages were probably placed into an ideal environment. If you are aware of potential issues or conditions upon placement, you should be able to implement strategies to try to prevent or minimize them from adversely affecting the long-term growth and health of the flock.

Basic management strategies in the brooder house are critical. Dr. Vern Christensen (1999) gave a wonderful summary of these strategies, as follows: buildings and equipment should be ready 24 hours prior to hatchling arrival; optimize temperatures of air and litter so hatchling activity is encouraged-not discouraged; optimize light intensity so the birds can find food and water; ensure enough fresh air and prevent CO_2 build-up, minimize human distractions after placement; don't overload brooder rings; and provide enough fresh water and feed at optimal locations.

Basic Management Strategies	
Buildings & equipment ready 24 hr in advance	Minimize human distractions after placement
Optimize temp. of air & litter	Don't overload brooder rings
Optimize light intensity (23 hr. & 100 lux for poults; 30-40 lux for chicks at placement)	Provide enough fresh H_20 & feed @ optimal locations
Fresh air – prevent CO_2 build-up	

Hatchling Quality Assessment Form

Date _____

The assessments itemized below should be performed on hatchlings at placement before they have received any water or feed. The focus is on documenting defects and estimating their frequency. Hatchlings not selected for sampling **should be placed** before these assessments are performed!

Source: _____ **Strain:** _____ **Farm:** _____

Weeks-in-lay: _____ **Sex:** _____ **House:** _____

No. Delivered: _____ **DOA count:** _____ **Sample count:** _____

Hatchery Services: beak trimmed _____ **toe trimmed** _____ **desnooded** _____

External Appearance Factors:		hash tally	#/100	Wtd
1. Unthrifty and listless		_____	_____	(9)
2. Dehydrated		_____	_____	(8)
3. Freaks (genetic anomalies)		_____	_____	(3)
4. Puffy eyes		_____	_____	(3)
5. Dark blue color (cyanosis)		_____	_____	(7)
6. Navel:	infected	_____	_____	(7)
	scabbed	_____	_____	(3)
	strings	_____	_____	(2)
7. Pasted vents		_____	_____	(4)
8. Bad legs		_____	_____	(6)
9. Improperly:	beak trimmed	_____	_____	(6)
	toe trimmed	_____	_____	(5)
	desnooded	_____	_____	(2)
10. Injured at hatchery		_____	_____	(6)
	Weighted Defects Sum		_____	

Body weights:

_____
Average

_____
Range (min-max)

_____
Uniformity + 10%

_____
Injured during placement

Brief sample collection instructions and space to record the results of the laboratory analyses needed to adequately assess poult quality are on the next page. Blood samples for the serological assay should be taken before the postmortem examinations are performed and swabs for bacterial culturing should be taken after the examinations are performed.

Postmortem Examinations:

		DOA's	Sacrificed
Sinuses:	puffy	_____	_____
Turbinates:	reddened	_____	_____
Trachea:	collapsed	_____	_____
	hemorrhagic	_____	_____
Heart:	enlarged	_____	_____
	flabby	_____	_____
	peri fluid	_____	_____
	hemorrhagic	_____	_____
Liver:	swollen	_____	_____
	mottled	_____	_____
Gallbladder:	distended	_____	_____
Lungs:	reddened	_____	_____
	granulomas	_____	_____
Air sacs:	foamy exudates	_____	_____
Yolk sacs:	watery	_____	_____
	small	_____	_____
Intestines:	hemorrhagic	_____	_____
Bursa:	inflamed	_____	_____
	atrophied	_____	_____
Kidneys:	pale	_____	_____
Hocks:	reddened	_____	_____
	swollen	_____	_____
Navel:	infected	_____	_____
	fluid	_____	_____
	Defects	Sum _____	Sum _____

Laboratory sample collection instructions

Blood samples from a minimum of 6 to a maximum of 10 hatchlings need to be obtained by euthanizing , decapitating and then placing their neck into a test tube. Collect one to two ml of blood from each hatchling into separate tubes.

Swab sample set 1* — from a minimum of 3 to a maximum of 5 hatchlings for *Salmonella* culturing need to be taken from the yolk sacs or cloaca. Use one culturette per hatchling and swab observed yolk sac defects swabbed first.

Swab sample set 2* — from a minimum of 2 to a maximum of 3 hatchlings for *Mycoplasma* culturing need to be taken from the cleft palate, sinuses, trachea, or infected air sacs of hatchlings with airsacculitis. Swab in all sites using one culturette per hatchling.

Swab sample set 3* — from a minimum of 3 to a maximum of 5 hatchlings for *Staphylococci* culturing need to be taken from the eyes and/or swollen hocks; swab hatchlings, using one culturette per bird, with observed symptoms swabbed first.

The collection of samples with the swab sample sets labeled (i.e. set 1, 2 and 3) should be forwarded immediately to your laboratory of choice!

* Culturette use: Read label instructions. Make appropriate swabs. With the ampule at the top, release culture support media by crushing ampule and squeezing liquid into the cotton end of the culturette. Promptly refrigerate and submit to laboratory.

Hatchling injection documentation

Hatchlings injected with: _____

Laboratory results recording

Serological assay:

Mycoplasma gallisepticum (MG): ____ positives out of ____ sampled

Mycoplasma meleagridis (MM): ____ positives out of ____ sampled

Mycoplasma synoviae (MS): ____ positives out of ____ sampled

Reovirus: ____ positives out of ____ sampled

Bacterial cultures:

Salmonella: ____ positives out of ____ sampled

Mycoplasma: ____ positives out of ____ sampled

Staphylococci: ____ >100 cfu's out of ____ sampled

____ >500 cfu's

Contact Person: _____ Phone: _____

(Hatchling Quality Assessment Form kindly provided by A. Rahn, Department of Animal Science; and R.M. Fulton, Animal Health Diagnostic Lab; Michigan State University

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