

Effect of incubation on poult quality

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Hatchery managers must not only provide the normally accepted 4 parameters of incubation for successful hatching but be able to understand embryonic development, and adapt incubation practices to optimize economic return. The nutrients packed into the hatching eggs can impact proper growth of the embryo and how later the hatchling will perform. As hatchery managers you impact how the embryo utilizes the nutrients within the egg. It is also important to understand water and its movement within the compartments of the egg and the diffusion of gases through the shell. The nutrients are utilized by the embryo using structures called extra embryonic components. The components include such things as the amnion, chorio-allantoic membrane, allantois, yolk sac membrane and sub-embryonic fluid. Failure of proper formation of one or all of these components results in depressed utilization of nutrients and poor hatchling quality. The shell not only supplies nutrients but additionally influences how other nutrients are utilized. Shell properties influence the ability of gases such as water vapor, oxygen and carbon dioxide to pass through the pores to and from the embryo. For example, oxygen is required for utilization of yolk lipids but carbohydrate found in the albumen or produced by the embryo during development does not. The ability of the shell to allow passage of gases is influenced by how one manages the environmental humidity, partial pressures of oxygen and room pressures within the incubators and hatchery rooms. Gases pass through the shell only through passive diffusion where gases move from an area of high concentration to an area of low concentration.

Temperature is typically regarded as the most important factor. During the initial stages of incubation we must supply adequate heat to allow for proper initiation of development of the organ systems. Toward the middle and latter stages of incubation when there is an increase in metabolic heat produced by the embryo it becomes important to remove excess heat from the egg. This relationship between air and embryo temperatures in the incubator was demonstrated by French (1997). Toward the end of incubation, the yolk is a primary source of energy for development of the embryo. We and others have demonstrated that yolk utilization by the embryo can be influenced by oxygen partial pressure, temperature and humidity. Work in our laboratory has demonstrated the effects of elevated incubator temperature during the plateau stage of incubation. When energy is limited from the yolk because of incubation conditions (elevated temperature, or humidity and low oxygen levels) then glycogen, a carbohydrate

form of energy that does not require oxygen for metabolism found in the liver and muscle could be used if sufficient stores exist for the time needed. However, when in the presence of low oxygen concentrations, glycogen stores may become limiting and depressed poult quality problems can develop.

Elevated temperatures during the last 4 days of incubation have an adverse effect upon the physical growth of the embryo and maturation of organ systems such as the intestine. Elevated temperatures reduced both tissue mass of the hatchling and decrease the maltase enzyme in the intestine that is an indicator of intestinal functional maturation. Muscle development can be influenced by incubational temperatures. Maltby et al. (2004) demonstrated that slightly elevated temperatures compared to their control between 9-12 days of incubation increased the number of fibers in the thigh muscle. Christensen et al. (2007) demonstrated that elevated temperatures during the last 4 days of incubation have different effects upon the pipping, thigh, and breast muscles. The pipping and thigh muscle are both functional during the hatching process while the breast muscle is not used for the process of hatching and could possibly be a source of energy if the yolk and muscle glycogen sources are limiting. Additionally, we have demonstrated effects upon the thyroid status of the turkey embryo (Christensen et al. 2005). Elevated incubational temperatures can produce hypothyroid hatchlings. Hypothyroidism impacts maturation of many other organ systems. Proper bone development appears to be another system that can be influenced by incubation. Experiments in our laboratory have examined the effects upon asymmetry of the long bones of the legs and the maturation of the chondrocytes as indicated by the amount of *Collagen Type X* which is necessary for ossification of the bones and *Transforming Growth Factor β -1* found in the bone (Oviedo et al., 2007, Small et al., 2007). The temperatures that an embryo experiences during incubation has also been suggested to influence the development of the thermoregulatory setpoint the hatchling experiences (Nichelmann and Tzschentke, 2003) There are interactions of incubation parameters also. The effects of elevated temperatures can be offset by improved oxygen availability with some but not all systems of the developing embryos (Wineland et al., 2004).

Moisture loss from the egg is a complex situation. The amount of moisture lost is influenced by both the humidity that surrounds the eggs in the incubator as well as the conductance or eggshell properties which limits passage of gases through the pores. It should be kept in mind that limited moisture loss due to high RH in the incubators may not have exactly the same limitation upon passage of other gases (oxygen and carbon dioxide) across the shell. The conductance of the eggs from any particular flock will vary as a normal bell shape distribution curve. Thus passage of water vapor, oxygen and carbon dioxide will vary between the developing embryos and can impact poult performance. Work by Wineland et al. (2004) illustrates the use of two relative humidities and eggs separated by their egg shell properties. We noted depressed growth rate to 6 weeks of age in the poult from low conductance eggs. It is also important to note that the higher day

old weights from the low conductance eggs was a result of the hatchlings inability to utilize yolk nutrients during the plateau stage of incubation and probably not the result of hydration status of tissue. If residual yolk is separated from the poult at hatch and we examine tissue mass, there is actually a greater percentage of poult tissue from the high and average conductance eggs (Funderburk et al., 2006). The same work from the group (Funderburk, 2006) demonstrated that poult from low conductance eggs showed a greater incidence of culls as well as poult that were slower to go to the feed when placed.

Turning of the eggs is also an important. Most work demonstrates that not turning eggs influence the proper development of the extra-embryonic components that are needed for development of the embryo. Turning of the eggs also will influence the air flow through the egg set and thus have some impact on how the embryonic metabolic heat is lost. Work of Cutchin et al. (2007) suggests that possibly nutrient stratification may play a role in the decreased hatch and hatchling quality when eggs are turned less than 45 degrees.

Incubation has dramatic and lasting effects upon the embryo and the growing poult. Attention to detail and understanding how management of the machines and rooms within the hatchery will help you to produce poult that will attain optimal performance.

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