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Poultry Egg External Characteristics: Egg Weight, Shape and Shell Colour

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Abstract: Egg weight, shape and shell colour are external characteristics that influence egg grading, packaging, price, consumer preference and hatchability. It is therefore important to understand the factors that influence them. Within a species, egg size may differ with younger birds of a species laying smaller eggs than older birds. Egg weight varies according to the oviposition time. Age of the hen is also important in determining egg weight which increases with increasing age. Higher bodyweights are generally associated with bigger eggs. Nutrition can partially control late egg size and the most important nutrients for control of egg size are linoleic acid, protein and specific amino acids. Lighting programmes influence egg size by accelerating or delaying the age at which hens start to lay eggs. The younger a hen is when she starts egg production, the smaller her eggs will be during her 1st year of life. The greatest consumer demand is for large and extra large eggs. Egg size affects hatchability and the hatchability for small eggs is lower compared to that of medium and large eggs.

Key words: Poultry eggs, egg grading, egg weight, egg shape, egg colour

INTRODUCTION

Fresh egg exterior quality includes egg weight, egg shape, shell thickness, shell weight, shell density, egg surface area and cleanliness. Egg weight, shape and colour are external characteristics that influence grading, price, consumer preference and hatchability. In the production of table eggs, the aim is to produce eggs with a high consumer preference of the best grade that fetch the highest price. On the other hand, hatchery operators aim at producing eggs with the highest hatchability. It is therefore, important to understand the factors that influence the egg weight, shape and shell colour. Grading classification is determined by interior and exterior quality and is designated by letters-AA, A and B (Georgia Egg Commission, 2011).

In descending order of quality grades are AA, A and B. In the grading process, eggs are examined for both interior and exterior quality and are sorted according to weight (size). Exterior egg quality is judged on the basis of texture, colour, shape, soundness and cleanliness according to USDA (2000) standards. The shell of each egg should be smooth, clean and free of cracks. The eggs should be uniform in colour, size and shape. The first step in egg grading is inspection of the shell for cleanliness, soundness, apparent texture, strength and shape. Shell color is not a factor in judging quality but influences consumer preference. To pass grading requirements, all eggs must be clean but a certain amount of staining is permitted in the lower grade. All eggs must have sound shells. The ideal shell shape is oval with one end larger than the other. Abnormal shells, permitted under B quality may be decidedly misshapen or faulty in texture with ridges, thin spots or rough areas. This study reviews the factors that influence the egg weight, shape and shell colour.

FACTORS INFLUENCING EGG WEIGHT

Within a species, egg size may differ. For example, younger birds of a species tend to lay smaller eggs than older birds. Eggs laid by a particular bird may vary in size, both within and between clutches. There is a strong correlation between early and late egg weights and a positive relationship between bodyweight at sexual maturity and egg size (Laughlin, 2011). Egg weight varies according to the oviposition time. Eggs laid in the morning are heavier than those laid late in the day (Tumova *et al*., 2007).

Eggs laid in the morning have slightly higher ratio of yolk than eggs laid in the afternoon (Tumova *et al*., 2007). Longer intervals of egg formation result in an increase in egg weight, albumen weight and in a decrease in yolk percentage. Age of the hen plays an important role in determining egg weight (Alsoyabel *et al*., 1991) and egg weight increases with increasing age. Higher bodyweights are generally associated with bigger eggs. Food availability is a controlling factor (Government of Alberta, 2006). Nutritional specification can partially control late egg size. The most important nutrients for control of egg size are linoleic acid, protein and specific amino acids. Reducing the level of one or a combination of these nutrients in the diet will reduce egg size. Reducing the linoleic acid content of this diet would be beneficial but it is more difficult to achieve in maize based diets than in wheat based diets. Protein level in the feed can be used to alter egg size at different stages of production. Lower total protein in the diet may be beneficial but a reduction in dietary protein can also reduce egg numbers as well as egg size. The most significant amino acid affecting egg weight is methionine. Reducing the methionine content of the diet is an option for controlling late egg size. In the first months of egg production, feeding an 18-20% protein layer ration will increase egg size. After reaching maximum egg production, high protein diets will not promote increase in egg size. After 36 weeks of age, feeding rations with 15-17% protein will help to slow down increases in egg size. Feed intake has a direct impact on the hen's intake of nutrients and the size of eggs that they produce. Any factor that limits feed intake will decrease egg size. Hens with bigger bones tend to become bigger hens and lay bigger eggs. The protein level in the ration fed before 10 weeks of age is the main factor influencing skeletal size of any breed of hen.

To have pullets with bigger skeletons, feed them a starter diet until 8-10 weeks of age. Lighting programmes influence egg size by accelerating or delaying the age at which hens start to lay eggs. The younger a hen is when she starts egg production, the smaller her egg will be during her 1st year of life. The start can be delayed by providing 10 h or less of light each day to 19 weeks of age. Decreasing the daily hours of light at any time after 10 weeks of age will also delay the start of egg production. Whilst it is possible to control late egg size by manipulating nutrition such an approach should be exercised with caution so that egg production is not adversely affected (Laughlin, 2011). There is a very fine balance between supporting persistent egg production and controlling late egg size. Controlling late egg size requires the achievement of a balance between bodyweight control, egg production and egg size.

In the United States, eggs are sold by size. The weight for each size classification is based on weight per dozen rather than weight per egg. The greatest consumer demand is for large and extra large eggs. This is due in part, to confusion between egg size and egg quality and to a lack of understanding of egg quality grades. Egg size affects hatchability (Neshiem and Card, 1972; Williamson and Payne, 1978; Mandlekar, 1981). Hatchability for small eggs is lower compared to that of medium and large eggs (Asuquo and Okon, 1993). Eggs within 45-56 g weight hatch better than lighter eggs. Mandlekar (1981) reported hatchability of large (51-56 g) and medium eggs (45-50 g) of 88.2 and 84.8%, respectively. These were higher than the hatchability of small eggs (37.5-44 g) reported by Asuquo and Okon (1993). Best hatchability (97%) was reported for medium size eggs (50 g) of Anak broiler eggs (Abiola *et al*., 2008). Large eggs (60 g) had the lowest hatchability (83%). As egg size increases, yolk size increases more than the quantity of albumen (North and Bell, 1990). Ideal hatchability in broilers is achieved when the egg weight ranges between 55-65 g (North and Bell, 1990) and 43-47 g in Kenyan indigenous chicken (King'ori *et al*., 2010). There is a positive correlation between egg weight and hatchability (Senapati *et al*., 1996). Gonzalez *et al*. (1999) recommended the setting of average weight eggs for maximum hatchability. Good early egg size is critical to ensuring early broiler chick quality and performance. There is a close correlation between egg weight and chick weight. Laughlin (2011) reported that day old chick weight is one of the major factors influencing 7 days weight and under good conditions this 7 days weight has a major effect on final broiler weight.

FACTORS INFLUENCING EGG SHAPE

The normal chicken egg is elliptical in shape. Eggs that are unusual in shape such as those that are long and narrow, round or flat-sided cannot be placed in Grades AA or A. In the United States, egg grades include AA quality, A quality, B quality and dirty. Only AA and A quality eggs are sold for supermarkets. Round eggs and unusually long eggs have poor appearance and do not fit well in cartons and are much more likely to be broken during transportation than are eggs of normal shape. Most bird eggs have an oval shape with one end rounded (the aerus) and the other more pointed (the taglion). The shape of a chicken's egg can vary a lot depending on the size, age and health of the chicken. Egg shape is determined by the internal structure of the hen. Her oviduct, distribution of internal organs and shape of her pelvic bones all affect egg shape (Government of Alberta, 2006).

Generally the shape of the egg is determined by the pressures exerted by the walls of the oviduct (egg passage) within the hen. A good healthy hen has strong muscles which push the egg through fairly quickly and mold the egg's shape as the shell is being formed. The pointy end at the back is produced by the muscles pushing on the back half of the egg to move it through the passage. The shape of an eggshell does affect its physical properties but influence the appearance. The general spherical shape of an egg maximizes shell strength while also conserving shell materials. More rounded eggs further maximize the volume of the egg for the amount of eggshell as well as ensure heat conservation.

Egg shape index described as maximum breadth to length ratio (Narushin and Romanov, 2002) vary according to strain of bird, size of the egg, position of the egg in the clutch (Romanoff and Romanoff, 1949: Marble, 1943) and time of oviposition (Roland, 1978). Shape index increases until the 5th or 6th month of production then decreases gradually. Eggs laid during the 2nd year of production have significantly lower shape indices than eggs laid in the 1st year of production (Mueller *et al.*, 1960).

FACTORS INFLUENCING EGG SHELL COLOUR

Most people in Britain prefer brown-shelled eggs while in the USA and Spain white eggs are preferred. The colour of eggshells is the result of pigments being deposited during egg formation within the oviduct. The type of pigment depends upon the breed and is genetically determined. All eggs are initially white and shell colour is the result of the pigments called porphyrins being deposited while the eggs are in the process of formation. In the Rhode Island Red, the brown pigment protoporphyrin, derived from haemoglobin in the blood is what gives the shell its light brown colour (Thear, 2005).

Shell color comes from pigments in the outer layer of the shell. Most eggshell pigments are located in the cuticle and outer portion of the calcified eggshell. As shell formation progresses, the epithelial cells lining the surface of the shell gland begin to synthesize and accumulate pigments. In brown eggs the three main pigments are biliverdin-IX its zinc chelate and protoporphyrin-IX (Baird *et al.*, 1975). Protoporphyrin-IX is the most abundant pigment. In the last 3-4 h of final shell formation, the bulk of the pigment is transferred to the protein-rich viscous fluid cuticle. The degree of brownness is dependent on the quantity of pigment directly associated with the cuticle. The pigment-rich cuticle deposited onto the eggshell at about the same time shell deposition reaches a plateau, 90 min prior to oviposition. Although, the eggshell contains traces of pigment its contribution to the intensity of brown colour is negligible compared to that of the cuticle.

Premature arrest of cuticle formation or release of stress-related hormones will result in the production of pale brown-shelled eggs (Hughes and Gilbert, 1984). Age of the bird use of certain chemotherapeutic agents and disease can also affect the intensity of pigmentation. The presence of the coccidiostat Nicarbazin in the feed can produce paler shells. Viral infections (Infectious bronchitis, newcastle disease and egg drop syndrome) can lead to loss of shell colour as well as egg deformities and a reduction in egg numbers (Thear, 2005). Older hens are more likely to produce paler eggshells than younger birds. The presence of parasitic red mites that emerge at night to feed on the perching hens can have a debilitating effect on the birds, leading to anaemia and the loss of egg colour. The presence of parasitic worms can debilitate the chickens to the extent that their nutritional intake is affected that leads to the production of pale eggs. There are also other reasons why shell colour becomes paler. A sudden disturbance to the normal routine may result in a hen retaining the egg within the shell gland area of the oviduct for a longer than normal period. During this time a very thin layer of extra calcium is deposited on the egg, producing a greyish, bleached outlook. Similarly an egg that is laid prematurely may not have had enough pigment deposited.

Many different factors including sudden changes to routine, moving to another environment, change to the diet and shocks such as loud noises, bullying within the flock or the presence of predators may lead to production of pale shelled eggs. Shell color is primarily a breed characteristic although, there is often variation among individual hens in a particular flock even when all are of the same breed and variety. Egg shells of commercial breeds of chickens are white or brown. Breeds with white earlobes ordinarily lay white eggs while breeds with red earlobes ordinarily lay brown eggs. There is no relationship between egg quality and shell colour. Nutritionally (egg quality, flavor, nutritive value or cooking characteristics) eggs with different shell colour are the same but many people think that brown eggs come from free-range hens while white ones come from batteries (Thear, 2005). Darker colored brown eggs tend to have thicker shells. Although, shell colour is mainly determined by genetics, the effect of strong sun and high temperatures on the hens can produce a fading effect on the shells. This may be a problem for those producing eggs described as free-range where the chickens are supposed to have unrestricted access to the outside during the day. However, research in Australia has shown that providing water at a temperature of 5°C in very hot weather enabled hens to produce eggs that maintained their dark shell colour (Tangkere *et al.*, 2001). The shells also had a better weight and shell breaking strength.

CONCLUSION

The shape of a chicken's egg can vary a lot depending on the size, age and health of the chicken. Egg shape is determined by the internal structure of the hen.

Generally the shape of the egg is determined by the pressures exerted by the walls of the oviduct within the hen. The shape of an eggshell does affect its physical properties. Round eggs and unusually long eggs have poor appearance and do not fit well in cartons and are much more likely to be broken during transportation than are eggs of normal shape.

The colour of eggshells is the result of pigments deposited during egg formation within the oviduct. The type of pigment depends upon the breed and is genetically determined. All eggs are initially white and shell colour is the result of the pigments called porphyrins deposited while the eggs are in the process of formation. Age of the bird use of certain chemotherapeutic agents and disease can affect the intensity of pigmentation. Most people in Britain prefer brown-shelled eggs while in the USA and Spain white eggs are preferred. This study is a review of the factors that influence the egg weight, shape and shell colour.

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