Journal of Agriculture and Sustainability
ISSN 2201-4357
Volume 12, Number 1, 2019, 107-123

INFINITY PRESS
www.infinitypress.info

Hatchability of Fertile Eggs in Poultry Industry

Onyinye C. Ogbu*
Agricultural Technology Department, Federal Polytechnic Oko, Anambra State, Nigeria

Mary A. Oguike
Animal Breeding and Physiology Department, Michael Okpara University of Agriculture Umudike, Abia State, Nigeria

Corresponding author: ogbuonyinyeac@gmail.com

Hatchability of Fertile Eggs in Poultry Industry

ABSTRACT

Hatchability is a trait of major economic importance on the poultry industry, because it has a strong effect on chick output. For poultry production at all scales to operate, it is solely dependent on regular or continuous supply of day old chicks. Besides egg cannot hatch, if they are not fertile. Hence the various factors which can influence the hatchability of a fertile egg in a contemporary situation includes environment of the egg, nutrients for the poultry, the laying bird, the egg itself, and tools used for hatchability processes. These factors bring about problems associated with poor hatchability like early embryonic death, egg rots, dead- in- shell chicks, prolonged pre-incubation storage, incubators and hatcheries malfunctions. Therefore to ensure successful production of day old chicks through successful, and prompt hatchability of fertile eggs, proper selection, management of breeding stocks, also improved handling of fertile eggs and correct incubating process are veritable tools.

Keywords: egg, poultry, hatchability.

Introduction:

Poultry production at all scales of operation is solely dependent on the regular supply of day-old chicks. The fertility and hatchability of these eggs are prime factors that can influence the supply of day old chicks in poultry production. Hatchability is the proportion of eggs that survive to the end of incubation to produce chicks. Hatchability is a trait of major economic importance in the poultry industry because it has a strong effect on chick output (Khalid *et al*., 2015).

In the early days, eggs were hatched by placing them under broody hens. This method of hatching is highly unsatisfactory for large scale production of baby chicks. Therefore incubators which provide similar environments as those of the broody hens, but more effectively are used at present for hatching of eggs.

In spite of all these innovations, some factors still promote energetic loss to the birds that laid the eggs and those that incubated it, through their failure to hatch. Fertility and hatchability are interrelated heritable traits that vary among breeds, variety and individuals in a breed or variety (King'ori, 2011). A number of factors that can influence these includes; egg age (Turongog *et al*., 1990), storage condition (Brah and Sandhu, 1989), age of flock (Buhr, 1995) system of husbandry and rearing technology (Weis, 1991). Mating system (Gebberdt – Henrich and Mark, 1991) incubation, relative humidity and egg turning (Permsack 1996). The hatching potential of an egg is totally dependent on the developing embryo and on the amount of micro and macronutrients that the hen puts in the egg (England *et al*., 2012). These nutrients are supplied from the different components, shell, yolk and albumen. There have been reports of strong correlation in hatched chick weight to yolk and albumen weights (Wolanski *et al*., 2007). Also the age of the broiler breeder hen influences the yolk: albumen ratio (Peebles *et al*., 2000). According to King'ori (2011), the most influential egg parameters that influence hatchability are; weight, shell thickness and porosity, shape index (described as maximum breath to length ratio) and

the consistency of the contents. Hatching of egg is also affected by heat stress, which reduces the external and internal egg qualities.

The various factors that can hinder the hatchability of eggs are assessed as follows;

Storage:

Eggs stored for more than a few days will not hatch, as well as eggs set when they are 10 - 14 days old. This occurs due to loss of carbon dioxide (CO_2) through the shell making the egg more alkaline thus, albumen becomes more transparent or watery (Ebenebe, 2014). Stored eggs have many early- embryo mortality, and the embryos that survive tend to develop slowly and are slow to hatch.

Hatchability fails as age of egg increases, a situation which can be improved by introducing, short periods of incubation during egg storage (SPIDES) (Aviagen undated). This means that short periods of incubation during egg storage the farmyard hen lays on the eggs in her nest every day until her clutch is complete. Each time she returns to the nest to lay an egg, the older eggs already in the nest will be warmed, effectively providing them with a short period of incubation. Well implemented SPIDES treatment can restore 60% or more of the hatch less than what would be observed in untreated stored eggs. If currently, 10% hatchability is lost due to storage, use of SPIDES will improve hatchability by 6-7% (Aviagen undated).

Nutrition:

Nutrition is a vital aspect of animal breeding. The right quality and quantity of feed, is essential for birds in providing energy to carry out process of mating and invest some nutrients in the egg. Feed is regulated to prevent excessive weight gain, a major cause of poor quality ejaculate and ovulation and at extremes lead to early ovarian and testicular regression (Brillard, 2007). In most poultry species like ostriches, egg size is an indicator of maternal investment on the egg (Dzoma, 2010). Egg size can be improved to

increase hatchability rate by manipulating fat levels, protein and enzymes addictive (Abiola *et al*., 2008).

Egg shell quality is an important economic factor in both hatching eggs and table eggs. Feed containing some mycotoxins, like *ochratoxin A*, can affect the kidney function by impairing vitamin D3 production and consequently, calcium metabolism (Biomin, 2013). This can lead to poorer shell quality, more breakage and reduced hatchability. In poultry diets, some nutrients are more essential than others, depending on the species of birds. Calcium and zinc have documented competition on gastro-intestinal tract absorption in ostriches (Dzoma 2010). Also an abnormal increase in some feed ingredients like conjugated linolenic acid (CLA) can have adverse effect on hatchability by decreasing egg weight and yolk size, and therefore causing embryo mortality among fertile eggs (Ayidin and Cook, 2004). Other nutrients that affect hatchability are vitamin E, B, folic acid e.t.c. On the other hand feed ingredients supplements like organic selenium will improve hatchability of fertile eggs (Hanacy *et al*., 2009). Anti-nutrients like gossypol toxicity which have marked difference in species susceptibility also affect egg hatchability (King 'ori, 2004). Excess cottonseed in a layer's diet causes them to lay eggs with rubbery or mottled albumen (pink white disease). This is because gossypol increases the permeability of the yolk sac membrane allowing the release of substances including pigments into egg white (King 'ori 2011).

The Hen:

The age of the laying hen has influence on the fertility of eggs. Age of hen has been reported to have influence on the size of the egg, as well as its yolk and albumen components (Uni *et al.,* 2012). Tomhave, (1958), however reported greater variation in fertile eggs in early production cycle than later. Hatchability also varies among breeds and strains. According to Isam *et al*., (2002), light breeds of birds have higher fertility when compared with heavy breeds like Rhode Island Red. Also there are reports of

higher hatchability among meat strains of birds when compared with the egg strains (Swan 1977, King 'ori 2010). When considering all hatchability traits, breed according to Islam *et al.,* (2002) has little effect on hatchability. Also the age of the broiler breeder hen influences the yolk: albumen ratio (Peebles *et al.,* 2000)

To ensure that eggs can hatch, they should be fertile. The optimum hen to cock ratio, should be maintained to ensure that fertile eggs are produced. The normal ratios of 1:5 or 10 hens, depending on the system of production (extensive or intensive) as well as size of the breed (heavy or light) should be taken into consideration. Inseminating a hen within 30minutes after oviposition, the connective tissue around the vaginal wall are flaccid. This will result to venting and therefore bringing about deep insemination which is associated with embryo mortality during hatching, which can lead to pathological polyspermy (Bakst and Dymond, 2013).

The Egg:

There are so many aspects of the egg that can either promote hatchability or mar it. These factors can be external or internal. The external properties includes; egg shell thickness and porosity (Gonzalex *et al.,* 1999) egg shell weight, egg shell breaking strength, egg shell chemical analysis (England *et al.,* 2012), egg shell colour and egg specific gravity (Bramwell, 2009). These external traits of the egg are measurable to determine their level of influence on the rate at which egg can hatch. Egg colour is determined by a colorimeter, specific gravity is checked with salt solution or Archimedes' method (Diamond 2013). The shell weight (g scale) shell thickness is measured with micrometer screw gauge (England *et al*., (2012).

The interior properties (yolk and albumen) which can be evaluated by, checking colour and strength of the pervitalline membrane with the aid of Roche scale (Roberts 2004). The albumen is measured with haugh unit.

Poor egg quality has peculiar implications for the hatching ability of an egg. Some of these are that; specific gravity of 1.070 or more in eggs hatches better than 1.065 or less (Bramwell, 2009). Specific gravity lower than 1.080 not only leads to poor hatchability but also brings about embryo mortality (Bennett, 1992). Lighter coloured eggs (colour scores above 87) hatches at a lower rate than the darker eggs (Bramwell, 2009). Egg shell pigment is usually added just before egg is laid, light colour may be a sign of prematurely laid egg (Bramwell, 2009). Egg with low porosity, and increased thickness hatch poorly (Dzoma, 2010). Extreme porosity of the eggshell can allow spoilage organisms to enter and an excessive loss of moisture from the egg. Contamination of eggs can be lethal to the embryo, even in low doses (Dzoma, 2010) hence, eggs should be free from both visible and hair line cracks. Abiola *et al*. (2008) has also stated that hatchability has a positive correlation with egg size. Washing of eggs with liquid disinfectant before setting them in the incubators, possible leads to disruption of the protective cuticles of eggs shell, hence the use of fumigation should be routinely carried out before setting the eggs in the incubator (Mastic et al., 2008). Reduced yolk proportion may have a negative effect in the nutrient supply of the embryo and consequently on hatchability of lager eggs (Cavero *et al*., 2011).

Weak perivitalline layer in the yolk is an indication that egg is old, therefore the yolk breaks easily and this brings low hatchability rate (Kirunda and McKee, 2000).

The Environment:

As soon as oviposition has occurred, embryo development in fertile egg is dependent on the environmental temperature to which the egg is exposed. Successful incubation environment depends on maintaining favorable conditions for hatching fertile eggs. The incubation environment of eggs is known to influence the growth of embryos, hatchability traits of egg, and the morphology, physiology and behaviour of chickens (Shafey *et al*., 2005). According to Kings' ori (2010) temperature and photoperiod are two

main environmental factors that influence fertility and hatchability of eggs. It involves a lot more, temperature (37.2- 39.4^{0}c), relative humidity of 56-60 and ventilation (21% oxygen) (Oluyemi and Roberts 2000). Incubation temperature for hatching most poultry eggs (domestic birds and some wild species) is surprisingly uniform 99 – 100^{o}F (Msucaores, 2004). Laying hens subjected to abnormally high environmental temperatures (heat stress) typically have declines in egg production and in the shell quality of eggs that are produced. The decline in shell quality is associated with a reduction in blood, as a result of hyperventilation induced by heat stress (Husvéth, 2011). Heat-stressed birds also reduce food intake, which would also contribute to the decline in egg quantity and quality, hence affecting hatchability. Excessive high or low temperature causes death of embryo at any stage of incubation. High environmental temperatures affects the albumen deterioration rate due to rapid loss of CO_2 from the egg. Excess water loss resulting from low relative humidity impairs the chorioallantonic process as well as its function in respiratory exchange. As oxygen is needed for hatching process to be efficient so is CO_2, which is needed for muscle tone towards the end of the incubation process. For incubating and hatching process to be efficient these factors should act their best in terms of functionality; incubating temperature, humidity, egg orientation, egg turning, ventilation and sanitation, as well as light. (Shafey, 2004) Adequate light provision during hatching and incubating periods improves hatchability traits, and post hatch performance of the chick (Shafey, 2004). Increase in environmental temperature may cause metabolizable energy to be diverted from growth and development to functions involved in homeothermy (Mecjerhof and Albers 1998). Shafey *et al.,* (2005) reported that Electric Field (EF) of 30kv/m; 60Hz during incubation increases embryonic growth and hatchability traits, therefore reducing the length of incubation of layer - type breeder eggs.

The incubation environment of eggs is influenced by the metabolism, heat production and growth of embryos and consequently hatchability and length of incubation (Safey *et*

al., 2006). Hence any alteration in the environment of set eggs may either improve or reduce their hatchability.

The Equipment:

Facilities have constantly used in the process of ensuring continuous production of chicks via hatching of fertile eggs. These equipment include incubators, hatchers, storage crates, thermometers, barometers etc. Factors that influence the incubator are egg turning practice, humidity as well as sanitization. Incubation can be done naturally by the brooding hen or artificially with a modern incubator, designed to hatch eggs. In artificial incubation, a constant temperature of 38.6^{o} C accelerates embryonic growth, utilization of nutrients and energy from the yolk and albumen reserves, but later decreases embryonic development due to limited metabolic process by insufficient exchange of oxygen (Louren *et al.*, 2005). In the incubator, hatchability of eggs stored for about 10-14 days before setting, reduces significantly (Roma *et al.,* 2008). Position of the egg in the incubating tray also influences hatchability. Tiwari and Maeda (2005) reported that eggs stored with the small end up had higher hatchability rates than those with large end up. This could be due to reduced water loss from the exposed surface area. But in the incubating tray, it is ideal to set large end up, for if small ends are set up, hatchability is reduced by 17% in breeder boilers (Bauer *et al*., 1990), while it takes longer time in quail eggs (Mahdi *et al.,* 2010).

No turning of eggs during incubation results in low hatchability and delays hatching by a few days (Van Schalkwyk *et al.,* 2000). If eggs are always laid down on one side of the shell, the extra embryonic membranes and the embryo may get stuck to the shell on this side (Oluyemi and Roberts 2000). Adequate sanitary conditions must be maintained on all the facilities that are involved in incubating and hatching eggs.

Conclusion:

Most causes and problems associated with poor hatchability are early embryonic death, egg rots, broken yolk, dead in shell chicks, prolonged pre-incubation storage poor breeder nutrition, breeder age, incubator and hatchery malfunctions (Malecki *et al.,* 2005). Therefore, to ensure successful production of day old chicks, proper selection and management of breeding stock as well as handling of fertile eggs and correct incubating process are veritable tools.

References

[1] Abiola S. S, Meshioya O. O, Oyerinde B.O. and Bamgbose M. A. (2008) Effect of Egg size on hatchability of Broiler chicks in Arch. Zootec 57 (217): 83 -86

[2] Asuquo B.O. and B. Okon, (1993), Effects of age and egg size on fertility and hatchability of chicken eggs. E. Agr. For. J., 59.79-83

[3] Aviagen (undated) How to improve the hatchability of Stored Eggs. www.aviagen.com

[4] Ayidin, R and M.E. Cook (2004) The Effect of dietary conjugated linoleic acid on egg yolk fatty acids and hatchability in Japanese quality J. Nutr., 131: 800-806.

[5] Bakst M. R and Dymond J.S (2013): Artificial Insemination in Poultry. INTECH 175 – 196 http://dx.doiory/10.5772/4918.

[6] Bauer F. S. G. Tullet and H. R. Wilson, (1990). Effects of setting eggs small end up on hatchability and post hatching performance of broilers, Br. Poult, Sci., 31, 715-724.

[7] Bennett C.D. (1992): The influence of shell thickness on hatchability in commercial broiler breeder flocks. J. of Applied Poultry Research 1: 61 -65.

[8] Biomin (2013) Egg quality and hatchability. www.biomin.net.

[9] Brah, G. S. and J. S. Sandhu, (1989). Preincubation storage of guinea fowl eggs in cooling cabinet vs room. Effect on hatchability components. Trop. Agric (Trinidad and Tobago), 66:265-268.

[10] Bramwell R. K. (2009): Measuring Hatching Egg Shell Quality. The Poultry Site 5m pub. Poultry News Bulletin p 1-9.

[11] Brillard, J. P, (2007). Control of fertility in poultry. World's Poult. Sci. J., 59: 441-446

[12] Buhr, R. J., (1995). Incubation relative humidity effects on allantoic fluid volume and hatchability. Poult. Sci., 74: 874-884.

[13] Canadian Poultry Consultants Ltd. (2008): Factors Affecting Shell Quality. A technical bulletin.www.canadian poultry.ca

[14] Cavero, D. Schmutz M. Lcken W. And Preisinger R. (2011): Improving Hatchablity of white egg layer strains through breeding. 46:44 – 55, Lohmann Information . Caxhaven Germany.

[15] Chabassi, C. S., S. Taddei, G. Predan, G. Galvani, F. Ghidini, E. Schiano and S. Gavirani, (2004). Bacteriologic finding in ostrich (*Stuthio camelus)* egg farms with reproductive failure. Avian Dis., 48:716 – 722.

[16] Diamond V (2013): Innovations in Egg Shell Quality Evaluation. Poultry News pg1-7. www.thepoultrysite .com/poultrynews

[17] Dzoma, B. M, (2010): Some factors affecting fertility & Hatchability in farmed ostrich: A review in J. of Anil & Veterinary Advances Vol. 9, Iss 2, pg 229 -239.

[18] England J. A, Salas C., Ekmay R. D. Coon C. N., (2012) Dual Energy X-Ray Absorptiometry Analysis of Broiler Breeder Eggs for prediction of Egg Components and Education of Egg Shell Quality. In International J. of Poult. Sc. 11(5) 316 – 325.

[19] Ebenebe C.I (2014) Hatchery Technology and Management Operations DjomPol Int'l Printers and Publishers Anambra state, Nigeria.

[20] Gebhardt – Henrich, S. G. and H. L. Mark, (1991). The effect of switching males among caged females on eggs production and hatchability in Japanese quail. Poult. Sci. 70: 1845-1847.

[21] Gonzalex A., D. G. Satterlee, F. Moharer and C. G. Gadd (1999). Factors affecting ostrich (*Struthio camelus)* egg hatchability. Poult. Sci., 78: 1257-1262.

[22] Hanafy, M. H., A. M. H. El-Sheik and E. A. Abdalla, (2009). The effect of organic selenium supplementation on production and physiological performance in a local strain of chicken. 1. The effect of organic selenium (Sel-Plex™) on productive, reproductive and physiological traits of bandarah local strain. Egypt Poult. Sci., 29: 1061-1084.

[23] Husvéth F. (2011) Physiological And Reproductional Aspects Of Animal Production Debreceni Egyetem, Nyugat-Magyarországi Egyetem, Pannon Egyetem .

[24] Islam, M. S. M.A.R. Howlinder, F. Kabir and J. Alam, (2002). Comparative assessment of fertility and hatchability Barred Plymouth Rock, White Rock Hen Hen. Int. J. Poult. Sci., 1: 85 – 90

[25] Khalid M. E, Huwaidi E. E. M, Ahmed I. Y. S, Hind, A.A. Ela, Bakheit M. D. (2015); Effect of Egg weight and Egg Shell thickness on Hatchability and Embryonic

Mortality of Cobb Broiler Breeder Eggs. Global J. of Anim Scientific Research Vol. 9 (1).

[26] King 'ori A. M. (2011) Review of the factors that influence egg fertility and hatchability in poultry. In International J. Of Poult. Sci., 10(6) 483 – 492.

[27] Kirunda D.F.K and Mckee, S.R. (2001): Relating Quality Characterics of aged eggs and Fresh eggs to vitelline membrane strength as determined by a texture analyzer. Poultry Science 79: 1189 – 1193.

[28] Lourens, A. H, Van den Brand. R. Meijerhof and B. Kemp, (2005). Effect of eggshell temperature during incubation and embryo development hatchability and post-hatch development. Poult. Sci., 84: 914-920.

[29] Mahdi, B. G, M. S. Naser, L. Alireza and S. A. Ayub, (2010). Effects of setting eggs small end up on hatchability and embryo mortality in Japanese quail (*Cotunix cotunix japonica).* Global Vet 4: 592-594.

[30] Malecki, I. A., J. O. Harbanczuk, C. E. Reed and G. B. Martin, (2005). The ostrich (*Struthio camelus)* blastoderm and embryo development following storage at various temperatures. Br. Poult. Sci., 46: 642-660.

[31] Meijerhof, R. and G. Albers, (1998). The influence of incubator conditions on the incidence of ascites. Incubation and fertility group meeting abstract,pp: 119 – 120.

[32] Msucares.com (Aug. 21, 2014) webmaster @ms state.edu.

[33] Oluyemi J.A and Roberts F.A (2000): Poultry Production in the Warm Wet Climates. Spectrum Books ltd pg224.

[34] Peeble, E. D, C D. Zumalt, S. M, Doyle. P. D. Gerard, M. A. Latour, C. R. Boyle and T. W. Smith (2000). Effect of breeder age and dietary fact source and level on boiler hatching egg characteristics. Poult. Sci., 79: 698 – 704.

[35] Permsak, S., 1996. Effect of water spraying and eggs turning angle to efficiency of duck hatchability. Proceedings of the 34th Kasetsart University annual conference, Bangkok (Thailand), 1996, pp: 517, 22-26.

[36] Roberts J. R. (2004): Factors affecting Egg Internal Quality and Egg Shell Quality in Laying Hens. Journal of Poultry Science 41:161-177.

[37] Romao, J. M, T.G.V. Moraes, R. S. C. Teixeira, W.M. Cardoso and C. C. Buxade, (2008). Effect of egg incubation length on hatchability and weight loss in incubation of egg and meat type Japanese quails. Braz. J. Poult. Sci., 10: 143-147.

[38] Shafey, T. M (2004) Effect of lighted Incubation on embryonic growth and Hatchability Performance of two strains of layer breeder Eggs. Br. Poult. Sc. 45: 223 -229.

[39] Shafey, T. M, Al-Batshan H. A, Al-Hassan M. J. Al-Haidray A. A, Al-Faraj A. and Ghannam M. M. (2005): Embryonic Growth of chicks under the influence of Electric filed. Int. J. of Poult. Sc. 11: 872 – 828.

[40] Shafey, T. M, Al-Batshan H. A, Shalaby M. I. and Ghannam M. M. (2006) Incubation Temperature and Hemoglobin dielectric of Chicken Embryos Incubated under the Influence of Electric Field. Electromagnetic Biol. Med., 25: 1-10.

[41] Shafey, T. M, Shalaby M. I and Bayoumic M.S. (2007): Effect of Electric Field during incubation of Eggs on the Hatchability and Post Hatch performance of Meat Chickens. International J. of Poult. Sc. 6(1) 1-7.

[42] Swan, S. E. J. (1977). Fertility and hatchability of meat and eggs trains of poultry in Fiji. Poult. Abstract 3: 425.

[43] Tarongoy, Jr. F. Eduave and E. K. Gemota, (1990). Age as a factor of hatchability. SWUCA-J. Agric Res (Philippines), 5: 22-26.

[44] Tiwari, A. K. R. and T. Maeda, (2005). Effects of egg storage position and injection of solution in stored egg on hatchability in chickens (*Galuus domesticus)* research note. J. Poult. Sci., 42:356 – 362

[45] Tomhave, A. E. (1958). Fertility and hatchability of eggs produced by New Hamsphire breeders during their first 365 days produced. Poult. Sci., 37: 27-29.

[46] Tona, K. V. Bruggeman, O. Onagbesana, F. Bamelis, M. Gbeasor, K. Mertens and E. Decuypere, (2005): Day-old quality. Relationship to hatching egg quality, adequate incubation practice and prediction of broiler performance. Avian Poult. Biol. Rev., 16: 109 – 119.

[47] Uni Z, L. Yadgary and R. Yari (2012): Nutritional Limitations during poultry embryonic development. J. Appl. Poult. Res., 29: 175 – 184.

[48] Van Schalkwyk, S. J., S. W. P. Cloete, C. R. Brown and Z. Brand, (2000): Hatching success of ostrich eggs in relations to setting, turning and angles of rotation. Br. Poult. Sci., 41: 46 – 52.

[49] Weis, J., (1991): Analysis of fertility, hatchability and egg quality indices in reproduction breeding of guinea fowls. Acta Zootechica Universitatis Agriculturae (CSFR), Number 47 pp: 5-15.

[50] Wolanski, N. J, R. A. Renema, F. E. Robinson, V. L. Varney and B. I. Fancher (2007): Relationships and early characteristics, chick measurements and early growth traits in then broiler breeder strains. Poult. Sci. 86: 1784 – 1792.