Erratic Oviposition and Defective Egg Syndrome (EODES)
Effects of Genetic Selection for Body Weight

Héctor L. Santiago

ABSTRACT

Reproductive performance of broiler breeders has been compromised due to intense selection for body weight resulting in modifications of the appetite control centers, hyperphagic behavior, and excessive deposition of fat leading to obesity. Therefore, broiler breeder hens fed ad-libitum become overweight developing ovulation and oviposition dysfunctions collectively known as Erratic Oviposition and Defective Egg Syndrome (EODES). EODES afflicted hens show reproductive anomalies that include; follicular atresia, internal ovulation and laying, multiple ovulations, the production of defective eggs due to multiple yolks, misshapen or poor shell quality, and laying out of the normal laying time of the day (erratic oviposition). These conditions eventually result in decreased egg production, increase incidence of hen and embryonic mortality, and reduced fertility. Consequently, the use of feed restriction during rearing and breeding has become a common management practice to overcome the negative effects of obesity and improve overall reproductive efficiency.

INTRODUCTION

The broiler industry is going through a gradual but definite change in product differentiation in response to demographic changes and consumer demands. Based on these changes, primary breeders have been selecting intensively for growth efficiency and carcass traits. Short-term consequences of selection are associated with a decrease in breeder reproductive performance with unknown long-term consequences. However, the application of quantitative and biometrical methods to poultry breeding have resulted in unprecedented genetic improvement in production efficiency. About 85 to 90% of the improvement in broiler growth has been achieved through genetic selection for body weight (Reddy, 1996). Coincident with significant improvements in broiler growth rate has been a progressive reduction in reproductive fitness of broiler parent stocks (Robinson et al., 1992). Broiler breeders are becoming dangerously unfit for reproducing due to the strong negative relationship between body weight and reproductive efficiency (Robinson et al., 1992). Intense selection for growth rate in broiler stocks has led to hyperphagic behavior in fast-growing birds and deposition of excessive fat leading to reproductive inefficiency (Reddy, 1996). Broiler breeders tend to produce excessive amounts of lipoprotein (yolk) leading to the production of defective eggs due to problems associated with follicle development, maturation, and ovulation (Reddy, 1996). Ovarian dysfunctions and reproductive disorders have been reported by Jaap and Muir (1968) to be higher in meat than in egg-type hens. The presence of two eggs in the oviduct at one time have been reported by Jaap and Muir (1968), Van Middelkoop (1972), and Yu et al. (1992b). Hocking et al. (1987) found that broiler
breeder hens had a greater number of atretic yellow follicles when compared to egg-type hens. A condition known as Erratic Oviposition and Defective egg Syndrome (EODES) has become a common term used to describe several reproductive problems including, follicular atresia, internal ovulation, internal laying, the production of soft-shelled or membranous eggs, multiple-yolk eggs, multiple-egg days and ovipositions not occurring in normal sequences (Van MiddleKoop, 1971; 1972; Siegel and Dunnington, 1985). Broiler breeder productivity has been dramatically improved by the adoption of feed restriction due to the fact that a desirable combination of body weight and reproductive fitness is achieved when compared to full fed allocation.

LITERATURE REVIEW

The Avian Reproductive System. The reproductive system of a sexually mature hen is composed of a single left ovary and oviduct working in close relationship with the brain, skeletal system, and liver. The ovary of an immature pullet is composed of microscopic undifferentiated follicles that at puberty undergo growth and differentiation. Biological cues at sexual maturity trigger the release of Gonadotropin Releasing Hormones (GNRH) from the hypothalamus, which in turn stimulate the release of Follicle Stimulating Hormone (FSH) and Luteinizing Hormone (LH) from the anterior pituitary (Etches, 1990). In response to FSH the follicles increase in size to form small follicles (stroma) and an orderly hierarchy of large follicles that vary in size. The ovary normally has between 5 to 10 large follicles greater than 1 cm in diameter on which the largest follicle (F1) is nearest to ovulation. The small follicles produce sex steroids that will initiate medullary bone development, stimulate yolk protein and lipid formation by the liver, and increase the size of the oviduct. The largest follicle when mature produces progesterone, exciting the hypothalamus to release LH causing the subsequent release of the ovum from the ovary (ovulation). However, since LH is only released from the pituitary for a period of 8 hours each day ovulation can not occur if follicular maturation is reached outside this time period. Therefore, ovulation will be postponed until the following open period of LH release (Etches, 1990). Since follicle maturation normally occurs between 24 to 26 hours, ovulation will be delayed each day creating a pause on consecutive ovulations and ovipositions due to the missed open period of LH release (Bahr and Palmer, 1989; Etches, 1990).

Eggs are laid in sequences of one or more eggs. A sequence is defined as consecutive daily ovipositions separated by a pause of 1 day or more in duration (Bahr and Palmer, 1989; Etches, 1990). The egg production and sequence length curves are similar in shape, the longest laying sequences are laid at the peak of egg production. Therefore, hens that lay very long sequences usually have very short follicular maturation rates of 24 hours or less while hens that have slow rates of follicular maturation, between 26-28 hours, lay short sequences of 2 to 3 days in duration (Bahr and Palmer, 1989; Etches, 1990). The longest sequence, or prime sequence, is seen in broiler breeders at about 30 to 35 weeks of age and is usually about 20 eggs in length (Robinson et al, 1992). Egg production rates are positively correlated to the length of the prime sequence, hens that are laying at high rates lay long sequences (Robinson, 1993).
Body Weight. Clayton (1972), Jaap and Muir (1968); and Robinson et al. (1993) observed an increased incidence of erratic ovipositions and defective eggs in broiler breeders and conclude that selection for body weight results in an imbalance between growth and reproduction. Luther et al. (1976) concluded that body weight at sexual maturity, irrespective of diet or feed restriction method was the most important determinant of broiler breeder performance. Flock uniformity for body weight is an excellent indication of uniformity in "body condition" or "reproductive maturation" (Robinson and Robinson, 1991). Robinson and Robinson (1991) stated that high standards of flock uniformity are essential to achieve high production peaks and overall rates of egg production. Limiting body weight of broiler breeders pullets by restricting feed increases production efficiency and has become a common management tool, even though it delays the onset of lay (Wilson et al., 1983; Robbins et al., 1988, Yu et al., 1992b). Broiler breeders fed ad-libitum produce excessive amounts of lipoprotein (yolk), follicle development, maturation and ovulation are asynchronous, all of which lead to the production of defective eggs. The increased number of large follicles results in double hierarchies with pairs of follicles of similar weights. Restricted feeding during rearing limits the incidence of double hierarchies and the production of defective eggs. Feed restricted broiler breeder hens compared to full fed hens produce more eggs (Robinson, 1991; Yu et al., 1992a; Robinson, et al., 1993a), persist in lay longer (Fatorri et al., 1991), lay longer sequences (Robinson, et al., 1991), lay fewer eggs outside the normal time of oviposition (Yu et al., 1992a), lay fewer defective eggs, and have fewer multiple ovulations in a single day (Fatorri et al., 1991; Yu et al., 1992a). Siegel (1999) reported that egg production of individual hens provided feed ad libitum was erratic suggesting a disruption of normal hierarchical development of ova, a complication associated with obesity. Hens that are obese, due to ad-libitum feeding have display enhanced follicular growth and ova production at sexual maturity, but ovulation rates and ovipositions are decreased. Feed restriction slows follicular growth and ova production and control the rate of recruitment of large preovulatory follicles into the ovary. Full-fed broiler breeder hens have an average of twelve large follicles at sexual maturity. In contrast, when feed restriction during rearing is applied only seven large follicles are observed, which is similar to the number of follicles seen in egg-type hens at puberty. The optimum number of follicles, as well as the factors that regulate the entry of follicles into the hierarchy, are poorly understood. Too many large follicles are associated with double hierarchies and multiple ovulations (Hocking et al., 1989; Yu et al., 1992b). However, too few large follicles may not be enough to sustain adequate egg production rates. Increased follicular development seen in full-fed broiler breeder hens is not associated with increased egg production. Furthermore, extra follicles are viewed as an undesirable trait, as the excess follicles disrupt normal ovarian function (Yu et al., 1992b).

Research. Robinson et al. (1992) studied the effects of ad-libitum and feed restriction during rearing and breeding of broiler breeder hens on reproductive performance. The treatments applied were denoted as follows: RR (restricted during rearing and breeding), RF (restricted during rearing and full-fed during laying), FF (full-fed during rearing and breeding) and FR (full-fed during rearing and restricted during
breeding). Feed restriction during rearing reduced body weight at 18 weeks of age from 4.2 kg to 1.9 kg, on fed restricted versus full-fed hens, respectively. Carcass fat content was significantly reduced by 20.1% on fed restricted (7.3%) when compared to full-fed hens (27.4%) while the other constituents remain similar. They reported that reproductive performance was significantly poorer the longer the duration of ad-libitum feeding and that fertility, hatchability and hatch of fertile eggs were all reduced with full-feeding. Full-feeding effects were more severe when they occurred during the breeding period than in the rearing period. The FF hens exhibited severe reproductive problems (32.6% soft-shelled and membranous eggs, 18.1% multiple-yolked eggs, 7.5% multiple-egg days, and 40.8% erratic laying) compared to RR hens (4.5% soft-shelled and membranous eggs, 2.3% multiple-yolked eggs, 1.2% multiple-egg days, and 13.3% erratic laying). Erratic laying was significantly correlated with the laying of poor quality shell eggs ($r=0.69$), multiple-yolked eggs ($r=0.29$), multiple egg days ($r=0.51$) and negatively correlated to the number of settable eggs laid ($r=-0.69$). The weight of the ovary in mature hens is largely a measure of the number of yellow follicles present in the ovary. The weight of the ovary and the number of large follicles at puberty was significantly reduced with the use of feed restriction (FF – 79.8 g (12.2), RR – 41.8 g (7.8)), while egg production and the number of settable eggs was improved with feed restriction (FF - 122.2 (102.6), RR (176.6 (172.4)). However, the weight of the oviduct was similar (FF – 67.4, RR – 61.7). Evidence of the existence of partial or complete double or, in some cases, triple hierarchies as well as ovarian hypertrophy was frequently observed in full-fed hens. They concluded that full-fed hens lose the capacity to regulate the recruitment of follicles into the hierarchy. Robinson (1992) reported that ad-libitum feeding reduced reproductive performance by reducing the length of the prime sequence and by increasing the number of long intersequence pauses. Broiler breeder hens fed ad-libitum have a higher incidence of ovarian regression resulting in egg production cessation.

**IMPLICATIONS**

Broiler breeder hen reproductive performance is highly compromised by obesity resulted from overfeeding. To achieve maximum egg production, fertility and hatchability and to minimize the incidence of erratic laying and defective eggs the use of feed restriction is compulsory. Limiting food intake assures an adequate body weight during rearing and breeding, controlling ovarian and follicular development diminishing the incidence of double hierarchies which will result in reproductive dysfunctions and anomalies.
REFERENCES


