Follicle Diameters, Egg Weight, and Egg Production Performance in Old Laying Hens Injected with Growth Hormone and Testosterone

H. Mohammadi\textsuperscript{1*}, and Z. Ansari-Pirsaraei\textsuperscript{2}

ABSTRACT

Hen aging is accompanied by a disruption of productive performance, namely, egg production. The current study was carried out to investigate how exogenous Growth Hormone (GH) and Testosterone (Ts) change diameters of hierarchal follicles, egg weight, and egg production performance of old laying hens in the late phase of production. To this end, 160 HyLine W-36 laying hens (aged 73 weeks), were injected (single injection) with GH and Ts as follows: Treatment 1: 100 µL distilled water (control group); Treatment 2: 500 µg Ts kg\textsuperscript{-1} Body-Weight (BW)+50 µg GH kg\textsuperscript{-1} body-weight; Treatment 3: 500 µg Ts kg\textsuperscript{-1} BW+100 µg GH kg\textsuperscript{-1} BW, and Treatment 4: 500 µg Ts kg\textsuperscript{-1} BW+150 µg GH kg\textsuperscript{-1} BW. The experiment had four replicates and 10 birds in each replicate in a completely randomized design. The diameters of Small White Follicle (SWF), Large White Follicle (LWF), the First (F\textsubscript{1}), Second (F\textsubscript{2}) and Third (F\textsubscript{3}) largest yellow follicles in treatment 3 were significantly larger than in the control group, in the second week after the injection. Hen-Day Egg Production percent (HDEP), egg mass, and Feed Intake (FI) of treatment 3 were significantly higher than all other groups, during the second week after the injection; besides, HDEP and FI in treatment 4 were significantly more than in the control group. These results suggest that in old laying hen, GH and Ts may positively influence follicular diameters and egg production performance.

Keywords: Egg parameters, Hen-day egg production, HyLine W-36 laying hens.

INTRODUCTION

Similar to a bunch of grapes in appearance, the ovary of a laying hen is a cluster of many follicles (Alodan, 2001). Follicles are arranged in a size hierarchy ranging from 6 to 20 mm (Johnson, 2000; Alodan, 2001). Comparing the rate of follicular maturation in young and aging birds, one can notice that the former is much slower (Johnson \textit{et al.}, 1986; Palmer and Bahr, 1992; Oguike \textit{et al.}, 2006). The reproductive performance in females is believed to deteriorate in accordance with age. The ovaries, and particularly the follicles, are the primary targets of senescence (Lebedeva \textit{et al.}, 2010). Various factors are associated with the initiation of the gradual decline in egg production in a flock of ageing birds which include the different sizes of yolky follicles as well as the changes in the pattern of yolk accumulation into the follicles and the high rate of atresia in the small follicles in addition to the slight transverse of follicles into rapid growth phase among both the old and young hens (Oguike \textit{et al.}, 2006); besides, more subtle changes in levels of sex steroids, namely time or amplitude of the pre-ovulatory surge of hormones, are considered to be responsible for the alterations in follicular growth of older hens (Johnson \textit{et al.}, 1986;

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Lebedeva et al., 2010). The rate at which follicles enter terminal follicular growth phase may alter the egg production rate (Reddy et al., 2006). The decline in egg production rate with the layers’ aging may also somehow be attributed to both an increased incidence of atresia and a reduced number of follicles reaching the final phase of rapid growth (Williams and Sharp, 1978; Palmer and Bahr, 1992; Johnson, 2000). Evidently, lower number of small follicles and the respective prevalence of atresia (Waddington et al., 1985; Palmer and Bahr, 1992; Oguike et al., 2006), in addition to a slower rate of follicular maturation were found in the ovaries of aged hens compared to the young ones (Johnson et al., 1986; Palmer and Bahr, 1992; Oguike et al., 2006).

Since increase in yolk and follicle weight may lead to enhanced egg weight (Gunawardana et al., 2008), and also plays a role in proper development of embryo, follicle size, diameter and weight are focused by animal science scientists.

**Treatments and Injection Manner**

Birds were injected (single injection) subcutaneously, at the base of the neck, with Ts and GH at body-weight-dependent dosages as follows: Treatment 1: 100 µL distilled water (control group); Treatment 2: 500 µg Ts kg\(^{-1}\) Body-Weight (BW)+50 µg GH kg\(^{-1}\) BW; Treatment 3: 500 µg Ts kg\(^{-1}\) BW+100 µg GH kg\(^{-1}\) BW, and Treatment 4: 500 µg Ts kg\(^{-1}\) BW+150 µg GH kg\(^{-1}\) BW. GH was prepared for injection according to manufacturer’s recommendations and neutral oil was used as vehicle for Ts injection.

Based on reviewed literatures (Oades and Messent, 1981; Stephen et al., 2001; Ansari-Pirsaraei, 2009), Eutropin\textsuperscript{TM} (Recombinant human somatropin\textsuperscript{TM}, LG Life Sciences Company, Korea) and Androne\textsuperscript{®} (Testosterone Enanthate, Caspian Tamin Pharmaceutical Company, Iran) were used in the present experiment.

**Follicle Diameter Measurements and Egg Weight**

Follicle diameters were measured at two stages. At the first stage, just eight h after the hormone injection, two birds from each replicate were randomly selected and slaughtered by decapitation (n= 2 × 16). Immediately after slaughtering, whole ovary and the accompanying follicular hierarchy were removed. If there was oviducal egg, it was removed, weighted and considered as one laid egg. Since it is elucidated that the follicular size is a better criterion of the follicular maturity than the weight of yolk-free mass (Etches et al., 1983), the diameter of the First (F\(_1\)), Second (F\(_2\)), Third (F\(_3\)), Fourth (F\(_4\)), Fifth (F\(_5\)) largest yellow follicles, Large Yellow Follicle (LYF), Small Yellow Follicle (SYF), Large White Follicle (LWF) and Small White Follicle (SWF) were measured along and across the stigma, to within±0.01 mm, by using a Vernier Calipers (Ansari-Pirsaraei et al., 2008).
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The second stage was carried out 14 days after the hormone injection as previously explained in the first stage. Fresh eggs were weighed (to within±0.01 g) individually during two weeks prior to the hormone injection and the second week after that. The Body Weight (BW) was used as a covariate in the analysis of egg weight.

Egg Weight and Egg Production Performance

Daily egg production was recorded throughout the experiment and HDEP percent was calculated (Ansari-Pirsaraei et al., 2008). HDEP percent was used as indicator for the rate of ovulation (Ebeid et al., 2008). Egg production percentage and egg weight values were used to calculate egg mass (EL-Husseiny et al., 2008). FI and egg weight were recorded on a weekly basis and feed conversion ratio for egg production was calculated. The equations used in the experiment are given as footnotes to Table 2.

Statistical Analysis

All data were analyzed using General Linear Model (GLM) of SAS (SAS, 2001). Differences among means were separated with Duncan multiple range test. Differences were considered significant when \( P<0.05 \).

RESULTS

Follicular Diameters and Egg Weight

The effects of hormone injection on follicular diameters and egg weight are shown in Table 1. The hormone injection increased the diameters of SWF, LWF, F3, F2 and F1. Diameter of SWF in treatment 3 was significantly higher than in the control group (\( P<0.05 \)); no significant difference was detected between the control group, treatments 2 and 4. Diameter of LWF in treatment 3 was found higher than in the control group and treatment 4 (\( P<0.05 \)). F3 was larger than in the control group and treatment 2 (\( P<0.05 \). The size of F2 in all injected hens were greater than in the control

Table 1. Effect of the hormone injection on the follicular diameters and egg weight.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Treatment 1 (Control)</th>
<th>Treatment 2</th>
<th>Treatment 3</th>
<th>Treatment 4</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>SWF (mm)</td>
<td>5.008±0.026</td>
<td>5.280±0.032</td>
<td>5.551±0.015</td>
<td>5.244±0.190</td>
<td>0.10</td>
</tr>
<tr>
<td>LWF (mm)</td>
<td>5.780±0.024</td>
<td>6.168±0.019</td>
<td>6.586±0.029</td>
<td>6.015±0.028</td>
<td>0.13</td>
</tr>
<tr>
<td>SYF (mm)</td>
<td>5.715±0.029</td>
<td>5.783±0.028</td>
<td>6.121±0.037</td>
<td>6.040±0.034</td>
<td>0.15</td>
</tr>
<tr>
<td>LYF (mm)</td>
<td>6.268±0.057</td>
<td>6.299±0.060</td>
<td>6.615±0.048</td>
<td>6.430±0.052</td>
<td>0.98</td>
</tr>
<tr>
<td>F3 (mm)</td>
<td>11.23±0.01</td>
<td>12.19±0.11</td>
<td>12.74±0.01</td>
<td>12.18±0.016</td>
<td>1.21</td>
</tr>
<tr>
<td>F2 (mm)</td>
<td>16.57±0.24</td>
<td>17.18±0.18</td>
<td>18.47±0.18</td>
<td>17.45±0.12</td>
<td>1.24</td>
</tr>
<tr>
<td>F1 (mm)</td>
<td>22.14±0.20</td>
<td>21.74±0.20</td>
<td>24.36±0.25a</td>
<td>22.36±0.23b</td>
<td>2.01</td>
</tr>
<tr>
<td>Egg weight (g)</td>
<td>63.31±1.73</td>
<td>63.35±2.01</td>
<td>64.12±1.86</td>
<td>63.43±1.49</td>
<td>0.712</td>
</tr>
</tbody>
</table>

* Small White Follicle;  b Large White Follicle;  c Small Yellow Follicle;  d Large Yellow Follicle;  e The fifth yellow follicle;  f The fourth yellow follicle;  g The third yellow follicle;  h The second yellow follicle;  i The first yellow follicle.  j Injection of 100 µl distilled water (control group);  k Injection of 500 µg Ts kg⁻¹ body-weight+50 µg GH kg⁻¹ body-weight;  l Injection of 500 µg Ts kg⁻¹ body-weight+100 µg GH kg⁻¹ body-weight;  m Injection of 500 µg Ts kg⁻¹ body-weight+150 µg GH kg⁻¹ body-weight.  n Standard Deviation.  

Values in the same row with different superscripts are significantly different (\( P<0.05 \). Values are expressed as mean±SEM (Standard Error of Mean).
Table 2. Effects of the hormone injection on egg production performance of the laying hens.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Treatment 1</th>
<th>Treatment 2</th>
<th>Treatment 3</th>
<th>Treatment 4</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Control)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ovulation rate a (%)</td>
<td>60.88±2.66</td>
<td>60.92±2.92</td>
<td>64.73±3.01</td>
<td>62.35±2.81</td>
<td>0.411</td>
</tr>
<tr>
<td>Egg mass g (of egg hen d⁻¹)</td>
<td>38.53±2.31</td>
<td>38.60±1.95</td>
<td>41.50±1.83</td>
<td>39.56±2.02</td>
<td>0.205</td>
</tr>
<tr>
<td>FI g (bird d⁻¹)</td>
<td>87.93±8.75</td>
<td>89.57±9.42</td>
<td>97.26±9.89</td>
<td>92.95±10.02</td>
<td>0.503</td>
</tr>
<tr>
<td>FCR g (of feed g⁻¹ of egg)</td>
<td>2.361±0.701</td>
<td>2.357±0.099</td>
<td>2.359±1.092</td>
<td>2.378±0.854</td>
<td>0.183</td>
</tr>
</tbody>
</table>

a Ovulation rate (Hen-Day Egg Production)= (Total number of eggs/Number of live layers)×100; b Egg mass= [Egg production (%)×Egg weight (g)]/100; c FI = Feed Intake; d Feed Conversion Ratio= Feed intake/Egg mass. e Injection of 100 µl distilled water (control group); f Injection of 500 µg Ts kg⁻¹ body-weight+50 µg GH kg⁻¹ body-weight; g Injection of 500 µg Ts kg⁻¹ body-weight+100 µg GH kg⁻¹ body-weight, and h Injection of 500 µg Ts kg⁻¹ body-weight+150 µg GH kg⁻¹ body-weight. i Standard Deviation.

Values in the same row with different superscripts are significantly different (P<0.05). Values are expressed as mean±SEM (Standard Error of Mean).

Egg Production Performance

Table 2 shows the effects of the hormone injection on egg production performance. Ovulation rate and FI in treatment 3 were higher compared to all other groups (P<0.05); besides, ovulation rate and FI in treatment 4 differed compared with the control group (P<0.05). Egg mass in treatment 3 was more than in the control group and treatment 2 (P<0.05). FCR did not differ significantly (P>0.05).

DISCUSSION

Little research has been carried out regarding the initiation and early stages of follicular growth (Yang and Fortune, 2006). Entering an abrupt growth phase by follicles when they have a diameter of less than nine mm and contain white yolk is observed. This is aligned with the previous findings on transformation of follicles from the resting stage to a rapid growth phase at a diameter of about five to six mm (Oguike et al., 2006). It is also suggested that the transitions happening in the theca and granulosa tissues of the follicles may change the follicles from non-ovulable to ovulable stage in the hierarchy and there is even a possibility that it is responsible for follicular maturation; however, the mechanisms which cause the delay of the transverse of follicles into rapid growth phase in aged hens is not clarified (Oguike et al., 2006). Each eight-mm follicle grows rapidly, three-fold increase in size (Yoshimura et al., 1994), during a 25–27 hour period of time and enters the follicular hierarchy, then ovulates after complete growth and development during five to seven days (Johnson, 2000; Goerlich et al., 2010). Follicular growth is affected by progesterone and androgens (Tonetta and diZerega, 1989). Gonadotropins play critical roles in terminal follicular development (Monniaux et al., 1997). Initially, Ts production experiences a slight increase and then almost levels out before plunging during the last 24 hours of yolk deposition (Tonetta and diZerega, 1989). Reduction in follicular maturation rate may lead to increased pause days (Reddy et al., 2006). Detailed mechanisms
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regulating follicle selection and maturation are still far from understood (Johnson and Woods, 2007; McLaughlin and McIver, 2009; Onagbesan et al., 2009; Goerlich et al., 2010). Lots of ambiguity exists in understanding the mechanisms causing the delay of the transformation of these follicles into rapid growth phase as hens age (Williams and Sharp, 1978; Oguike et al., 2006).

The earliest visible sign of primordial follicular recruitment into the growth pool is the transformation of the flattened, squamous-appearing granulosa cells into cuboidal epithelial-type cells, resulting in an increase in follicle diameter (Vendola et al., 1999). Since granulosa cells of the mature preovulatory follicle contain nuclear androgen receptors, they are assumed to be target cells for Ts (Yoshimura et al., 1993; Ansari-Pirsaraei et al., 2008). On the other hand, the presence of androgen receptors in avian and mammalian oocytes has been demonstrated and it is assumed that Ts has a potential role in prehierarchical follicle maturation and selection for ovulation (Yoshimura et al., 1993; Ansari-Pirsaraei et al., 2008). Further, with regard to recent evidence showing the significant role of Ts in steroid production and ovulation of the preovulatory follicles, Rangel and Gutierrez (2014) believe that the role of Ts in ovulation has been redefined. They also emphasize on the stimulatory effects of Ts on progesterone production (in vivo), the necessity of Ts presence in preovulatory progesterone and LH peaks and the Ts and LH interaction resulting in progesterone production (Rangel and Gutierrez, 2014).

Very low density lipoprotein VLDL (whose main function is to transport triglycerides, phospholipids, and cholesterol), and vitellogenin (which is a phosphoglycolipoprotein), are the two main precursors of yolk (Shen et al., 1993; Johnson, 2000). In a maturing pullet, yolk deposition is triggered by the Follicle-Stimulating Hormone (FSH) (Johnson, 2000). We have previously found that GH plus Ts injection may increase plasma concentrations of LDL, HDL, cholesterol and also estradiol in old laying hens (Mohammadi and Ansari-Pirsaraei, 2014). Getting the signals directly from estrogen, the formation of yolk protein takes place in the liver (Gilbert, 1971) under the control of gonadotropins and ovarian-derived steroids (oestrogen, progesterone and Ts) (Shen et al., 1993; Johnson, 2000). Specific dose of GH injection, through IGF systems, may increase yolk production in liver and, additionally, it could stimulate other growth factors in small follicles. For a full understanding of these mechanisms, more experiments should be done using different doses of hormones (Ansari-Pirsaraei et al., 2008). On the other hand, IGF-I and FSH are proposed to be involved in regulation of the follicular hierarchy and onset of preovulatory steroidogenesis (Cassy et al., 2004). Hrabia et al. (2012) propose that both GH and IGF-I are important stimulators of estradiol production in chicken nonhierarchical ovarian follicles (Hrabia et al., 2012). Also, Hrabia et al. (2014) have recently suggested that GH plays a role in the development and activity of the chicken oviduct prior to the onset of egg laying. Ts, oestrogen, progesterone and gonadotropins have role in the yolk precursor transportation to the growing follicle (Shen et al., 1993; Johnson, 2000).

It has been shown that progesterone injected broiler breeder hens have heavier F1 follicles (Liu and Bacon, 2005). Injection of premature layers with Ts, GH and GH plus Ts, increased diameter of SWF compared with none injected layers, however, only GH plus Ts injection significantly increased the diameter of LWF and SYF. This effect is attributed to elevated growth factors, especially IGPs, in small and large growing follicles (Ansari-Pirsaraei et al., 2008); these results are, in part, in line with our findings. Follicular growth may be improved as a result of androgens, progesterone (Tonetta and diZerega, 1989) and also GH functions of local production of IGF-I in ovary (Ansari-Pirsaraei, 2009), and liver
production of yolk precursors (Ansari-Pirsaraei et al., 2008). Besides, Ts plays a role in yolk lipid deposition in growing follicle (Ansari-Pirsaraei, 2009). Several in vivo and in vitro investigations have revealed that GH exerts stimulatory influences on follicular growth, development and atresia blocking (Ansari-Pirsaraei et al., 2008). It is reported that ovine GH could enhance the number of small follicles in the domestic hen (Williams et al., 1992). It is demonstrated that egg weight may be increased due to enhanced yolk and follicle weight (Gunawardana et al., 2008). Also, the significant effect of IGF-I genotype on egg weight is demonstrated (Nagaraja et al., 2000). Synthesis of ovalbumin, conalbumin, ovomucoid, and lysozyme in the oviduct and vitellogenin in the liver may be increased by estradiol, which may result in enhanced egg weight (Johnson, 2000). With respect to abovementioned evidence, increase in diameters of follicle in different stages of development and egg weight was anticipated; however, it was significant only in SWF, LWF, F3, F5, and F7.

Available data suggest that GH is involved in the control of reproduction in birds. During reproductive development, GH may influence body weight leading to alteration of the number of LYF (Renema et al., 1999). A relationship between GH and GH Receptor (GHR) genotypes and age at first egg and the rate of egg production is observed in laying hens (Feng et al., 1997; Kuhnlein et al., 1997; Lebedeva et al., 2004; Ansari-Pirsaraei et al., 2008). It is also demonstrated that GH local production, by means of an autocrine/paracrine mechanism, may directly stimulate progesterone production in the hen granulosa cells (Ahumada-Solórzano et al., 2012); and it has recently been demonstrated that GHR mRNA is also greatly expressed in the magnum, isthmus, and shell gland of laying hens, and the possibility of significant role of GH in oviduct function of domestic hens was revealed (Hrabia et al., 2013). It has also been shown that egg-laying hens have higher plasma GH concentrations and pituitary GH mRNA expression than non-laying hens (Scanes et al., 1979; Karatzas et al., 1997; Lebedeva et al., 2004; Ansari-Pirsaraei et al., 2008) and that androgens, through nuclear and extranuclear signaling pathways, decrease number of atretic follicles. Sen et al. (2014) demonstrated that androgens may enhance FSH-receptor expression, resulting in follicular growth and development. It is suggested that GH and Ts, influencing the follicular growth and oviposition, alter the egg production rate (Ansari-Pirsaraei et al., 2008, 2010). The effect of GH and Ts on egg production rate is attributed to stimulated IGF system (Ansari-Pirsaraei et al., 2008). On the other hand, it is elucidated that the GH and GHR genes are associated with the rate of egg production (Hockinga et al., 1994; Kuhnlein et al., 1997; Nagaraja et al., 2000) and double-yolk egg production (Hockinga et al., 1994). According to the available data, the central role of estradiol in egg production is demonstrated and it would be expected to play a central role in the determination of egg mass and quality (Christians and Williams, 1999). Besides, as stated above, in our previous work, it was found that injection of old laying hens with 500 µg Ts plus 100 µg GH kg<sup>-1</sup> BW increased plasma concentration of estradiol eight h after the injection (Mohammadi and Ansari-Pirsaraei, 2014).

It is suggested that Ts modulates follicular growth and development via control of plasminogen activator. This enzyme is located in preovulatory follicles and plays a role in follicle differentiation, recruitment, ovulation, and atresia (Goerlich et al., 2010). It has reported that injection of Ts to laying hens induces ovulation within eight h (Fraps, 1955). Additionally, it is reported that injection of Ts to laying hens which have a functional ovary with mature preovulatory follicles may induce ovulation (Fraps, 1955; Croze and Etches, 1980). It has been thought that preovulatory surge of Ts causes LH surge before ovulation by influencing hypothalamic–pituitary–ovarian axis, suggesting important role of Ts in ovulation.
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process. Furthermore, active or passive immunization against Ts leads to ovulation halt (Tanaka et al., 1996; Croze and Etches, 1980; Pierce et al., 2005; Ansari-Pirsaarei et al., 2008, 2009). According to above-mentioned materials, improvement in ovulation rate and egg mass was anticipated.

GH plays a multifunctional role in hen’s body. It may affect growth, body composition and appetite (Byatt et al., 1993). We previously showed that injection of 500 µg Ts kg⁻¹ BW+100 µg GH kg⁻¹ BW and also 500 µg Ts kg⁻¹ BW+150 µg GH kg⁻¹ BW significantly increased FI during the first week after the injection. GH injection may directly influence the adrenal and also may increase Thyroxin (T₄) in line with our previous results (Mohammadi and Ansari-Pirsaarei, 2014) and corticosterone (Scanes, 2000; Ansari-Pirsaarei, 2009). On the other hand, elevated leptin production (as an appetite increasing hormone (Niv-Spector et al., 2005)) due to T₄ is detected (Zou et al., 2007). It is assumed that in treatments 3 and 4, GH dose was effective enough to increase FI significantly compared with the control group and treatment. The same effect was also detected in treatment 3 compared with treatment 4. These results were expected and are partly in agreement with assumed GH functions. The dual role of GH in synthesis and secretion of IGF-I by hen granulosa cell has been shown by some authors (Ansari-Pirsaarei, 2009). IGF-I may increase protein breakdown rate and play an important role in body growth and food utilization efficiency (Tomas et al., 1998). In contrast with the present study, we have already shown that GH and Ts may have significant effect on FCR during the first week after the injection (Mohammadi and Ansari-Pirsaarei, 2014).

In this study, we noticed that physiological manipulation of old laying hens may improve at least some follicular diameters as well as ovulation rate and egg mass. It is notable that the present study was an attempt to shed more light on the GH and Ts roles in old laying hen reproductive system, therefore, because of the hormone residual risks, the authors do not recommend farmers to inject the laying hens with GH and Ts. The positive effects of the enhanced GH and Ts on reproduction performance may be considered in bird selection and breeding plans to estimate future reproduction performance. Obviously, further work is needed to make such decision.

ACKNOWLEDGEMENTS

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REFERENCES


قطر فولیکولی، وزن تخم مرغ و عملکرد مرغ های تخمدان مسن تزریق شده با هورمون رشد و تستوسترون

ج. محمودی، و. ز. انصاری پیرسازی

چکیده

همراه با افزایش سن مرغ صفات تولیدی، از جمله تولید تخم مرغ، کاهش می‌یابند. آزمایش حاضر، به صورت یک طرح کاملاً تصادفی با ۴ تیمار و ۰/۰۲ تکرار و ۱۰۰ مرغ تخمدان دار قهر کردن به منظور تعیین اثر تزریق هورمون رشد و تستوسترون بر قطر فولیکولی، وزن تخم مرغ و عملکرد مرغ های تخمدان در سن مسن در اواخر دوره تولید انجام شد. وزن تخم تخمدان تجاری از نژاد های لاین W-36 در سن ۳۳ هفته‌گی، به صورت زیر تحت یک تزریق قوار گرفتند: تیمار یک (شاهد): تزریق ۱ میلی لیتر آب مقطور، تیمار دو: تزریق ۵۵۰۰۰ میکروگرم تستوسترون و ۵۰ میکروگرم هورمون رشد به ازای هر کیلوگرم وزن بدن، تیمار سه: تزریق ۵۰۰۰۰ میکروگرم هورمون رشد و ۱۰۰ میکروگرم هورمون رشد به ازای هر کیلوگرم وزن بدن و تیمار چهار: تزریق ۵۰۰۰۰ میکروگرم هورمون رشد به ازای هر کیلوگرم وزن بدن در زمان دو هفته بعد از تزریق، قطر فولیکول های سفید کوچک، سفید بزرگ، F۲ و F۳ در تیمار سه به طور معنی‌داری از گروه کنترل بیشتر بود. درصد تولید تخم مرغ (روز مرغ)، تولید توده‌ای تخم مرغ و میزان مصرف خوراک در دو هفته بعد از تزریق، افزایش معنی‌داری دری از تیمار سه نسبت به سایر گروه‌ها نشان دادند. همچنین درصد تولید تخم مرغ (روز مرغ) و میزان مصرف خوراک در این زمان در تیمار چهار به طور معنی‌داری از گروه کنترل بیشتر بود. نتایج حاصل از این آزمایش نشان داد که تزریق هورمون رشد و تستوسترون می‌تواند اثر مناسبی بر قطر فولیکولی و عملکرد تولید مرغ های تخمدان مسن داشته باشد.