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Original Paper

Morphological changes of reproductive organs during egg formation of autochthonous Oravka hens

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In this study we investigated the changes of reproductive organs and duration of egg formation in autochthonous Oravka hens. The changes of ovary and oviduct in defferent time were investigated on 66 hens at the top of the laying. Reproductive organs have to change their weight and morphological structure depending on the dynamics of egg formation. From ovulation to laying the ovary weight increased from 47.29 to 51.55 g, oviduct weight from 71.89 to 76,31 g. Oviduct length varied from 67.39 to 68.51 g, thee functional parts were changed depending on their activity. Length of the individual oviduct parts was – *infundibulum* from 3.46 to 3.59 cm, *magnum* 36.89 to 39.98 cm, *isthmus* 8.87 to 10.78 cm, *uterus* from 10.39 to 11.97 cm and *vagina* from 4.89 to 5.41 cm.

Keywords: Oravka, hen, egg formation, ovary, oviduct

1 Introduction

The poultry oviduct provides the biological environment for the egg formation and fertilization of ovulated oocyte. The hens are born with a pair of ovary and oviduct, however, the development of the right ovary and oviduct cease and gradually regress. The left ovary and the oviduct remain functional and contribute in the egg formation. The oviduct is a long tubular structure consisting of five functionally and histomorphologically distinct segments namely: *infundibulum*, *magnum*, *isthmus*, *utterus* and *vagina* (Pollock and Orosz, 2002; Mishra et al., 2019).

The poultry oviduct provides the biological environment for the egg formation and fertilization of ovulated oocyte. The hens are born with a pair of ovary and oviduct, however, the development of the right ovary and oviduct cease and gradually regress. The left ovary and the oviduct remain functional and contribute in the egg formation. The oviduct is a long tubular structure consisting of five functionally and histomorphologically distinct segments namely: the *infundibulum* (site of fertilization), the *magnum* (production of components of egg white), the *isthmus* (formation

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of the eggshell membranes), the *uterus* (formation of calcified eggshell), and the *vagina* (oviposition or egg laying). Following ovulation, the ovum passes through the entire length of the oviduct, where the constituents of the egg are secreted and deposited from respective parts of the oviduct (Iwasawa et al., 2010; Rahman, 2013; Vijayakumar et al., 2014).

The aim of the study was to analyze the morphological changes of the ovary and oviduct during egg formation of autochthonous Oravka hens.

2 Material and methods

Experiment was realised in deep litter system in pens with density 7 hens/m^2. Feeding of hens was providing by feed mixture HYD-10 (crude protein 158.06 g/kg, metabolic energy 11.32 MJ/kg). Feeding and watering were *ad libitum*. Birds were exposed to natural light as a practiced in rural areas of South-West Slovakia.

The changes of ovary and oviduct in defferent time were investigated on 66 Oravka hens at the top of the laying. Hens were randomly selected and slaughtered by decapitation. Immediately after slaughtering, whole ovary with follicular hierarchy and oviduct were removed in different stage of egg fromation (Table 1). Ovary weight, the weight of the first, second, third, fourth and fifth largest *follicles* were measured by Mohammadi and Ansari-Pirsaraei (2016). The oviduct weight, total length of oviduct, length of individual parts of oviduct were considered by modified method of Halaj (1983).

Table 1 Scheme of experimental analysis in different stage of egg formation

Stage of egg formation	Time frequency	Hens number
Ovulation	after 10 minute intervals 0–30 minutes	9
Egg white formation	after 30 minute intervals from 30 to 180 minutes	18
Eggshell membranes formation	after 30 minute intervals from 180 to 270 minutes	12
Eggshell formation	after 150 minute intervals from 270 to 1560 minutes	27

The data generated during the experiment were subjected to one-way analysis of variance per Duncan's Multiple Range Test (Duncan, 1955) and with the help of JASP 0.8.6 software (JASP, 2018).

3 Results and discussion

The ovary weight increased depending on the location of the follicle in the ovary. We found the lowest ovarian weight after laying an egg (46.29 g), which causes follicle to fall out after ovulation. During the period of egg white formation, the ovum weight gradually increased to 47.81 g, to the eggshell membranes formation to 49.08 g and most to the eggshell formation (51.55 g). The ovary reached its maximum weight 20 hours after the egg was laid, which means that the follicle growth had already stopped during this period and was matured the next time. These weight changes were significant (p <0.05) in last two stages of egg formation (Table 2).

Table 2 Morphological characteristics of the ovary during egg formation

Stage of egg formation	Ovary weight (g)	Weight of *follicles* (g)				
		1.	2.	3.	4.	5.
Ovulation	47.29^{b}	13.22^{b}	9.51^{c}	6.65^{b}	3.09^{c}	0.92^{b}
Albumin formation	47.81^{b}	14.74^{b}	11.28^{bc}	8.21^{a}	4.43^{bc}	1.76^{bc}
Eggshell membranes formation	49.08^{b}	16.22^{b}	13.62^{b}	9.84^{a}	5.97^{ab}	3.25^{ac}
Eggshell formation	51.55^{a}	17.46^{a}	14.89^{a}	10.41^{a}	7.74^{a}	4.71^{a}

a, b, c – mean values within a column with different superscript letters were significantly different (p <0.05)

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The weight of the largest follicle varies from 13.22 to 17.46 g, the second from 9.51 to 14.89 g, the third from 6.65 to 10.41 g, the fourth from 3.09 to 7.74 g and the fifth from 0.92 to 4.71 g. Number of visible *follicles* on ovaries varies from 1000-3000 and in modern hybrids even more. *Follicles* of smaller diameter are pale, whereas *follicles* that already started to grow and develop are yellow (Hocking et al., 1987; Hocking and McCormak, 1995; Robinson et al., 1996; Peris et al., 2005).

Hobson and Lewis (2009) respectively Head (2010) recorded that variability in follicle weight is related to several factors, e.g. laying intensity, length egg series and laying rhythm.

The current findings of oviduct which appeared to be long, less convoluted, highly vascular tube and occupied the most left side are similar to those recorded by Khokhlov and Kuznetcov (2007), Mahmud (2017). Similarly, Veterany and Jedlička (2002) reported that the oviduct of the hen was well-developed at the left side, atrophied at the right side and consisted of all five regions as described in the present study.

The oviduct weight significantly increased with increasing time of egg formation. After ovulation, the oviduct weight averaged 71.89 g, egg white formation 75.30 g, eggshell membranes 75.84 g and eggshell 76.31 g (Table 3).

Table 3 Changes in the oviduct weight during egg formation

Stage of egg formation	Oviduct weight (g)	Weight of oviduct parts (g)				
		infundibulum	*magnum*	*isthmus*	*uterus*	*vagina*
Ovulation	71.89^{b}	4.81	36.29^{a}	4.74^{b}	22.51^{b}	5.54
Albumin formation	75.30^{a}	4.74	35.75^{a}	4.89^{b}	23.19^{b}	5.73
Eggshell membranes formation	75.84^{a}	4.79	32.86^{b}	6.21^{a}	25.87^{a}	6.11
Eggshell formation	76.31^{a}	4.82	31.22^{b}	5.07^{a}	26.42^{a}	6.82

a, b – mean values within a column with different superscript letters were significantly different (p <0.05)

Similarly, the functional parts of oviduct change their weight. The *infundibulum* did not change its weight significantly (from 4.74 to 7.82 g). The *magnum* reaches its highest weight just after ovulation (36.29 g), when proteins ready for secretion during egg white formation were formed. Gradually, the weight of this portion decreased to 35.75 g, eggshell membranes 32.86 g and eggshell 31.22 g. The *isthmus* increases weight especially in the period of the formation of eggshell membranes (6.21 g). The *uterus* records an increase in weight during the period of eggshell formation (25.87 g), but has the lowest weight after ovulation (22.51 g). The *vagina* during period of eggshell formation has the highest weight (6.82 g).

As shown Table 4, after ovulation, the oviduct length was 68.29 cm, in the egg white formation 67.29 cm, eggshell membranes 67.11 cm and the eggshell 67.39 cm, We also observed a balance in length in the functional parts of oviduct, *infundibulum* from 3.46 to 3.59 cm, *magnum* 36.89 to 39.98 cm, *isthmus* 8.87 to 10.78 cm, *uterus* from 10.39 to 11.97 cm and *vagina* from 4.89 to 5.41 cm.

Table 4 Changes in the oviduct length during egg formation

Stage of egg formation	Oviduct length (cm)	Length of oviduct parts (cm)				
		infundibulum	*magnum*	*isthmus*	*uterus*	*vagina*
Ovulation	68.51	3.46	39.98^{a}	8.87^{b}	10.98^{b}	5.22
Albumin formation	67.29	3.48	39.11^{a}	8.92^{b}	10.89^{b}	4.89
Eggshell membranes formation	67.11	3.51	36.89^{b}	9.38^{b}	11.97^{a}	5.36
Eggshell formation	67.39	3.59	37.22^{b}	10.78^{a}	10.39^{b}	5.41

a, b – mean values within a column with different superscript letters were significantly different (p <0.05)

In the adult hen, the oviduct receives the ovum from the ovary and provides the biological environment for the formation and potential fertilisation of the egg. During egg formation, albumin, from the *magnum* is deposited

around the yolk, followed by the eggshell membranes from the *isthmus*, which subsequently surround the egg. As the yolk traverses through the oviduct, calcium is deposited on to it, from the *uterus*, forming a hardened eggshell (Morales et al., 2010; Sah and Mishra, 2018).

4 Conclusions

In conclussion,when analyzing the ovary of 66 Oravka hens at the top of the laying, we found that its weight and the weight of the largest follicle change over time depending on the formation of egg parts. During the period of ovulation, ovary weight decrease and during the formation of the eggshell membranes and eggshell there is an increase, which is related to the transport of nutrients to the *follicles* and increases their growth. The oviduct varies in weight and length of functional parts depending on the location of the yolk in the oviduct.

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