CHANGES IN UTERINE CAPABILITY DUE TO THE INCREASED LITTER SIZE AT 7 WEEKS OF PREGNANCY IN KACANG GOAT

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ABSTRACT

The purpose of this research was to study the changes in uterine capability due to the increased litter size in Kacang goat. In this study, 9 pregnant female Kacang goats were divided into 4 different groups based on litter size, namely 1, 2, 3, and 4. At 7 weeks of pregnancy, the experimental Kacang goats were sacrificed to observe the macro and micro parameters of the uterus. The results showed that the litter size had a quadratic correlation with micro parameters of uterus but it had a linear correlation with macro parameters of the uterus. The variables of uterine glands area, glands lumen area, and cytoplasmic area reached maximum conditions at the litter size of 2.5. Litter size had a linear relationship with the volume, weight, and dimension of the uterus. It can be concluded that the optimal number of litter size in Kacang goat was two offsprings which was proven by the optimal function of the uterus to support fetal development.

Key words: Kacang goat, linear correlation, litter size, quadratic correlation, uterine capacity

INTRODUCTION

Pregnancy is an important process in the reproductive cycle. Pregnancy consists of three phases, namely early, middle, and end phase. The Early phase starts from conception, implantation, and embryogenesis. The middle phase starts from embryogenesis until organogenesis, while the end phase starts from the maturation phase until delivery. Every process in pregnancy is regulated by a regulating system which is started and initiated by primary pregnancy hormone (Fowden, 1995; Spencer et al., 2012). Every phase of pregnancy is an important process which affects the quality of the offspring.

There are numerous factors which affect the pregnancy period which then influence the quality of the offspring, one of them is the number of offspring in one pregnancy period (litter size). Prolific animals normally tend to have more than one litter size, one of which is Indonesian local livestock, namely Kacang goat (Sodiq and Sumaryadi, 2002). However, the problem that is commonly found among prolific animals is the higher the litter size, the lower the weight of offspring produced. In addition, low birth weight is directly correlated with high postnatal mortality and low survival rate (Gardner et al., 2002).

Low birth weight and high mortality due to the high litter size are strongly associated with maternal uterine capacity (Robinson, 1977). Uterine capability to support fetal growth strongly depends on the quality and quantity of uterine glands. Uterine glands consist of cells that express specific genes to produce essential materials to support the growth and development of conceptus (Bell, 1988; Cooke et al., 2013). The function of the glands is very dominant to maintain the viability of conceptus during the early phase of pregnancy because placenta and blood vessels are not completely formed yet. Moreover, the function of uterine glands to provide nutrition for fetuses is still prominent although the placenta and the blood vessel have already completely formed at 15 weeks of pregnancy (Cheong et al., 2013; Filant and Spencer, 2014).

Lower litter size should allow the uterus to provide better supports to the growth and development embryo and fetus during prenatal growth. This condition can be measured from the changes in the uterine macro and micro variables. Information on the change of uterine capability to support the fetal development due to an increase in litter size is not available yet. Therefore, this study was designed to analyze the relationship between the increased litter size and uterine macro and micro variables. Based on the result, it will be found the optimum litter size that can be supported by the uterus.

MATERIALS AND METHODS

Nine female Kacang goats which had been proven to be pregnant were divided into 4 different groups. Pregnancy examination was performed using ultrasonography (USG) at 7 weeks of pregnancy. The results of USG in the form of the number of conceived offspring were used as a basis to divide the samples into different treatment groups. The results of USG showed that there were 4 different litter sizes, therefore the
samples were divided into 4 different treatment groups, namely female with a litter size of 1, 2, 3, and 4. After USG examination, the pregnant female goats from each group were sacrificed. Uterine macro and micro parameters examination were performed afterward.

The uterine macro parameters were uterine volume, weight, and morphometric measurement, while the micro parameters were histological examination of uterine cell and glands. The morphometric examination consisted of measurements of uterine thickness, uterine length, uterine horn length, body length, and cervical length. Histological examinations were performed for uterine wall thickness, uterine gland number, uterine gland area, gland lumen area, glandular cells nucleus area, and gland cytoplasmic area. The examination was performed using a routine hematoxylin-eosin staining.

**Data Analysis**

The data acquired were grouped according to female groups with similar litter size i.e. into 4 different litter size groups. The data were analyzed using polynomial contrast analysis to evaluate the correlation between litter size and micro and macro parameters measured. Based on the results found, the linear equation and coefficient of determination were determined.

**RESULTS AND DISCUSSION**

**Correlation between Litter Size and Uterine Micro Variables**

The results of average measurement of gland area, lumen area, cytoplasmic area, and uterine glands number in litter size 1, 2, 3, and 4 are presented in Table 1. Along with the increase in litter size in the uterus, the micro image of uterine glands also changed. Afterward, p-values from 3 equations which described the correlation between litter size and micro and macro parameters measured. Based on the results found, the linear equation and coefficient of determination were determined.

![Figure 1](image_url)

**Figure 1. Quadratic relationships between the litter size and uterine gland micro characteristics**

<table>
<thead>
<tr>
<th>Litter Size</th>
<th>Gland area</th>
<th>Cytoplasmic area</th>
<th>Cytoplasmic area</th>
<th>Number of gland</th>
<th>Nuclear area</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1000</td>
<td>500</td>
<td>250</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>1</td>
<td>1500</td>
<td>750</td>
<td>375</td>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td>2</td>
<td>2000</td>
<td>1000</td>
<td>500</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>3</td>
<td>2500</td>
<td>1250</td>
<td>625</td>
<td>15</td>
<td>25</td>
</tr>
<tr>
<td>4</td>
<td>3000</td>
<td>1500</td>
<td>750</td>
<td>20</td>
<td>30</td>
</tr>
</tbody>
</table>

The values of coefficient of determination of glands area, lumen area, cytoplasmic area, glands number, and nuclear area were 59.7%, 50.5%, 66.4%, 12.8%, and 29.3%, respectively. Based on those values, micro characteristics that changed as litter size increased were gland area, gland lumen area, and uterine gland cytoplasmic area, while gland number and uterine gland nuclear area had no significant change. These results indicated changes in uterine gland cellular activities in response to the change in litter size. In litter size 1, the uterine gland characteristics were seemingly low, while litter size 2 showed the most optimum uterine glands characteristics. In litter sizes 3 and 4, there were decreases in the uterine gland characteristics instead. At a glance, litter sizes 2 and 3 appeared to have similar uterine gland characteristics because the relationship pattern was quadratic. However, litter size 2 tended to be better because it had a higher average of uterine gland characteristics. Furthermore, in litter size 2, the uterine space for fetal development was developed better.
compared to litter size 3. These facts showed that uterus had a maximum capacity to support and accommodate the prenatal growth.

Maximum litter size in which the uterus is still capable of providing good supports to maintain the growth and development of conceptus was litter size 2. With litter size of 2, uterine gland micro characteristics appeared more capable of providing nutrition which was showed by the increases in uterine gland area, uterine gland lumen area, and uterine gland cell cytoplasmic area. These better uterine gland characteristics could not be separated from the increases in uterine glands morphogenetic factors, including progesterone, estrogen, IFNT, CSH1, and GH1 (Bartol et al., 1988; Bazer et al., 2012). The increases in uterine gland area showed the increases in gland size and hypertrophic activity, therefore the quality and glandular secretion became more optimal (Igwebuike, 2009). Large uterine gland cytoplasmic area indicated more active synthesis processes. These results increase the secretions of materials required by the fetus in the uterine gland lumen (Nieburgs, 1967). Therefore, uterine gland lumen appeared wider.

**Correlation between the Increased Litter Size and Uterine Macro Variables**

Changes in uterine macro variables were different from micro characteristics. The results of measurements of total uterine weight, total uterine volume, uterine lumen area, and uterine thickness in litter size 1, 2, 3, and 4 are presented in Table 3. The correlation patterns in the uterine macro parameters tend to be linear rather than quadratic or cubic. The p-values of correlations between uterine macro parameters and litter size are presented in Table 4.

The most evident pattern was showed in uterine weight, total uterine volume, uterine lumen area, and uterine thickness. The changes in these parameters tended to have linear rather than quadratic or cubic. The p-values of correlations between these parameters and litter size are presented in Table 4.

Parameters of total uterine weight and volume only had coefficients of determination of 35.1% and 36.5%, while uterine width and uterine thickness had coefficient...
of determinations of 87.8% and 78.8%. Although the total uterine weight and volume had low coefficient of determinations, the results still showed that an increase in litter size had a direct and linear relationship to uterine weight and volume. The low values of coefficient of determinations were caused by the large variations in uterine weight and volume as litter size increased.

Increase in litter size was automatically followed by the increases in the uterine volume and weight which resulted in the low weight of conceptus in high litter size compared to low litter size (Brooks et al., 1995; Gardner et al., 2007). Besides the low weight of conceptus product, the weight variation also increased in a female with a high litter size, which indicates the presence of competition to obtain nutrition among fetuses (Robinson, 1977). These results showed that maternal environment was not sufficient to provide the nutrition required by the conceptus, which subsequently resulted in the low birth weights (Brooks et al., 1995; Giussani et al., 2003; Gardner et al., 2007).

Meanwhile, the uterine dimension (uterine width) also significantly increased along with the increase in litter size. Increase in the uterine width was followed by the thinning of the uterine wall. These conditions could be caused by the increase in the pressure from the lumen of the uterus that will push the uterine wall, therefore the stretching conditions will make the uterine wall thinner.

CONCLUSION

Increase in litter size among Kacang goat has quadratic correlations with uterine micro parameters and linear correlations with uterine macro parameters. The optimal number of litter size in Kacang goat was 2, which was proven by the optimal function of the uterus to support fetal growth and development.

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