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Research Article

Effect of Group Size on Physiological Response of Goat-An Exploratory Study

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Abstract

Background and Objective: Group size has a great effect on goat physiology but hard to predict if it acts as a stress factor. The aim of the present study was to show that what extent the number of goats/group affects the hormonal balance. **Materials and Methods:** In the present study, 12 adult female goats were divided into two groups, large and small size group. Some stress indicators as cortisol and prolactin were measured through blood samples to evaluate the effect of group size on goat physiology and to ensure the stress effect of the group size if present. SPSS was used to analyze the data using t-test. **Results:** The final result revealed that there was no significant effect of the group size on goat hormonal balance, despite the difference in hormonal concentrations between the two groups, as in the last month of the study the p-value for the difference in cortisol concentrations between the two groups was ($p = 0.1$) and ($p = 0.6$) for the difference in prolactin concentrations between the two groups. **Conclusion:** It was concluded that by increasing the number of goats/group, affected on physiology of the goats through elevations of some hormones like prolactin but this effect was not significant.

Key words: Cortisol, group size, hormonal balance, prolactin, welfare

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Group size is defined as “the number of individuals that form a group”¹. Small ruminant livestock occur widely, including many developing countries, which use traditional extensive production systems designed to meet the needs of the families. In the more developed countries, to be more efficient and to increase production, the systems are changing from traditional to semi-intensive or intensive conditions².

Living in a group provides additional benefits that help to increase animal fitness and welfare. Companionship in animals is considered a basic need and animals are willing to work for access to conspecifics as demonstrated in social motivation studies^{3,4}. Under natural conditions, goats live in fairly small, stable groups, which are reported to contain from 4-6 goats⁵. In stable groups, goats develop affinity and affiliative relationships, which increase the cohesion of the group and decrease the frequency of agonistic interactions⁶. Most farm animal species, including goats are highly gregarious and social relationships are very important for group cohesion^{7,8}. Group size is expected to act as a stress modulator which affected both physiological and behavioral responses of the animals⁹, to this stress effect some hormones like cortisol and prolactin seem to be increased¹⁰.

In this study hypothesized that group size itself acts as a stress modulator. To test this hypothesis, the effect of group size on some stress related hormones like cortisol and prolactin was studied. This study may be one of the first studies which show the effect of group size on prolactin concentrations on domestic goats.

MATERIALS AND METHODS

This study was conducted at goat farm of Tokyo University of Agriculture and Technology, in Fuchu, Tokyo, Japan, from June-September, 2016. All procedures were carried out in accordance with guidelines established by the Tokyo University of Agriculture and Technology, Japan, for the use of animals.

Animals: Adult female Shiba goats (*Capra hircus*) (n = 12), 3-4 years old. The animals were divided randomly to 2 groups according to the group size. The first group contains 4 animals (small size group) while the second one contains 8 animals (large size group).

Housing and management: All goats were housed at goat farm of Tokyo University of Agriculture and Technology, each

animal received a maintenance diet of 375 g of hay cubes (Eckenberg #1^o, made of pure alfalfa with no binders, these cubes are green, soft, the cube has an average protein level of 18% and high fiber and nutrient levels) 2 times/day, clean water and salt rocks were available ad libitum. For the small size group there was a pen with the dimensions (2.30 m×2.45 m) in length, width, respectively, while the dimensions of the pen of the large size group were (2.30 m×4.90 m) with a constant space allowance for each goat/group about 1.40 m². The pens were naturally ventilated. All animals were individually identified with plastic numbered band hanged on the neck.

Experimental procedures: The idea of this study is to have 2 groups of goats, small and large size group. It was hypothesized that number of goats/group affected on plasma concentrations of cortisol and prolactin and may act as stress factor.

Blood sampling: Every month 10 mL of blood from each goat per the two groups was collected into an evacuated heparinized tube (Venoject II, Terumo, Tokyo, Japan). Blood was centrifuged by using (automatic balancing centrifuge, Japan) at 3000 rpm for 15 min at 4°C and plasma was aspirated by plastic pipette and stored at -20°C until hormonal analysis.

Hormone analysis: Hormonal assay for goat cortisol was performed in triplicates by a double antibody radio immuno assay system using I¹²⁵ labeled radio ligands, as described by Taya *et al.*¹¹. Hormonal assay for goat prolactin was performed in triplicates by a double antibody radioimmunoassay system using I¹²⁵ labeled radio ligands, using anti-ovine PRL, NIDDK-anti-OPRL (AFP-C3581069 II) and ovine purified PRL, NIDDK-OPRL-I-2 (AFP-7150B) as described by Kandiel *et al.*¹².

Statistical analysis: The SPSS Statistics for Windows, version 23.0. Armonk, NY: IBM Corp was used to analyze the plasma concentrations of cortisol and prolactin using independent t-test. The data are presented as means ± standard errors and difference was declared as-significant when (p<0.05).

RESULTS

Cortisol concentration: The concentrations of cortisol as affected by the group size are summarized in (Table 1). The difference in cortisol concentrations due to group size was

Table 1: Least square means and standard errors (X±SE) for cortisol concentrations of goats as affected by group size

Items	Cortisol ng mL ⁻¹		p-value
	Small size group	Large size group	
First month	22.05±4.522	30.63±6.56	0.30
Second month	20.83±2.070	13.43±2.10	0.06
Third month	12.63±0.870	10.13±1.00	0.10

Data were declared significant when (p<0.05)

Table 2: Least square means and standard errors (X±SE) for prolactin concentrations of goats as affected by group size

Items	Prolactin ng mL ⁻¹		p-value
	Small size group	Large size group	
First month	38.58±8.611	41.24±11.25	0.8
Second month	54.90±22.23	68.23±8.370	0.5
Third month	30.23±8.790	36.08±9.655	0.6

Data were declared significant when (p<0.05)

not significant throughout the study period, (p = 0.3), (p<0.06) and (p<0.1) for the first, second and third month of the study, respectively.

Prolactin concentration: The result revealed that the group size had no significant effect on prolactin concentrations despite the large group size characterized by higher prolactin concentrations during the period of the study, (p = 0.8), (p<0.5) and (p<0.6) for the first, second and third month of the study respectively (Table 2).

DISCUSSION

It was hypothesized that goats housed in the large group would have higher plasma cortisol and prolactin levels but the results of the present study revealed that group size did not alter circulating cortisol and prolactin concentrations, which may be attributed to housing of goats in the same space area per goat. Previous study by Sabek *et al.*¹³ reported that group size doesn't have a significant effect on growth performance and hematological parameters of goat, also Fæverik *et al.*¹⁴ and Vieira *et al.*¹⁵ reported similar growth performance among different group sizes in dairy calves.

In the first month of the study, the cortisol concentration was higher in large size group than the small one unlike the other two months of the study which may be attributed to adaptation of goats in the large group for overcrowding, in sheep Michelena *et al.*⁹ reported that cortisol concentration in sheep decreased as group size increased.

Overall the results showed that increase number of goats/pen does not lead to increase cortisol concentrations. Abdelfattah *et al.*¹⁶ found that plasma cortisol concentration were similar (p = 0.37) among calves in groups of 2, 4 and 8 calves/pen, Previous study of Veissier *et al.*¹⁷ reported the

same results of the current study as they found that group housing has no effect on circulating ACTH level in response to a corticotrophin releasing factor challenges or on cortisol level.

The group size may act as stress factor, prolactin will play an important role in control of stress. The physiological importance of stress-induced prolactin increase is not clear, but prolactin has been suggested to have a protective role against the damage caused by stress¹⁸, possibly through immune enhancement¹⁹ and to be a regulator of the stress response²⁰. From the obtained results there was no significant effect of group size on plasma prolactin concentration as affected by group size, although the large size group characterized by higher prolactin concentration than the small one throughout the period of the study. De Vlaming²¹ said that plasma prolactin levels rapidly increase during acute stress in mammals and this rise in plasma prolactin levels is often considered part of the classical stress response.

CONCLUSION

Despite increasing the number of goats per group leads to elevation of prolactin concentration, with the identical space allowance, housing of goats in groups of 4 and 8 had no significant effect on physiological response.

SIGNIFICANCE STATEMENTS

The present study discovers the possible significant effect of group size on hormonal response of female goat. The study will help the researcher to know the optimum number of goats/group which is suitable and does not cause any stress for animals.

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