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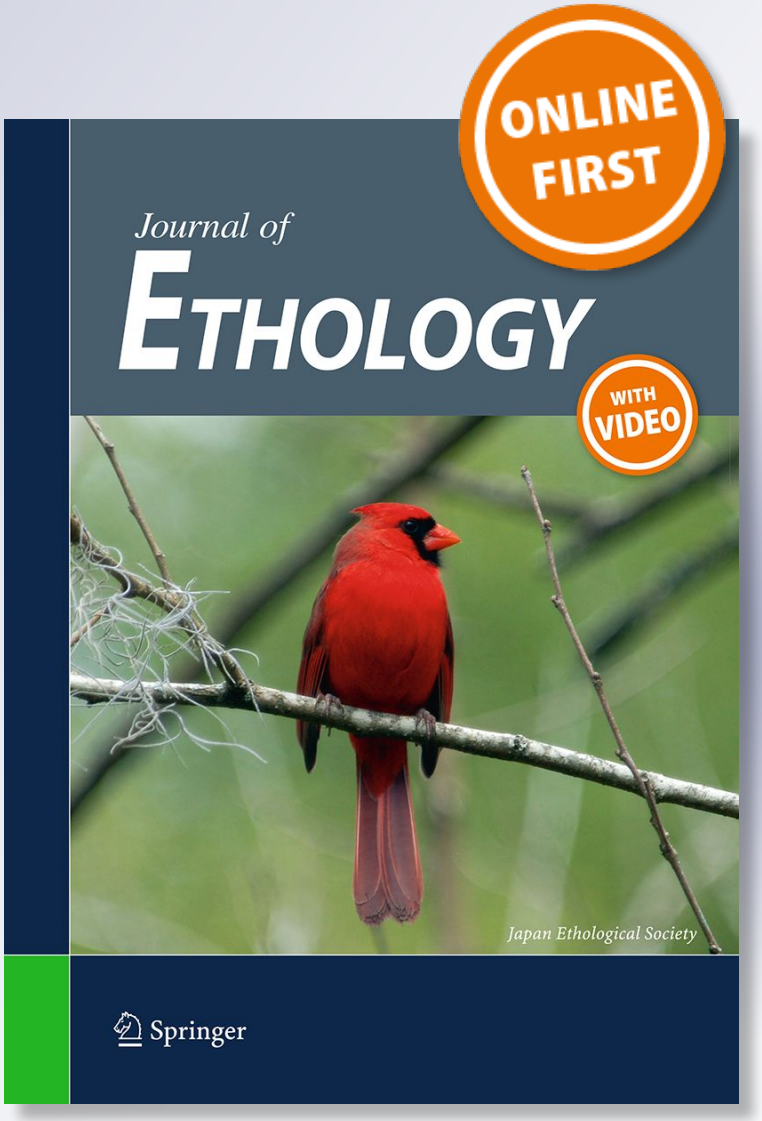
Journal of Ethology

ISSN 0289-0771

J Ethol
DOI 10.1007/s10164-019-00623-4



Springer

Journal of Ethology
https://doi.org/10.1007/s10164-019-00623-4

ARTICLE

Effect of additional outdoor yard on behaviour of lactating domestic goats (*Capra hircus*) in different seasons

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Received: 15 February 2019 / Accepted: 24 October 2019

Abstract

This study covered the effects of an improvement of the breeding environment on the behaviour of lactating goats. Two groups of 25 lactating Saanen goats were used: animals were reared in indoor pen (1.6 m^2/head) without (control IP group) or with (experimental OY group) access to an outdoor yard (1.0 m^2/head). For the trial, carried out in two different periods (winter and spring) 5 days lasting, a specific ethogram including feeding, resting, moving and play fighting (mock butting) or socio-positive (nuzzling) social behaviour was developed. Animals' behaviour was continuously video monitored. Goats in experimental OY group showed greater moving ($P < 0.01$), a tendency to less feeding and resting ($P < 0.10$). Social behaviour (butts + nuzzles), in both periods, showed significant differences ($P < 0.01$) between the two groups while as for the comparison among periods of the year, within the group, there were meaningful differences only for OY group ($P < 0.01$). Experimental OY group's social behaviour analysis, between periods, revealed a significant difference in the outdoor yard only. On the other hand, the differences between indoor and outdoor were significant for both the periods ($P < 0.01$). Butts and nuzzles of the goats in the control IP group are statistically different only in the second period ($P < 0.05$). The OY group showed higher nuzzling in both periods, even though it was statistically confirmed only for the first one ($P < 0.05$). Comparing the OY group butts and nuzzles between the two periods, only butts proved statistically different ($P < 0.05$) according to an improvement in climatic conditions. Giving the goats the possibility to use an outdoor yard, their competitiveness increases. As for the use of the space by OY group, staying in the indoor pen and in the outdoor yard as well as the looking out *activity* time suggests that the behaviour of goats was influenced by climatic conditions with regard to the utilization of the outdoor yard exclusively ($P < 0.01$). Goats that have an external space available are more active in socialization and show greater disposition to perform their normal, natural and complete behaviour patterns.

Keywords Lactating Saanen goat · Social relationship · Butting · Nuzzling

Introduction

Domestic animals have a wealth of behavioural patterns, derived from their wild ancestors, which are unable or not allowed to manifest to their entirety under intensive rearing conditions. The ability to express own typical behaviour is one of the "five freedoms" according to the Brambell Report of 1965 on the protection of the welfare of reared animals (Croney and Millman 2007). Many studies found a relation between intensive breeding and animals' inability to express normal behaviour patterns, as well as with the occurrence of abnormal behaviour due to an alteration of the emotional state (Panzera 2013). Therefore, considering that the rearing environment directly affects social behaviour (Loretz et al. 2004), animal welfare, including physical and emotional state, may be changed by its modification. In the recent years, the scientific community has grown interested in evaluating the welfare of livestock, while animal nutrition, reproduction and health have already been deeply studied. This is primarily due to the requests of farmers, interested in

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Published online: 06 November 2019

yield enhancement, as well as to those of the consumers, more and more conscious of the importance of sustainable and respectful rearing techniques (Tosi et al. 2001, 2003; Canali 2008). Even though it has been long neglected by researchers, well-being is not simply the absence of negative experiences, but it is primarily the presence of positive experiences (Boissy et al. 2007); obviously an environmental amelioration may be included among the positive experiences.

Agonistic interactions are very strong in goat (Nicolussi 2008); behavioural pattern includes the composition of a hierarchical order within the group that has the essential function of influencing individual access to basic resources such as food, water, rest areas and sexual partners. Aggression–dominance relationships, according to Barroso et al. (2000) are more frequent and marked in intensive rearing than in semi-intensive or extensive rearing. In some European Union countries there has been a gradual spread of intensive and semi-intensive breeding systems for dairy goat breeds; the main factors regarding a reduction in well-being, with consequences on the health status and the quality of products, can be attributed to type of facilities, micro-climate control, animal–breeder interaction, milking management and climatic extremes (Sevi et al. 2009). The research about social behaviour in small ruminants has almost exclusively focused on sheep, but goat is supposed to be more reactive and so quite different from this point of view (Miranda de la Lama and Mattiello 2010). For instance, goats are more explorer and inquisitive than sheep, usually fearful and shy (Kilgour and Dalton 1984). Environmental influence on social behaviour of different domestic species (including cattle, sheep, etc.) has been described by Houpt (2005) and several differences were pointed out from the author, according to resting, feeding and moving. Currently, as for the goat species there are few studies regarding the evaluation of intensive rearing behaviour, and most of these studies are based on indirect parameters (type of housing structures and systems, management, etc.). Besides, few researches address the influence of micro and/or macro climatic condition on goat's behaviour. Therefore, more information on the effect of direct parameters (addition of outdoor space and climate, etc.) on goat behaviour is needed, given the specific attitude to range and to explore the surrounding environment, naturally expressed by that species, to quantify the expected differences.

The aim of the present research was to test the effect of an additional external space on moving, feeding, resting as well on the social behaviour (mock butting and nuzzling) of a group of lactating goats, intensively reared according to EU regulation on internal space available for organic farming. The effect of climate variations was also evaluated in that perspective.

Materials and methods

Two series of recordings (24 h per day), 45 days interval, were carried out; each series lasted 5 days: the first period was in the winter, from 6 to 10 February, the second in the spring, from 28 March to 1 April.

The study was carried out on a farm located in the northern part of the Lazio region (central Italy), at 590 m above the sea level, where goats are reared for milk production, according to an intensive breeding system, consisting in free-housing within straw-bedded pens.

Examined aspects and definition of the ethogram

The research concerned a study on the social behaviour of lactating Saanen goats in relation to the availability of an external space. The following aspects have been examined: analysis of the use of the outdoor yard and of the indoor pen. The percentage of presence was obtained on the number of animals observed at first second frame of the first 15 min of each recorded hour (total number of presences for each period = 25 goats × 24 h × 5 days); analysis of the effect of the availability of an outdoor yard on the behaviour of the subjects distinguished as staying in, staying out or looking out (standing on the doorway between indoor pen and outdoor yard), activity which may indicate curiosity and/or uncertainty.

A specific ethogram including feeding, resting (absence of movement), moving, play fighting and socio-positive behaviours was developed. Butting that did not give rise to an aggressive attitude, i.e. without injury (mock butting), was considered to be a part of play fighting, whilst nuzzles, namely smelling and contact with the muzzle between subjects was regarded as socio-positive behaviour.

Animals

Two groups (control IP and experimental OY) of 25 lactating Saanen pluriparous goats each, balanced for body condition, age (21.30 ± 1.50 and 22.10 ± 1.75 months) and weight (46.70 ± 3.01 and 48.76 ± 5.73), were used, after 1-week adaptation, for two different experimental periods. Animals were free of evident lesions and pathologies and were bred in an indoor pen. Only OY group had the possibility to use an outdoor yard.

All animals were fed the same diet consisting of second cut alfalfa hay, barley grain, beet pulp and an industrial pellet. The same amount of feed was administered as total mixed ration to the two groups. A part of the pellet was administered during the milking session.

Potable water was used and each group had two water dispensers according to the number of individuals (Ehrlenbruch et al. 2010).

Facilities

The barn used had brick walls consisting of blocks of lapillus and cement, roof consisted of reinforced concrete beams and a sheet metal roof, the height of the stall was 5 m. The size of each of the two indoor pens used was 40 m^2 (4 x 10 m) and the surface area of 1.6 m^2/head is in accordance with the European standard for organic agriculture (Council Regulation (EC) No 1804, 1999). The length of each trough was 10 m with a width of 0.5 m. Each of the two indoor pens had two windows of 4 m^2, positioned upward near the roof and the animals had at least 9 h/day of light with a luminous intensity greater than 100 lux. The surface area of the outdoor yard was 25 m^2 (5 × 5 m) so the subjects of the experimental OY group had 2.6 m^2/head available. The passage from the indoor pen to the outdoor yard was ensured by a door, which was always open, 1.0 m wide and 1.8 m high. The milking system was moveable and specific for goat. Litter was changed once per month, but new wheat straw was added every day to ensure comfortable housing and an adequate level of cleanliness for limb and udder.

All the above values are included within the recommended values of spatial and microenvironment parameters for housed goats reported by Sevi et al. (2009).

Detection station

The work was undertaken by activating a fixed detection station consisting of a personal computer and three infrared cameras for the acquisition of images even throughout the night, one for detection in each indoor pen and one for filming in the outdoor yard. The station was equipped with a specific software (EasyCap-Syntek DC60) for the operation of the cameras and for timely recording of the images; the image analysis was performed by scan sampling of first 15 min video of each recorded hour (120 scans for each experimental period).

Meteorological data

Along with survey activities, data regarding the main meteorological parameters were collected from the Research Unit for Climate and Meteorology applied to Agriculture of the Council for Agricultural Research and Economics (CREA-CMA). The observed weather data were temperature, precipitation, humidity, windiness, solar radiation and are reported in Table 1.

Statistical analysis

All behavioural parameters were tested by means of the GLM procedure (SAS, 2001) using the bifactorial model with interaction:

$$Y_{ijk} = \mu + \alpha_i + \beta_j + (\alpha\beta)_{ij} + \epsilon_{ijk}$$

Table 1 Meteorological data recorded in the two experimental periods

	T_{min} at 2 m (°C)	T_{max} at 2 m (°C)	T_{mean} at 2 m (°C)	Rainfall (mm)	Relative humidity, night at 2 m height (%)	Relative humidity, day at 2 m height (%)	Wind speed at 10 m height (m/s)	Prevalent direction at 10 m height (°)	Solar radiation (kWh/m^2)
First period									
February 6th	4.3	14.0	9.2	3.8	89.4	60.3	1.4	315	11,495
February 7th	3.8	11.9	7.9	4.0	90.0	36.4	5.6	45	11,057
February 8th	1.0	7.6	4.3	0.0	37.7	32.4	8.1	45	11,653
February 9th	2.0	9.9	6.0	0.0	44.8	35.8	6.8	45	11,758
February 10th	1.6	10.0	5.8	0.0	65.9	36.5	5.1	45	11,224
Mean	2.5	10.7	6.6	1.6	65.6	40.3	5.4	–	11,437
Second period									
March 28th	4.3	15.0	9.7	4.4	98.6	69.8	3.3	45	21,605
March 29th	6.8	18.0	12.4	0.0	69.3	49.1	2.5	315	23,822
March 30th	9.0	19.2	14.1	0.0	64.0	50.4	2.1	45	25,473
March 31th	7.0	17.2	12.1	0.0	69.1	57.2	1.8	139	22,625
April 1st	8.8	20.5	14.7	0.0	67.5	36.8	4.0	45	25,574
Mean	7.2	18.0	12.6	0.9	73.7	52.7	2.7	–	23,820

where μ = general mean, α_i = periods ($i = 1, 2$), β_j = groupings ($j = 1, 2$), $(\alpha\beta)_{ij}$ = interaction period × group, ε_{ijk} = error of the model (for Table 5, $j = 1,2,3$).

Results

During the trial any dominant goat in the OY group had never blocked the entrance of outdoor yard to prevent other animals from going in or out.

Primary needs: feeding, resting and moving

Considering both the first and the second experimental periods (Fig. 1), feeding, resting and moving data, expressed as percentage of total time (first 15 min video of each recorded hour for 5 days, 24 h per day), within group, were significantly different ($P < 0.01$) either for the group with (1.6 + 1 m^2/head) or without outdoor yard availability (1.6 m^2/head).

The OY group showed a greater moving in both periods (30.80 vs 26.50% and 33.0 vs 29.3% $P < 0.05$). Moreover, OY goats moved more in spring than in winter (33.0 vs 30.8%, $P < 0.05$).

Social relationships recorded in the two periods

No fights, withdrawals and threats were observed. With regard to social relationships, given by the sum of different types of behaviours that are either agonistic (mock or playful butting, not really impactful) or socio-positive (nuzzles meant as sniffing and contacting with the muzzle), there were significant differences ($P < 0.01$) between the two groups in both survey periods (Table 2). Social relationships, expressed as a percentage, in the first period were 24.39 for the IP group and 75.61 for the OY group and in the second period 22.33 for IP group and 77.67 for OY group. Considering the differences between the two periods within each group, expressed as number of events, no significant difference was noted (52.20 and 72.80) for the social relationships in control IP group. Conversely, for experimental OY group a very significant difference was registered (161.80 vs 253.20, $P < 0.01$). Taking account of the daily results (Fig. 2), social relationships in both groups tended to be more in the second period than the first period.

Table 3 shows the data related to the social behaviour (mock butting + nuzzling) of group OY only, either in the indoor pen or in the outdoor yard. During the first period in winter (average weather values: outdoor temperature 6.6 °C,

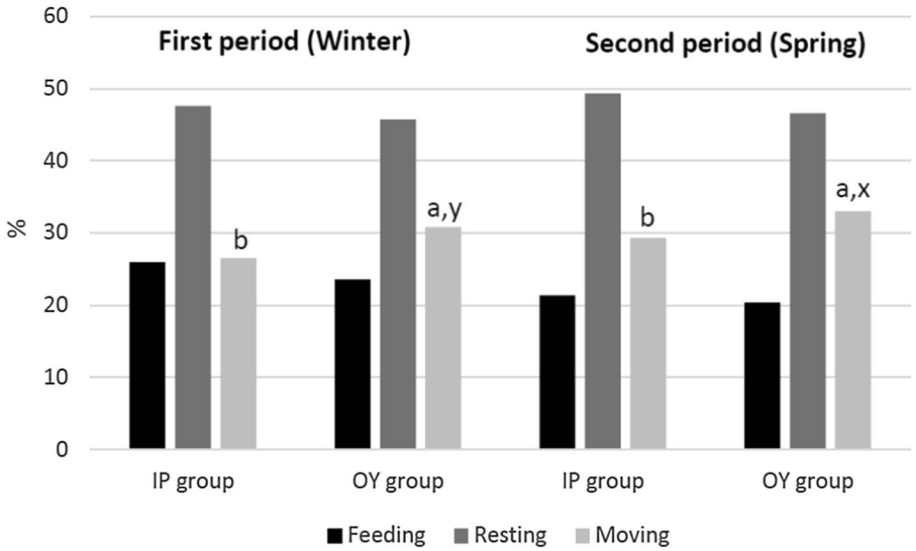

Fig. 1 Comparison of means (percentage) of feeding, resting and moving in IP group (control) and OY group (experimental). *a*, *b*: $P < 0.05$ (between group in the same period). *x*, *y*: $P < 0.05$ (between period in the same group)

Table 2 Social relationships (mock butts + nuzzles), recorded in the two periods, for the two groups

	First period		Second period		RMSE
	IP Group (control)	OY Group (experimental)	IP Group (control)	OY Group (experimental)	
Mean	52.20^{B}	161.80^{AY}	72.80^{B}	253.20^{AX}	39.27
%	24.39	75.61	22.33	77.67	

RMSE root means square of error

Mean in the row with different superscripts are significantly different between groups (A, B: $P < 0.01$) and between periods (X, Y: $P < 0.01$)

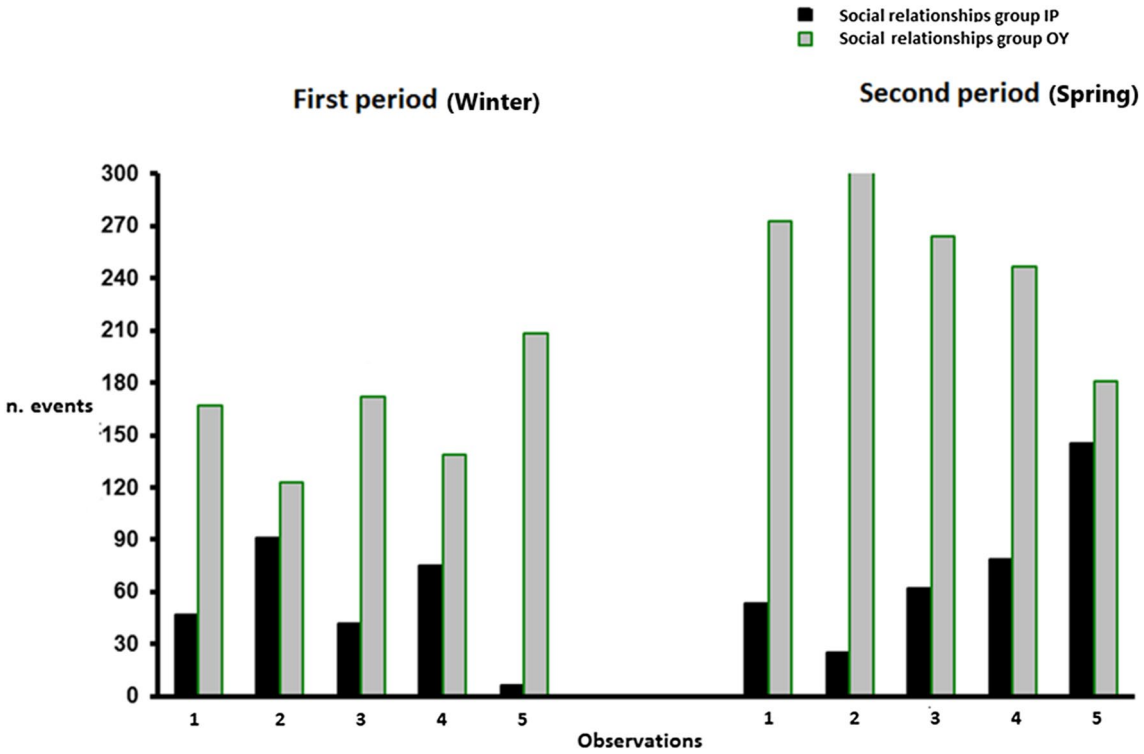

Fig. 2 Daily social relationships (butts + nuzzles), recorded in the two periods, for the two groups

Table 3 Social relationships (mock butts + nuzzles), recorded in the two periods, for OY group in indoor pen or outdoor yard

	First period		Second period		RMSE
	Indoor pen	Outdoor yard	Indoor pen	Outdoor yard	
Mean	107.80^{A}	54.00^{BY}	100.20^{B}	153.00^{AX}	26.69
%	66.62	33.38	39.57	60.43	

RMSE root means square of error

Mean in the row with different superscripts are significantly different between groups (A, B: $P < 0.01$) and between periods (X, Y: $P < 0.01$)

wind speed 5.38 m/s, solar radiation 11437 kWh/m^2) the percentage of social activities was 66.62% in the indoor pen and 33.38% in the outdoor yard (107.80 vs 54.00, $P < 0.01$). Conversely, in the second period (average weather values: outdoor temperature 12.6 °C, wind speed 2.75 m/s, solar radiation 23,820 kWh/m^2) there was a reversal of the trend with 39.57% social activity in the indoor pen and 60.43% in the outdoor yard (100.20 vs 153.00, $P < 0.01$). On the other hand, considering the differences in social activity between the two periods, no significant difference (107.80 and 100.20) within the indoor pen was observed while in the outdoor yard there was a meaningful difference (54.00 vs 153.00, $P < 0.01$). As for the daily trend of social relations in the indoor pen or outdoor yard of the group OY, in the first period, social activity took place predominantly in the indoor pen in four observations. In the second period a contrary trend was registered and it is interesting to note that on the third and fourth day, when the wind speed is lower, goats reached a maximum level of social interaction in the external paddock; in the fifth observation, wind speed (4.04 m/s) was a limiting factor.

Social relations, subdivided into mock butting and nuzzling, recorded in the two periods

The first part of Table 4 shows the social relationships, subdivided into mock butting and nuzzling, of the subjects of control IP group. Statistical analysis highlights a significant difference between mock butts and nuzzles only in second period of observation (14.40 vs 58.40, $P < 0.05$); in the first period there was a percentage of 26.44 of mock butts and 73.56 of nuzzles, in the second 19.78 and 80.22, respectively.

The second part of Table 4 reports the social relations of the experimental group (OY), subdivided into mock butts and nuzzles. Only in the first period of detection the differences between mock butts and nuzzles were significant (42.40 vs 119.40, $P < 0.05$) with percentage of 26.20 for mock butts and 73.80 for nuzzles while in the second period percentages were 42.65 for mock butts and 57.35

Table 4 Mock butts and nuzzles recorded in the two periods of the IP group and of the OY group

	First period		Second period		RMSE
	Mock butts	Nuzzles	Mock butts	Nuzzles	
IP group					
Mean	13.80	38.40	14.40^{b}	58.40^{a}	24.53
%	26.44	73.56	19.78	80.22	
OY group					
Mean	42.40^{by}	119.40^{a}	108.00^{x}	145.20	44.78
%	26.20	73.80	42.65	57.35	

RMSE root means square of error

Mean in the row with different superscripts are significantly different between groups (a, b: $P < 0.05$) and between periods (x, y: $P < 0.05$)

for nuzzles. The differences between periods within mock butts were significative (42.40 vs 108.00, $P < 0.05$). The results obtained comparing mock butts and nuzzles of the two groups are interesting. In the two periods, the data concerning nuzzles of experimental group (OY) compared to those of control group (IP) were always higher (119.40 vs 38.40, $P < 0.01$, 145.20 vs 58.40, $P < 0.05$); the same trend (42.40 vs 13.80 and 108.00 vs 14.40, $P < 0.01$) was detected for the mock butts.

Space use and relative type of activity for OY group

Data relative to the spatial distribution of animals are shown in Table 5. Regarding the use of the structure by OY group, in the first period subjects preferred to stay in the indoor pen ($N = 462.8$) rather than looking out ($N = 102.0$) or exit into the external paddock ($N = 35.2$). In the second period, the behaviour denoted a prevalent presence in the indoor pen ($N = 413.6\%$), while subjects preferred to stay in the outdoor yard ($N = 115.6$) rather than looking out ($N = 70.8$). Considering the two periods, there was a significant difference only for presence in the outdoor yard ($P < 0.01$).

Discussion

Primary needs: feeding, resting and moving

In both the considered periods, the experimental group of goats that used an external paddock (Fig. 1) moved more ($P < 0.05$), showing a tendency to rest less and spend less time feeding, even though the total mixed ration was distributed to the two groups in the same amounts and the size of the trough was the same for the two groups, according to the type recommended by Toussaint (1997). On the other hand, Loretz et al. (2004) found a reduction in feeding and resting with decreasing space allowance (from 2 to 1 m^2/head). Higher movement activity of experimental OY group may lead in the end to better muscle tone and being goats very lively and explorer animals (Pakhretia and Pirta 2010; Miranda-de la Lama and Mattiello 2010), to better emotional state and more favourable interaction animal/environment. Hypothetically, this last aspect might even affect the production capacity both from a qualitative and quantitative point of view. The effect on yield and products' quality will be the object of a further study. Bøe and Ehrlenbruch (2013) found that as the temperature drops, stressed goats remain less time in the outdoor yard; the low temperature effect could level out the behaviour of the two groups.

When comparing these results with those of Terramoccia et al. (2009) on two groups (control and experimental) of Comisana sheep, with the same available space, some similarities with goats' behaviour could be observed when the experimental thesis envisages the presence of an external paddock. Indeed, when there is no paddock, the sheep move less and show a greater propensity for rest.

Social relationships recorded in the two periods

The presence of only 1 m^2 of outdoor space available for each goat in the experimental OY group led to greater relational activity (Table 2) even if 1.6 m^2/head space for adult goats housed indoors seems to be suitable and could confirm what was reported by Kilgour and Dalton (1984) and by the Council Regulation (EC) No 1804 (1999).

Table 5 Use of the space and activity of the OY group during the two periods: staying inside, looking out and presence outside (cumulative daily presences = 25 goats × 24 h)

	First period			Second period			RMSE
	Inside	Looking out	Outside	Inside	Looking out	Outside	
Mean	462.8^{A}	102.0^{B}	35.2^{CY}	332.2^{A}	56.8^{B}	93.0^{BX}	38.89
%	77.13	17.00	5.87	68.93	11.80	19.27	

RMSE root means square of error

Means in the same row with by different superscript are significantly different between groups (A, B, C: $P < 0.01$) and between periods (X, Y: $P < 0.01$)

According to Toussaint (1997), temperature and relative humidity matched specific requirement for goat all over the trial, but the improvement in climatic conditions (higher average temperature, lower wind speed, etc.), which occurred between the two periods (Table 1), led to a more intense relational activity ($P < 0.01$) in the OY group, albeit did not determine any significant change in the social relationships of the IP group. These results confirm that temperature variation modifies behaviour of the goat species, according to Sevi et al. (2009) and Bøe and Ehrlenbruch (2013).

Considering the daily observations of the second period (Fig. 2), even though the number of observations should not allow to make rigorous conclusions, goats of OY group seemed to display a more intense social activity on the second day (outside temperature max of 18.0 °C and a wind speed of 2.54 m/s). On the fifth day (20.5 °C and 4.04 m/s) we also observed a low value in the social activity of OY group, suggesting wind as a cause of thermal discomfort. Wind has been recognized as one of the main factors for this kind of stress (McGregor 2002; Bøe and Ehrlenbruch 2013). It is also interesting to point out that the number of social activities that experimental OY group was involved in on that day was close to the average for the winter period. Wind speed on this particular day was four times higher than the optimum for cooling efficiency indicated by Sevi et al. (2009) that is 1 m/s. In contrast, the outdoor temperature of 20.5 °C intensified to a maximum the social activity of the goats of control IP group, not disturbed by the wind. It could be assumed that a further temperature rises in the presence of stronger wind could hide the effect of the external paddock. As for OY group (Table 3), while improvement in climatic conditions, due to seasonal effect, did not lead to any significant change in social activities taking place in the indoor pen, it led to more intense social activity ($P < 0.01$) in the outdoor yard. The use of the external paddock combined with improved meteorological conditions made social activities in second period three times higher than first period. This confirms what found by Galindo et al. (2000) and Miranda-de la Lama and Mattiello (2010) who highlighted that animal behaviour depends on the interaction of different factors. The comparison between the social activity performed in the indoor pen by IP group (Table 2) and by OY group (Table 3) is also interesting. It can be noted that social activity always tended to be higher for OY group, even though reached a statistically significant level only in the first period (52.20 vs 107.8, $P < 0.05$); there were no significant differences in the second period (72.80 and 100.20) although the value of social activities was 37.6% higher for OY group. Therefore, the opportunity to utilize an external paddock increased social relationships within the indoor pen.

Our findings seem not to counteract the claims made by McGregor (2002) and Bøe and Ehrlenbruch (2013) that the goat, although is described as an adaptable and rustic species, shows a behaviour negatively influenced by windiness and temperature.

Social relations, subdivided into mock butting and nuzzles, recorded in the two periods

In the enclosed environment, whose data are showed in the first part of Table 4, nuzzles were always higher in modulus than mock butts. but statistically different only in the second period. The amount of this amicable signs can confirm, according with Kilgour and Dalton (1984) and with Sevi et al. (2009), that the type of structure used, the space available for each animal of control IP group, and microclimatic conditions were adequate for intensive breeding. Similar considerations are reported by Miranda-de la Lama and Mattiello (2010) who claim that animal aggression is not determined just by intensive farming itself but in particular by the characteristics of its facilities. However, there was no meaningful differences between the first and the second period both for mock butts and nuzzles; in this intensive breeding environment, nuzzling (socio-positive behaviour) was positively influenced (73.56 and 80.22%) according to the amelioration of climatic conditions and longer duration of daylight. It is interesting to underline that in two out of five observations over the spring period, no agonistic behaviour was observed; so, a suitable structure in an intensive breeding farm, as reported by Špinka (2006), reduces the competitiveness of animals.

In the spring survey (second part of Table 4), when subjects of experimental OY group were supposed to increase the outdoor yard utilization, the percentages of mock butts and nuzzles were not different (42.65 and 57.35).

When comparing the frequencies of mock butts and nuzzles between the two periods, only mock butts were significantly higher in the second period than the first period (42.40 vs 108.00; $P < 0.05$). Therefore, with an improvement in the climatic conditions and with the goats having an outdoor yard, the play increases. These results are consistent with those reported by Orgeur et al. (1990) that found that in semi-intensive or extensive goat breeding systems, the level of vivacity of the animals is greater than in an intensive system. The presence of this small yard led to higher well-being derived from a greater vivacity of the goats of the OY group because they were more able to carry on their behaviour repertory, as also found by Tønnesen et al. (2008).

It is worthwhile to emphasize that, the percentage of mock butts and nuzzles of goats of experimental OY group (second part of Table 4) was the same of control IP group (first part of Table 4) in the winter period; since nuzzles are threefold higher than mock butts, the suitability of both

breeding techniques could be stressed. In the spring surveys, the percentage of the mock butts of OY group (42.65) was more than twice as high as that of IP group, confirming that the goats were livelier and proving that the effect of outside space is evident when climatic conditions are favourable. In the spring period it should be noted a positive relationship between mock butts and the external temperature and opposite between nuzzles and temperature. This is not necessarily a negative aspect assuming that the increase in temperature makes animals more active and pushing as well.

Space use and relative type of activity for OY group

Neither the presence in the indoor pen, that was predominant in both periods ($N = 462.8$ and 413.6), nor looking out ($N = 102.0$ 70.8) seemed to be influenced by climatic conditions. Climate improvement allowed greater use of the external paddock (35.2 vs 115.6, $P < 0.01$). The recording of attendance in the indoor pen and in the outdoor yard and of looking out showed how the behaviour of the examined subjects was affected by climatic conditions only for outdoor yard. Behaviour of sheep is different; sheep, in similar conditions and in both periods, preferred to stay inside the indoor pen up to 85% of the time despite good climatic conditions. It has also to be noted that in this species there was no activity of looking out (Terramoccia et al. 2009).

In conclusion, the results obtained demonstrate how the presence or absence of an outdoor yard affects the behaviour of the examined goats. The goats having access to an external paddock, move more frequently and perform more social relationships than the animals kept in the indoor pen.

Improvement in climatic conditions did not lead to any relational change in the control group without the outdoor yard. On the contrary, we observed more social activity in the experimental group that used the external paddock.

In the enclosed environment, nuzzles, which denote a friendly social relationship and presumably a state of well-being, were always higher than mock butts and emphasize the suitability of this kind of intensive breeding. More frequent nuzzles were noted also for the goats that use the external paddock. In any case, in the warmer period, mock butts increased significantly, demonstrating a greater vitality of the subjects of experimental group who can have expressed their behavioural traits more authentically.

The recording of utilization of both the indoor pen and the outdoor yard, showed that indoor stay was predominant in both periods and that with the improvement of climatic conditions, there has been a significantly greater use of the external paddock.

These results demonstrate the validity of experimental thesis. Anyway, the availability of an outdoor yard enabled the animals to express their behavioural pattern more completely and naturally, in line with the "five freedoms" of animal welfare. Furthermore, some specific trait, such as nuzzling and mock butting rate, type of activity and relative time spending, can likely be used as indicators to verify animal welfare in relation to breeding systems.

Acknowledgements This work was financially supported by the Regione Lazio within the Project "OPTOZOOTEC". Many thanks to "Azienda Agricola Manzi Annunziata" (Montefiascone, Viterbo) for their assistance during the entire experimentation period carried out at their breeding farm.

Compliance with ethical standards

Conflict of interest Authors declare that they have no conflict of interest.

Ethical approval All applicable international, national, and/or institutional guidelines for the care and use of animals were followed.

References

Barroso FG, Alados CL, Boza J (2000) Social hierarchy in the domestic goats: effect on food habitats and production. Appl Anim Behav Sci 69:35–53

Bøe KE, Ehrlenbruch R (2013) Thermoregulatory behavior of dairy goats at low temperatures and the use of outdoor yards. Can J Anim Sci 93:35–41

Boissy A, Manteuffel G, Jensen M, Oppermann Moe R, Spruijt B, Keeling L (2007) Assessment of positive emotions in animals to improve their welfare. Physiol Behav 92:375–397

Canali E (2008) Il concetto di benessere nelle produzioni animali. Benessere animale e sistemi zootecnici alpini, Saint Vincent, Aosta, Italia, Quaderno SooZooAlp. 5:9–17

Council Regulation (EC) No 1804 (1999) Supplementing regulation (EEC) No 2092/91 on organic production of agricultural products and indications referring thereto on agricultural products and foodstuffs to include livestock production

Croney CC, Millman ST (2007) Board-invited review: the ethical and behavioural bases for farm animal welfare legislation. J Anim Sci 85:556–565

Ehrlenbruch R, Pollen T, Andersen I, Bøe K (2010) Competition for water at feeding time. The effect of increasing number of individuals per water dispenser. Appl Anim Behav Sci 126:105–108

Galindo FM, Broom DM, Jackson PC (2000) A note on possible link between behaviour and occurrence of lameness in dairy cows. Appl Anim Behav Sci 67:335–341

Houpt KA (2005) Domestic animal behavior for veterinarian and animal scientists, 4th edn. Blackwell Publishing, Ames

Jørgensen GHM, Bøe KE (2011) Outdoor yards for sheep during the winter—effect of feed location, roof and weather factors on resting and activity. Can J Anim Sci 91:213–220

Kilgour R, Dalton C (1984) Livestock behaviour a pratical guide. Westview Press, Boulder

Loretz C, Wechsler B, Hauser R, Rusch P (2004) A comparison of space requirements of horned and hornless goats at the feed barrier and in the lying area. Appl Anim Behav Sci 87:275–283

McGregor BA (2002) A extent and source of short and cotted mohair RIRDC Research Paper, Rural Industries Research and Development Corporation, Burton A.C.T., 02/108 RIRDC, Australia

Miranda-de la Lama GC, Mattiello S (2010) The importance of social behaviour for goat welfare in livestock. Small Rumin Res 90:1–10

Nicolussi P (2008) Il benessere degli animali di allevamento. Il mensile del medico veterinario 66–78

Orgeur P, Mimouni P, Signoret J (1990) The influence of rearing conditions on the social relationship of young male goats. Appl Anim Behav Sci 27:105–113

Pakhretia S, Pirta RS (2010) A behavioural study of the sheep and goats of the transhumant gaddis. J Hum Ecol 29(2):93–100

Panzera M (2013) Sickness and behaviors as indicators of animal suffering. In Relations. Beyond Anthropocentrism. Inside the emotional lives of nonhuman animals, vol. I. 1(1), 23–31. LED on line, Milano. ISSN 2280-9643

SAS, Statistical Analysis System Institute (2001) SAS user's guide, statistics. Sas Institute Inc., Cary

Sevi A, Casamassima D, Pulina G, Pazzona A (2009) Factors of welfare reduction in dairy sheep and goats. Ital J Anim Sci 8(Suppl 1):81–101

Špinka M (2006) How important is natural behaviour in animal farming systems? Appl Anim Behav Sci 100:117–128

Terramoccia S, Bartocci S, Di Giovanni S, Negretti P, Bianconi G (2009) Analisi comportamentale di caprini e ovini eseguita con monitoraggio video. In: Monitoraggio video dei comportamenti e termorilevazione, in condizioni di allevamento mirate al benessere e alla salute degli animali, e analisi di immagine computerizzata per gli aspetti morfologici correlati con le produzioni di qualità, Viterbo, Italia

Tønnesen HG, Bøe KE, Andersen IL (2008) Group size and social interactions in goats. In: Proceedings of the 18th Nordic Symposium of the ISAE, Oscarsborg, Norway, pp 16–18

Tosi M, Canali E, Gregoretti L, Ferrante V, Rusconi C, Verga M (2001) A descriptive analysis on welfare indicator measured in Italian dairy farms: preliminary result. Acta Agric Scand Sect A Anim Sci 30:69–72

Tosi M, Canali E, Mattiello S, Ferrante V, Carenzi C, Verga M (2003) Il benessere dei suini e delle bovine da latte: punti critici e valutazioni in allevamento, vol 53. Fondazione Iniziative Zooprofilattichee e Zootecniche, Brescia

Toussaint G (1997) The housing of milk goat. Livest Prod Sci 49:151–164