

Sporkmann, Katrin; Georg, Heiko; Bender, Sophia and Ude, Gracia

Heart rate variability of goat kids to evaluate stress in different weaning situations

The weaning process is stressful and often leads into depression of performance for both, dairy goats and kids, if after 45 days rearing and mother-kid-bond ends in an abrupt separation. An alternative could be a gradual weaning method, where kids are let in intervals to her mothers after the colostrum period (1 week). Aim of our study was a comparison between an abrupt weaning of kids after 45 days (ML) and a variant which allows kids (RL) restricted milk suckling three times daily. To make this difference measurable, heart rate variability was used for the assessment of stress of goat kids depending on weaning and rearing method. Kids of the RL-group showed significant differences in heart rate variability between basal values and day of weaning. In contrast, there was no significant difference found between ML- and RL-kids concerning day of weaning and basal heart rate variability.

Keywords

Organic dairy goat kids, weaning, rearing method, heart rate variability

Abstract

Landtechnik 67 (2012), no. 6, pp. 417–420, 4 figures, 15 references

■ Weaning of goat kids is in many cases a psychic and physiological strain for kids and dams. Frequently goat kids suffer from a decline of performance, e.g. of weight gain. To facilitate transition for goat kids by an alternative, a gradually weaning process should be considered under the same feeding regime of continuous whole milk consumption according EU-Organic-Farming regulation for a period of 45 days.

Thus, in the study presented here, a group of goat kids assigned to a restricted feeding regime (RL) was compared with another group of mother bonded goat kids (ML) until day of weaning. The restricted feeding group of goat kids had been kept separately from their dams but with an admission to meet their mothers three times a day for a suckling period of 15 minutes each. Mother bonded goat kids were raised together with their dams until the end of the suckling period. Husbandry of all goats and kids took place according EU-Organic-Farming regulations in an experimental barn of the Thunen - Institute of Organic Farming, Trenthorst.

The hypothesis of the study was to test if there was a habituation effect of repeated admission and separation within

the RL-group compared with the ML group after abrupt weaning. To achieve a quantitative measurement of strain, heart rate variability was used to evaluate strain response of goat kids depending on the rearing method.

State of knowledge

Heart rate (HR) and heart rate variability (HRV) are used in human medicine in recent decades for diagnostic analysis of cardiac diseases as well as for stress monitoring or psychosomatic diseases.

Heart rate variability is more suitable for the evaluation of stress than heart rate. HR or HRV are often used parallel to blood or saliva cortisol content in order to measure stress. Recording of cardiac activities benefits from being non-invasive as well as non-disturbing for the animal after a short adaptation period. Studies of heart rate with lambs proved that [1].

Several research studies on the impact of production techniques, husbandry systems or evaluation of transportation of animals relied on measuring HR [2; 3; 4]. HR can be used to determine metabolic energy, in particular when energy turnover should be validated outside of respiratory chambers [5; 6].

HRV is preferably used for stress assessment in animal husbandry. Heart rate variability describes irregularities between two consecutive heartbeats called beat-to-beat interval or RR-interval or NN-interval.

To achieve compatibility to other studies using the same method, minimum standards should be considered [7]. To these belong measurement of 5-minute intervals and a quantity of

minimum 512 records. To calculate frequency domain variables (FFT), the higher respiratory rate of goat kids should be taken in account [7]. In animal husbandry, HRV was mainly applied to cattle, pigs, sheep, chicken and horses.

HRV in goats was used to validate learning behaviour of dwarf goats [8]. Time domain variables like RMSSD (Root Mean Square of Successive Differences), SDNN (Standard Deviation of all Intervals) as well as the relation between RMSSD and SDNN were used.

Nordmann et al. used HRV to measure stress load in different feeding place designs for dairy goats. They used exclusively undisturbed lying periods to determine HRV and calculated time domain variables RMSSD, SDNN and the ratio of RMMSSD to SDNN [9].

Behaviour, rearing and weaning of goat kids

The mother-kid-bond starts immediately after giving birth and is mainly olfactorily based on the odours of the kid. Suckling and licking intensifies the mother-kid-bond. A stable relationship between dam and goat kids will be established after staying together undisturbed for more than 4 hours as shown by [10]. Within the following 5 days after birth goats behave as “hidlers”. This means, goat kids do not follow their dams all the time, they will be visited by their dams in sporadic intervals [15]. During this period, goat kids meet their dams approximately 6-times per day for suckling. In present goat husbandry or within the first 6 to 8 weeks goat kids live and play in groups with other goat kids. In this process, goat kids meet their dams every 3 to 4 hours for a suckling period of 10 to 30 minutes [11].

Raising goat kids mother bonded parallel to milking could decline milk yield after weaning due to the missing stimulation of the kid and psychic stress cause of separation [11]. Goat kids may suffer from declination of body weight after weaning [12]. According to [13] weaning is an enormous change for the dams.

Animals, Materials and Methods

12 goats of the breed “German Improved Fawn” (BDE), which had twins were selected for the experiment. Our intention was the formation of two homogenous groups of 6 goats each and their 12 corresponding kids. Selection of goats kids considered age, sex and weight at birth. Goat kids of the RL-group (restricted feeding) got 15 minutes access to their dams three times per day and were kept separated by their dams for the rest of the time. Admission of the goat kids to their dams happened at 5 a.m., 1 p.m. and 9:30 p.m.

Goat kids of the ML-group (mother bonded) were kept together with their dams and suckled unrestricted until day of weaning. During the rearing period, recordings of basal cardiac activities were conducted as well as recordings at the day of weaning. Measurement of HRV was done using heart rate monitors Polar-S810i (**Figure 1**), parallel to synchronised video recording of behaviour and direct observations. Variables of HRV

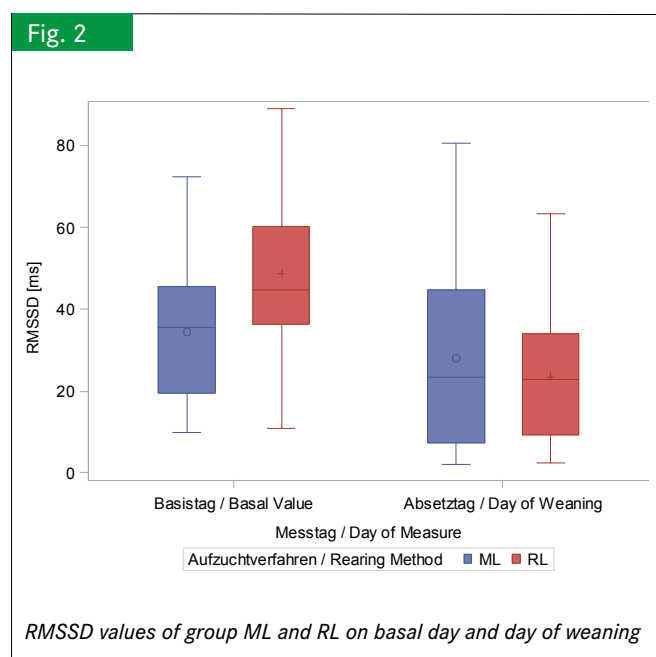


Goat kid wearing chest strap and heart rate monitor
(Photo: R. Hermann)

(RMSSD, SDNN and SD1 as standard deviation of rectangular component of Poincaré-plot) and HF (ratio of high-frequent performance compared to total performance) were calculated for undisturbed lying periods of minimum 5 minutes using Kubios software tool. Statistical analyses were performed using SAS 9.3 regarding descriptive statistics and test-statistic.

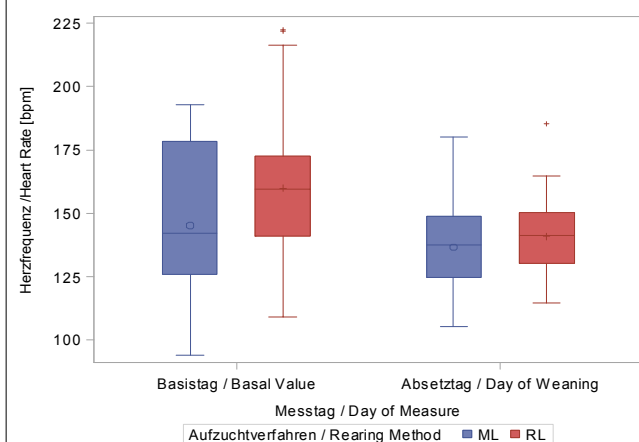
Results

As indicated in **Figure 2**, RMSSD-values of ML are considerably lower than that of the RL-group at basal day. This showed, that RL goat kids were less stressed than the ML kids at basal day. At day of weaning, median values for RMSSD of both groups were almost equal. Highly significant differences existed between basal and weaning day regarding RL but not ML (**Figure 2**). Thus, referred to RMSSD, RL-goat kids experienced more stress during day of weaning.



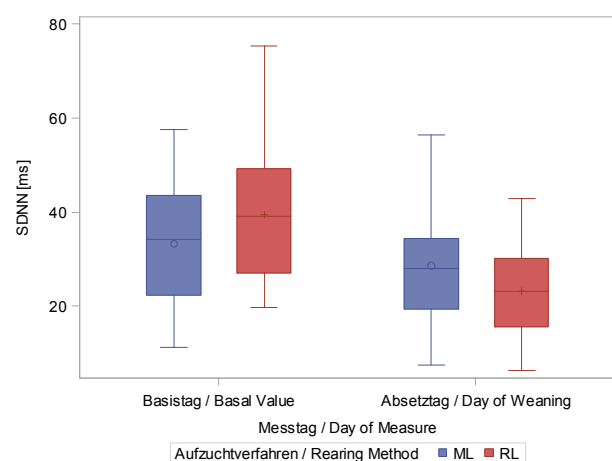
RMSSD values of group ML and RL on basal day and day of weaning

Fig. 3



Heart rate measures of RL- and ML-group during basal day and day of weaning

Fig. 4



SDNN-values for both groups ML and RL during basal day and day of weaning

Measuring (simple) heart rate (**Figure 3**) resulted in no difference for RL and ML concerning day of weaning and basal day. Lower values for both groups at day of weaning may be explained due to a decline of heart rate with advancing age of the goat kids.

Figure 4 shows for both groups an almost symmetric distribution of SDNN-values. Median basal values of the RL group were higher compared to ML. In contrast to that, ML values showed higher median values at day of weaning. A comparison of median values between basal day and day of weaning showed decreased values for both groups at day of weaning. A highly significant difference between basal day and day of weaning could be found only for RL similar to RMSSD.

Discussion

HRV results of both goat kid groups we showed differences within groups regarding basal day and day of weaning as well as difference between groups. HRV variables RMSSD and SDNN at basal day were higher for RL compared to ML. Whereas values of HRV recorded at day of weaning were higher for ML compared to RL.

Particularly HRV variable RMSSD and SDNN showed similar distributions of values. No statistically significant difference could be demonstrated for heart rate measures between RL and ML. There were no significant differences between ML and RL regarding basal day and day of weaning. This could indicate that goat kids of RL group were less stressed at basal day or had a better well being. On the other hand, goat kids of RL might feel better compared to ML, because they were reared separately from their mothers and the herd. La Miranda-de Lama and Matiello support this thesis, explaining that goat kids form “kindergartens” in contrast to sheep [14]. Contacts between dams and kids were irregular and corresponded to the natural behaviour of “hiding” kids in order to protect them. As a conclusion, goat kids must not be reared in continuous presence to their mothers and other adult goats. Observations in goat herds with mother bonded rearing showed, that there was more disturbance in the environment of the goat kids. Goat kids were hit more often by adult goats.

Conclusions

Results indicate that HRV is a reliable tool to measure psychic load of goat kids. Significant differences of HRV variables could be shown for the RL-group. Measured HRV-variables were analysed according to [7] in order to realise better compatibility with other studies. More basic measures should be conducted to validate HRV results regarding stress responses of goat kids to facilitate classification. Further studies should consider individual differences of animals as well as social rank.

Literature

- [1] Tallet, C.; Veissier, I.; Boivin, X. (2006): Does the use of a device to measure heart rate affect the behavioural responses of lambs to humans? *Applied Animal Behaviour Science* 99(1-2), pp. 106-117.
- [2] Müller, C.; Ladewig, J.; Thielscher, H. H.; Smidt, D. (1989): Behavior and heart rate of heifers housed in tether stanchions without straw. In: *Physiology & Behavior* 46(4), pp. 751-754
- [3] Hopster, H.; Blokhuis, H. J. (1994): Consistent individual stress responses of dairy cows during social isolation. *Applied Animal Behaviour Science* 40(1), pp. 83-84
- [4] Lefcourt, A. M.; Erez, B.; Varner, M. A.; Barfield, R.; Tasch, U. (1999): A Noninvasive Radiotelemetry System to Monitor Heart Rate for Assessing Stress Responses of Bovines. *Journal of Dairy Science* 82(6), pp. 1179-1187
- [5] Puchala, R.; Tovar-Luna, I.; Goetsch, A. L.; Sahlu, T.; Carstens, G. E.; Freedly, H. C. (2007): The relationship between heart rate and energy expenditure in Alpine, Angora, Boer and Spanish goat wethers consuming different quality diets at level of intake near maintenance or fasting. *Small Ruminant Research* 70(2-3), pp. 183-193
- [6] Green, J. A. (2011): The heart rate method for estimating metabolic rate: Review and recommendations. *Comparative Biochemistry and Physiology - Part A: Molecular & Integrative Physiology* 158(3), pp. 287-304
- [7] Borell, E. v.; Langbein, J.; Després, G.; Hansen, S.; Lettieri, C.; Marchant-Forde, J. et al. (2007): Heart rate variability as a measure of autonomic regulation of cardiac activity for assessing stress and welfare in farm animals – A review. *Physiology & Behavior* 92(3), pp. 293-316

- [8] Langbein, J.; Nürnberg, G.; Manteuffel, G. (2004): Visual discrimination learning in dwarf goats and associated changes in heart rate and heart rate variability. *Physiology & Behavior* 82(4), pp. 601–609
- [9] Nordmann, E.; Keil, N. M.; Schmied-Wagner, C.; Graml, C.; Langbein, J.; Aschwanden, J. et al. (2011): Feed barrier design affects behaviour and physiology in goats. *Applied Animal Behaviour Science* 133(1-2), pp. 40–53
- [10] Bordi, A.; Rosa, G. de; Napolitano, F.; Litterio, M.; Marino, V.; Rubino, R. (1994): Postpartum development of the mother-young relationship in goats. *Applied Animal Behaviour Science* 42(2), pp. 145–152
- [11] Gall, C. (2001): *Ziegenzucht*. Stuttgart, Ulmer
- [12] Rahmann, G. (2010): *Ökologische Schaf- und Ziegenhaltung – 100 Fragen und Antworten für die Praxis*. Westerau: Institut für Ökologischen Landbau (OEL-vTI). Eigenverlag des vTI
- [13] Korn, S. v.; Jaudas, U.; Trautwein, H. (2007): *Landwirtschaftliche Ziegenhaltung*. Stuttgart, Ulmer
- [14] La Miranda-de Lama, G. C.; Mattiello, S. (2010): The importance of social behaviour for goat welfare in livestock farming. In: *Small Ruminant Research* 90(1), pp. 1–10
- [15] Lickliter, Robert E. (1987): Activity patterns and companion preferences of domestic goat kids. In: *Applied Animal Behaviour Science* 19(1), pp. 137–145

Autoren

B. Sc. Katrin Sporkmann, Dipl.-Ing. agr. Sophia Bender, Dr. agr. Heiko Georg and **Dr. agr. Gracia Ude** are members of the scientific staff at the Thünen-Institut für Ökologischen Landbau (Head: **Prof. Dr. G. Rahmann**), Trenthorst 32, 23847 Westerau, e-mail: heiko.georg@vti.bund.de