GOAT KIDS STOMACH MORPHOLOGICAL DEVELOPMENT DEPENDING ON THE MILK TYPE

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Abstract
In goats (*Capra)* the growth and functional development of certain parts of the multi-chambered stomach continue during the first few months after birth. The aim of this research was to clarify morphofunctional changes in the kids abomasa and rumina and live weight gain during the first 8 weeks of life. Research was performed in two parts. In the first part (P1) we used Saanen breed kids which were all kept in the same conditions and in the second part (P2) we used Saanen breed kids which were separated in two groups with different feeding diets. In P1 the stomach contents of the goat kids were collected after slaughter (on day 1, 17, 25 and 30), weighed full and empty. The gastrohromoscopical method proved that in the newborn kids the area where the abomasal pH is 3.0 and lower is about 10% of the surface of the abomasum, but in age of three weeks it is composing 80% of the mucosal surface of the abomasum. In P2 were two groups – in the first group (MMG) kids which were fed with dairy (mother) milk and lived with mothers, the second group (MRG) kids were fed with milk replacer and lived separate from mothers. The stomach contents were collected after slaughter(at day 45 and 60).We confirm that the most important age of stomach development and kids growth in postnatal period are the first 45 days. During this period the most significant differences can be observed. On day 60 there are no significant differences ($p>0.05$) between MMG and MRG stomach development.
Key words: goat kids, gastric development, weight gain.

Introduction

In goats (*Capra)*, like in other ruminants, growth of the stomach parts and their functional development continues during the first months after birth. Studies have proved that different feeding factors and environmental conditions can influence the development of the ruminant stomach parts in kids (Hamada, 1975; Church, 1979; Smith and Sherman, 1994). However, studies should be continued in this field because not only the goat keeping and feeding management changes (feed components, way of feeding, frequency and duration) but also research methods (Sanz-Sampelayo et al., 2000; Khan et al., 2007; Fernandes et al., 2012; Mahouachi et al., 2012; Ripoll et al., 2012).

Recently, investigations are carried out on issues whether the kids of different cross- breeds need a different amount of feed, vitamins and macro-elements during their intensive growth and development period. Attention is paid not only to the growth and development stimulation by choosing the optimum amount of feed for each breed or cross-breed of goats, but also to the amount and quality of the obtained products (meat and milk yield) (Fernandes et al., 2012; Mahouachi et al., 2012; Ripoll et al., 2012). The authors, investigating identification mini-boluses influence on the underdeveloped goat forestomach in the first month of life, point out that we lack modern studies on the growth and development of different stomach parts (Pinna et al., 2006; Carnes et al., 2009; Castro et al., 2010). By studying literature, we established that studies on the functional activity changes of the abomasum during the first month of postnatal life are scarce.

Goat kids weight gain is one of the quality indicators as well as economically important for breeders. There are findings about body weight and possibilities to increase meat production, meat quality, carcass characteristics and tissue composition, including fatty acids and cholesterol contents, carcass yield, feed intake and digestibility by crossbreeding (Potchoiba et al., 1990; Sen et al., 2004; Mekonnen et al., 2014; Ozcana et al., 2014).

Therefore, the aim of the present study was to determine if the feeding of milk replacer, which was intended for calves, changed both the functional activity of the abomasa in goats and the weight ratio of the ruminant stomach parts during the first month of postnatal development, as well as to clarify morphofunctional changes in the kids' abomasa and rumina and live weight gain during the second month of life.

Materials and Methods

Research was performed in two parts, both of which were carried out in one farm in Latvia, Zemgale region, during the months of February to April in 2013.

In total 40 goat kids were used in the research. In the first part of the study (P1) 20 kids of Saanen breed were kept and fed identically. The investigation took place from the animal birth till the 30th day of postnatal life. All kids after birth lived with their mothers and the first seven days were fed on colostrum (*ad libitum*) but on day eight they were weaned. After weaning, kids were placed into two cotes 10 per each, and four times a day by using nipple buckets they were fed with calf milk replacer (with the fallowing content of nutrients - crude whey protein 220 g kg^{-1}, lysine 17 g kg^{-1} fat,

160 g kg^{-1} and 380 g kg^{-1} lactose). During investigation, a control slaughter was carried out: at the age of one day (6 hours after birth; n=5), 17 days (n=5), 25 days (n=5), and 30 days (n=5). To find out the development of the multi-chambered stomach, its morphometric analysis – length and width of abomasum (Hamada, 1975) and weight measurements - were carried out as described by other authors (Church, 1979; Khan et al., 2007; Castro et al., 2010). After macroscopic examination, ingest was removed from the stomach, and the following measurements of stomach were made: total weight, weight of each stomach part using scales CAS Model:SW-1 with accuracy 10 x 0.005 kg - after which weight percentage of full abomasal and forestomach parts was calculated (Castro et al., 2010).

To evaluate the functional condition of abomasum, gastrochromoscopic examination was carried out by using 3 g kg^{-1} of Congo red as an indicator. The method described by other authors was used in order to detect the parietal cell activity (Harinder, 2005; Cellorama, 2007). The abomasum was opened, cleaned and spread. Then, 3 g kg^{-1} of indicator Congo red was sprayed on the clean mucosa, and in 1-2 minutes the result was evaluated. The indicator coming into contact with hydrochloric acid producing parietal cells changed its colour from red to dark blue-violet. The area of the active (hydrochloric acid producing) parietal cells was calculated as percentage ratio of the abomasal surface.

In the second part (P2) of research, the age of two kids groups were 15 days (n=20). In the first group (MMG) were kids which were fed with dairy (mother's) milk *ad libitum* and lived with mothers (n=10), second group (MRG) kids were fed with foregoing calf milk replacer using nipple buckets, and lived separate from mothers in cote (n=10). Drinking water and hay were easy accessible for all goat kids which were involved in this research.

The stomach contents (*reticulum, rumen, abomasum, omasum*) of the goat kids were collected after slaughter on day 45 MMG (n=5), MRG (n=5), on day 60 MMG (n=5), MRG (n=5). All gastric parts were weighed full and empty after washing with 9 mlL^{-1} NaCl (abomasum and reticulorumen with omasum), and immediately processed for anatomical analyses. After full stomach weighing we detected the length and width of rumen and length of abomasums (Hamada, 1975; Church, 1979; Khan et al., 2007; Castro et al., 2010). The relative stomach weight was calculated by relating the body weight and concrete weight of stomach separately for each kid.

The data obtained in the research were statistically processed by using R Studio programme. Mean arithmetic value and the standard error were calculated.

Results and Discussion

In P1 research, analysis of adapting processes in the stomach of kids in postnatal ontogenesis we performed starting at 6 hours from birth until the animal reached the age of 30 days.

As kids are developing, the relation between weights of the gastric parts changes - the rumen in seventeen days old kids is 33.5% and the abomasum - 48.8% of the total gastric weight. After day 25 this relation changes in to the favour of the rumen – which then already reaches a 49% mark of the sum weight of the stomachs, the weight of abomasa then decreases to 33.4%. Similar dynamics are found by other authors (Sanz-Sampelayo et al., 2000; Khan et al., 2007; Carnė et al., 2009; Castro et al., 2010; Mahouachi et al., 2012).

We found that new born kids have 5-10% stomach area where the indicator Congo red solution changes colour from red to dark blue-purple. And it shows that on the first day after birth in fundal glands area there are only 10% of all parietal cells are developed and functional. Moreover, it is proved that at this age the level of enzymes and hormones involved in the process of curdling and processing of colostrum is sufficient in calves and kids (Moschopoulou et al.,

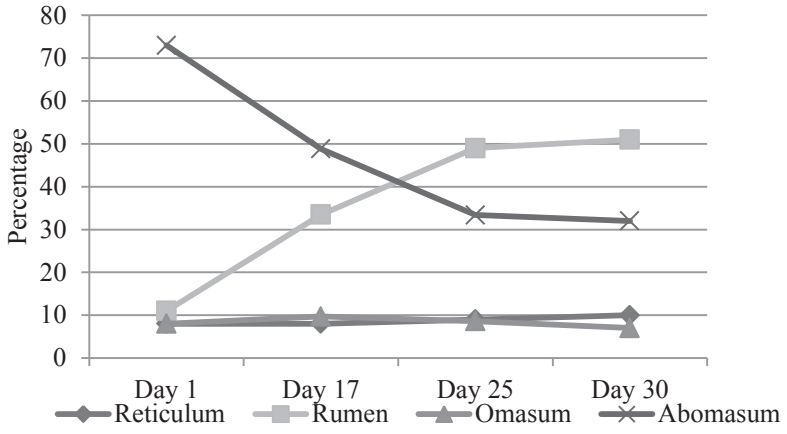

Figure 1. The weight ratio of percentage in the various kids' stomach compartments.

Table 1

The size of rumen and abomasum in kids fed on calves milk replacer (MGR) or mother's milk (MMG)

	Lenght (cm)				Width (cm)			
Group	Day 45		Day 60		Day 45		Day 60	
	mean	Stdev	mean	Stdev	mean	Stdev	mean	Stdev
Rumen								
MMG	21	1.1	23	0.8	23	0.8	25	1.0
MRG	19	0.7	22	1.2	22	0.6	25	1.7
Abomasum								
MMG	-	-	-	-	22	0.9	26	1.3
MRG	-	-	-	-	18	0.7	25	1.2

2006; Khan et al., 2007). The level of the hydrochloric acid secretion in the abomasum, that was determined in kids immediately after birth, is exactly as it is needed for digestion and absorption of the most important constituent parts of colostrums (Mahouachi et al., 2012).

The mucosal surface of the abomasum significantly increases ($p<0.01$) and by the time they reach 25 days of age it composes 70-72%, but at the age of 30 days 80%. This indicates that when the animals are 25 days old, the fundal glands in the abomasal mucosa are already fully developed and produce hydrochloric acid which provides pH 3.0 and lover acidity level of abomasa. Such pH is necessary for pepsin activation in the abomasum. Furthermore, during this period not only hydrochloric acid reaction increased in the stomach juice of kids but also the enzyme secretion (chymosin and pepsin) (Smith and Sherman, 1994; Winden et al., 2002; Moschopoulou et al., 2006).

In P2 research, analysis of clarify morphofunctional changes in the kids abomasa and rumen and live weight gain during the second month of life.

After the control slaughtering on day 45 and 60 we determined the size of rumen and abomasum in MRG and MMG.

Results show that the average length of rumen on day 45 in MMG group kids was 21 ± 1.1 cm, in MRG group it was 19 ± 0.7 cm, but on day 60 the average length in MMG and MRG was 23 ± 0.8 cm and 22 ± 1.2 cm respectively. Rumen width on day 45 in MMG group kids was 23±0.8 cm, in MRG groups it was 22 ± 0.7 cm, but on day 60 all kids rumina width reached 25 ± 0.8 cm. Our data show that between 15 and 45 days of age feeding on milk replacer increases speed of rumen development compared to feeding with mother's milk. It is possible that kids' limited access to milk replacer contributed to reinforcement of the combined feed and hay intake, and feeding with roughage feed promotes rumen development (Van Soest, 1994; Suárez et al., 2007; Mishra et al., 2013). Kids who stayed with their mother, could reduce hunger with mother's milk at any time, which does not promote roughage feed intake.

In kids which were fed with mother's milk the length of abomasum (*curvature minor*) on day 45 was 22 ± 0.9 cm, but in milk replacer group at day 45 was 18 ± 0.7 cm.

On day 45 kids who were fed with mother's milk showed higher abomasal length compared with kids who were fed with milk replacer. Normally mother's milk bypasses proventriculus and goes directly into the abomasum; perhaps it contributes to the development of this part of stomach. It must be admitted, that the abomasum and rumen size on day 60 between groups did not show any differences. At this age goat kids start intensively feed on hay and silage, which likely contributed to the development of multi-chamber stomach.

In the second part of research we also calculated the relative weight of the stomach.

Weight gain from day 45 till day 60 in MMG was 0.044 g day^{-1}, but in MRG it was 0.0073 g day^{-1} and it shows that for the live weight it is very important to feed kids on mother's milk.

After slaughtering we weighed all multi-stomach parts together and separately – full and empty. In MRG the full abomasal weight was 112 ± 15.5 g, but empty 30 ± 2.54 g and the full weight of rumen was 1174.4 ± 39.70 g, empty 144 ± 11.22 g while in MMG full abomasal weight was 255.6 ± 5.50 g, but empty 69 ± 4 g, and the full weight of rumen was 1739 ± 131.7 g, empty 225.4 ± 7.05 g ($p<0.05$).

The relative stomach weight on day 45 was 6.01 ± 0.004% in MRG and 4.98 ± 0.005% MMG, while on day 60 in MRG it was 5.57 ± 0.001% and in MMG 5.88 ± 0.11%. The relative weight of stomach was significantly higher ($p<0.05$) in kids which from day

Table 2

Live weight and the weight of the stomach in kids fed with calves milk replacer (MRG) or mother's milk (MMG) at 45 and 60 days of age

Group	Live weight (kg)				Weight of the stomach (g)				Relative stomach weight (%)			
	Day 45		Day 60		Day 45		Day 60		Day 45		Day 60	
	mean	Stdev	mean	Stdev	mean	Stdev	mean	Stdev	mean	Stdev	mean	Stdev
MMG	9.3	0.18	9.9	0.56	1978	94.3	2055	62.3	4.98	0.01	5.6	0.01
MRG	7.8	0.26	7.9	0.37	1339	54.7	1476	184.4	6.01	0.01	5.9	0.11

15 to day 45 were fed on mother's milk (MMG). On day 60 this difference is not significant.

In general, we can confirm that mother's milk at early age (up to 45 days of life) can significantly accelerate the growth of kid and multi-chamber stomach, where the animals are provided with sufficient amount of hay and roughage. This is important when the kids are grown for meat production. Reaching 60 days of age, this difference is not significant between groups.

Conclusions

In conclusion, as kids grow the weight relations between individual gastric parts change. One day old kids abomasal weight makes up to 80% of gastric total weight, whereas in 25 day old up to 33.4%. The gastrohromoscopical method proved that in newborn kids the area of pH≤3.0 it is about 10% of the surface of the abomasum,however, with time it significantly increases and by the time kids reach 30 days of age it is composing 80% of the abomasal mucosal surface.

During the second part of research we confirmed that the most important age of stomach development and kids growth is approximately 45th day of age when the most significant differences can be observed. On day 60 there are no significant differences in stomach development between goat kids' groups. Differences in weight gain were observed between groups – live weight gain in MMG was six times higher than in MRG.

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