

Effect of noninvasive castration method on weight gain, behavior and meat quality of ram lambs

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SUMMARY

In the course of producing heavyweight lambs (above 35 kg), males need to be separated from females at the end of the fattening period. If not, the rams must be castrated because they reach sexual maturity, and their activity bothers the ewes or unwanted pregnancy may occur. The present study surveys if the Hungarian sheep keepers know or use the non-surgical elastrator method for castration and assess the effect of castration (surgical and non-surgical) on daily weight gain, behavior, moving activity, and meat quality of rams, respectively. We found many advantages regarding the use of the elastrator method. Based on the survey results, 100% of farmers who used elastrator had a positive experience and favorable opinion about this method. There is no need to separate the rams, which allows for less area requirement and more economical technological conditions. The traditional castration (with a knife) process is longer (4–6 minutes), and caused longer-lasting stress while the elastrator application is bloodless, took only 20–30 seconds, and were stress-free. The number of steps of ring-gelded individuals was much lower than that of the non-castrated rams. The difference in steps number could also be seen in ewes separated into different ram groups. The weight gains of individuals castrated by the ring were better than the surgically castrated ones and also individuals with testicles. The palatability of the meat from the non-castrated group was less favorable, and the chewiness of the ringed group was the best. Finally, our results highlighted the benefits of the noninvasive elastrator method in animal welfare aspects.

Keywords: elastrator, locomotion measurement, ram behavior

INTRODUCTION

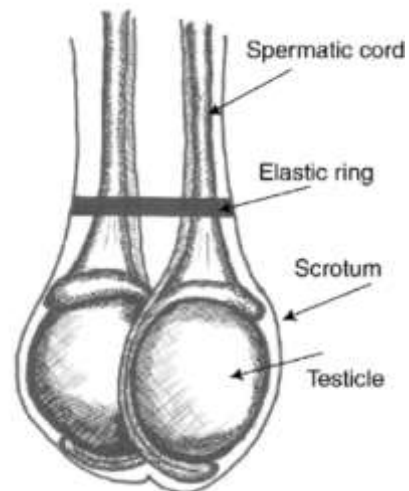
In Hungary, the sheep livestock population number is less than 1 million (KSH.hu, 2022), unfortunately, the trend is declining in recent years. Eighty-eight percent of the population belongs to private farmers, and 12% belongs to cooperatives. The number of restarted sheep-keepers of the Hungarian Sheep and Goat Breeding Association is 8.650. The flock size changes between wide ranges, but more than 90% of sheep farms have less than 300 ewes. Meat is the dominating product of the sheep industry, about 60–95% of the total income is obtained from selling lambs. The slaughter meat production is 21.4 thousand tons per year (Kukovics, 2019). The demand for heavy-weight lamb (above 35 kg) has increased nowadays accounting for 30% of the total export sales of Hungary (Kukovics, 2019).

The production of heavy-weight lambs takes 5–6 months and if farmers keep the not-castrated rams and female lambs together undesirable pregnancy could occur. Because of testosterone production, carcass composition and weight development debase as well. According to research (Kent et al., 1993 and Kent et al., 1998), lambs that are surgically castrated had higher amounts of cortisol compared to lambs castrated using other methods. This procedure causes acute pain and stress routinely conducted without analgesia. Despite their justification for animal health, production and management reasons, there is a growing concern for the welfare of animals undergoing these procedures (Lomax, 2014)

The banding or elastrator method involves cutting off the blood supply to the testicles by applying a

heavy-duty rubber band or ring to the neck of the scrotum (Yami, 2009). For the proper placement of the rings, see *Figure 1* (Hamito, 2008).

Figure 1: Proper placement of the rings



The scrotum and testes will fall off in two to 4 weeks, depending on the size of the testicles (Hamito, 2008).

Introduction of males into a group of females in seasonal anestrus can rapidly induce an increased plasma luteinizing hormone (LH) level, leading to ovulation within 72 h. The "male effect," or sexual stimulation, has been extensively studied in sheep and

goats (Bedos et al., 2014). The sudden introduction of estrous ewes into a group of rams induces changes in the behavioral and endocrinological state of these rams, referred to as the "female effect." Sexual activity of males improves LH and testosterone concentrations increase. The female effect can even originate at a very young age and enhance sexual performance. However, of all the reproductive effects caused by social interactions, the regulation of ovarian activity in females brought about by male proximity is the most evident and best-known phenomenon (Rosa, 2002).

The age of puberty is influenced by several factors, e.g. breed, nutrition, the season of birth, as well as the presence of the ram. Well-grown ewe lambs with a body condition score of 3–3.5 can be mated at 7–8 months. To prevent unwanted pregnancy, the female should be separated from ram lambs at five months of age (Menzies et al., 2019).

The male sexual behavior expressed is to seek out oestrus females, and check the reproductive status by sniffing the anogenital area and urine, followed by Flehmen-reflex. Once an estrus female is detected, the male will attend and court the female, nudge with his muzzle, and kicks her with his forelegs. Oestrus females will seek out the male and show some courtship behavior. However, the sexual behavior of the males is more overt. The female turns in front of the male, rubbing his chest and flanks and following him (Jensen, 2017).

Using quantitative descriptive analysis, Gkarane et al. (2017) showed that there were small but significant sensory differences in meat quality due to the sex of lambs. The flavor of rams' meat is more intense and undesirable smelly, while the meat of castrated animals is more tender (Misock et al., 1976).

MATERIALS AND METHODS

In our study we examined the effect of noninvasive castration (banding or elastrator) method on weight gain, behavior and meat quality of ram lambs. The study was performed on a single commercial farm located in the eastern part of Hungary (Tiszaeszlár village) between April and June 2018. The farmer produces Merino x Dorper crossbreed heavyweight lambs (above 35 kg) for market needs and sells them at 5–6 months old. There was no way to keep the male and female animals separately, so the males had to be castrated as the sexual activity escalated at the end of the fattening period. The farmer noticed the elastrator technique in France and decided to try it on his flock.

Survey

We surveyed if the Hungarian sheep breeders knew or used the elastrator. Moreover, we asked the opinion of those who were using it. There were 30 questions on the questionnaire. One hundred and seven questionnaires were completed via the internet and personal interviews. The responders were members of the Hungarian Sheep and Goat Breeders' Association.

Farm experiment

Animals and groups

There were 90 Merino x Dorper lambs in three experimental groups (15 males and 15 females in each group) where the rams were:

1. not castrated (C = control).
2. castrated with a knife (S = surgical).
3. castrated with an elastrator (E = nonsurgical).

The rams in different groups were signed with different colored collars: C = green, S = orange, and E = red. The husbandry procedures were part of the normal husbandry practices performed on the farm where the studies took place.

Castration and time requirement

The castration was performed at weaning on April 17, 2018, when the lambs were two months old (\pm one week). On the day of castration, the time requirement for different castration methods (knife/elastrator) was measured at 15–15 rams.

Weight measurement

The 90 lambs' weaning weight was measured with a digital scale (± 0.1 kg), and the weight was recorded every week for nine weeks. From this data, we calculated the daily weight gain (g day^{-1}).

Locomotion measurement

One week before the castration, an odometer (OnWalk100) was placed on the rams to measure basic activity. From the day of castration, the movement of castrated and not-castrated individuals was followed. The odometer was on the rams' leg for six weeks. Three weeks before the end of the fattening period, we placed the odometer on the ewes' legs to see if the castrated or the non-castrated group's females walked more.

Behavior observation

On the day of castration, the behavior was monitored by counting the incidences of restlessness (during the first hour only), normal and abnormal standing and walking, and normal and abnormal lying. The movement was observed for a week after the castration of the postures. We measured the locomotor activity of rams with a pedometer. At the end of the fattening period, we monitored the sexual behavior of the groups and measured the ewe's locomotion activity with the pedometer.

Organoleptic characteristics

12 rams had been slaughtered, 4 from each group. The samples were taken from each slaughtered animal and stored in a freezer until evaluation. The frozen samples from the loin (longissimus dorsi) were taken from the freezer one day prior and thawed at 4 °C for 24 h. Samples were cooked for 3–3 minutes on each side without any flavoring. Each sample was divided into 5 pieces. Sensory evaluation was performed by

nine experienced panelists. The evaluated characteristics can be seen in *Table 1*.

Table 1: The examined organoleptic features and their grades

Grade	Taste	Odor	Firmness	Texture
1	very tasty	perfect	very soft	juicy
2	tasty	appropriate	soft	soft
3	satisfying	unsatisfactory	not soft, but not chewy	elastic
4	less bad taste	ram smell	chewy	greasy
5	bad taste	rancid smell	very chewy	tough

Statistical analysis

The data were evaluated using repeated measure ANOVA. The first weight measurement was used as the covariate for weight gain assessment. Differences between means were calculated using estimated marginal means and Bonferroni correction.

RESULTS

Survey

In a preliminary survey, we asked Hungarian farmers if they were familiar with or used the elastrator method. The results of the survey are shown in *Table 2*.

Table 2: The results of the survey, if Hungarian sheep farmers know or use the non-surgical elastrator method for castration

		n	%
A.	Filled the questionnaire	107	100
B.	from A keep lambs for slaughter	75	70
C.	from B (n=75) keep the rams and ewes together	61	81
D.	from B (n=75) castrate the rams	22	30
E.	from A (n=107) know the elastrator and/or use(d) it	47	44
F.	from E (n=47) have/had positive experience with the elastrator-use	47	100
G.	don't know the elastrator /n=60/ but would try	15	25

One hundred and seven farmers filled out the questionnaire. Although only 44% of the responders were familiar with or had ever used an elastrator, it should be noted that 100% of them were satisfied with it and had a positive experience with this method. One-quarter of the responders had not heard of the elastrator yet but would try the new device because it reduces the risk of infection and they had heard positive feedback from elastrator-users.

– There were some personal notes as well:

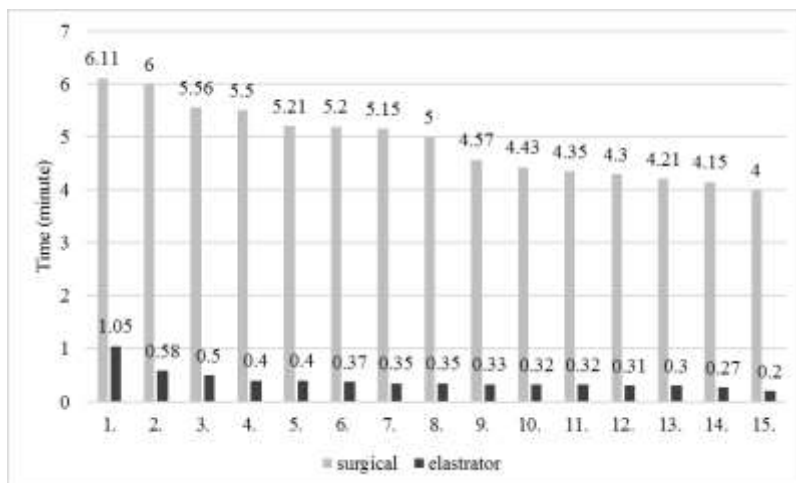
- 11% of the elastrator-users had some little problems (for example, a minor wound arose on the skin, and attracted flies came in).
- 75% of those who are familiar with both surgical and non-surgical castration methods prefer the elastrator.

- Those who would not try it said they had been using the surgical method for a long time or because the use of elastrators is not widespread.
- Inserting the ring is quick and easy to perform without cutting.
- The castrated rams show less aggression and are calmer.

Time requirement of the castration

Meanwhile, the farmer did the castration, the required time was measured. We concluded that the elastrator method takes only one minute, but he surgically more than six the first time. As the work progressed, the time requirement decreased in both cases. The surgical method took at least 4 minutes (at the 15th animal), while the elastrator application took only 12 seconds (0.2 minutes) (*Figure 2*).

Figure 2: Time requirement of castration (surgical vs. elastrator) (minutes)



Behavior observation

After the castration process, we observed the ram's behavior for one hour. Lambs of the S and E groups were let out together; they could be distinguished by the color of their collars. The rams in the surgically castrated (S) group stood in one place, hyperventilating for more than half an hour. The shoulder and posterior joint positions were inadequate, the belly was pulled, and the back was humpbacked. The non-surgically castrated (E) rams, after inserting the rings, took a ventral laying posture, head up, and rested.

The lambs in the S group did not eat and drink for a half-day and were languorous for a day. When they started moving, the stride length was shorter than normal. Based on locomotion measurement (see later,

Table 7), the knife-castrated lambs moved about 2.5 km less in the first week after castration than the elastrator-castrated and 12.7 km less than the not-castrated ones, respectively.

Weight measurement

The lambs were born in February, and the castration and first weight measurement were performed in mid-April, when the animals were two months old (\pm one week). These values were used as starting points (covariance) for weight measurement.

Table 3 and Table 4 show the results of the weight measurements of the ewes and rams from weaning till the end of the fattening period.

Table 3: The average weight of ewes in different groups after the treatments

Weeks after treatment		0	1	2	3	4	5	6	7	8	9
Treat- ment of rams		Sex: Female									
	elastrator n=15	average	16.5	17.6	19.6	21.4	23.2	25.4	27.4	29.6	31.8
	weight (kg)										
	SD \pm	3.0	3.2	2.9	3.0	2.9	2.9	3.0	3.1	3.0	3.0
knife n=15	average	18.7	19.7	21.6	23.3	25.2	27.4	29.5	31.6	33.6	35.8
	weight(kg)								*	*	*
	SD \pm	2.8	3.0	2.8	2.7	2.8	2.8	2.9	3.0	3.0	3.0
not castrated n=15	average	16.5	17.6	19.1	20.7	22.7	24.7	26.6	28.5	30.6	32.9
	weight(kg)										
	SD \pm	3.4	3.5	3.4	3.5	3.6	3.6	3.6	3.6	3.4	3.4

* mark within a column denotes statistically significant differences ($P < 0.05$)

Table 4: The average weight of rams in different groups after treatments

Weeks after treatment		0	1	2	3	4	5	6	7	8	9
Treat- ment of rams		Sex: Male									
	elastrator n=15	average	16.9	18.2	20.0	22.0	24.0	26.6	28.9	31.2	33.7
	weight (kg)										
	SD \pm	2.0	2.0	2.1	2.1	2.1	2.5	2.6	2.6	2.6	2.6
knife n=15	average	19.0	19.9	21.5	23.5	25.7	28.1	30.3	32.7	34.9	36.9
	weight (kg)										
	SD \pm	2.2	2.2	2.3	2.3	2.3	2.4	2.4	2.5	2.5	2.5
not castrated n=15	average	18.0	19.6	21.3	23.3	25.2	27.3	29.3	31.3	33.3	35.1
	weight (kg)										
	SD \pm	4.2	4.4	4.4	4.4	4.4	4.5	4.4	4.5	4.4	4.3

There were no statistically significant differences between the average weaning weights of the groups within sex, so the initial stock was homogenous.

At the end of the fattening period, there were no significant differences in the rams' average weight.

The castrated rams showed a tendency to be heavier than the non-castrated ones. Every week during the

measurement, the non-castrated group had the highest standard deviation (4.2–4.5 kg). The SD in the two castrated groups was only between 2.0 and 2.6 kg, so these groups were more uniform.

Based on the statistical analysis, the average weight of the ewes in the group of knife-castrated rams was significantly higher from the 7th week after treatment compared to the other two groups. At that time, the age of animals was already four months.

The sexual activity of non-castrated rams started to express itself, and they began to show courtship behavior. The average slaughter weight of the ewes in the non-castrated rams' group was the lowest: 32.9 kg vs. 34.0 and 35.8, respectively.

Daily weight gain

The average daily weight gain was calculated from the weekly weight data. The results see in *Table 5 and Table 6*.

Table 5: The average daily weight gains of the rams (g day⁻¹) in different groups (castrated with elastrator, with knife or not castrated) between 1 and 9 weeks after treatment

weeks after treatment		1.	2.	3.	4.	5.	6.	7.	8.	9.
treatment		sex: Male								
elastrator n=15	average weight gain g/day	187	249	291	291	370*	324*	324	359*	373*
	SD±	30	38	14	13	66	13	12	43	38
knife n=15	average weight gain g/day	131	230	287	306	348	318	345*	305	291
	SD±	20	27	17	12	27	31	51	17	78
not castrated n=15	average weight gain g/day	226	248	282	275	295	290	286	283	261
	SD±	60	38	17	20	20	43	19	39	23

* mark within a column denotes statistically significant differences (P<0.05)

Table 6: The average daily weight gains of the ewes (g day⁻¹) in different groups (rams castrated with elastrator, with knife or not castrated) between 1 and 9 weeks after treatment

weeks after treatment		1.	2.	3.	4.	5.	6.	7.	8.	9.
treatment		sex: Female								
elastrator n=15	average weight gain g/day	170	275	256	261	311*	295	302	322	315
	SD±	56	83	59	10	10	39	13	39	15
knife n=15	average weight gain g/day	138	284*	243	265	309	303	308	280	319
	SD±	49	57	40	9	9	12	11	75	15
not castrated n=15	average weight gain g/day	156	211	234	275	288	278	265	305	329
	SD±	36	56	18	49	40	38	18	74	29

* mark within a column denotes statistically significant differences (P<0.05).

Based on the statistical analysis, the average daily weight gain was the highest in the rams' group castrated with elastrator. There were significant differences between the two other groups on weeks 5, 6, 8, and 9 after treatment, respectively.

The daily weight gains of not-castrated rams were less than 300 g day⁻¹, but the values in the two castrated groups were more nearly every week since week 5 (*Figure 3*). The highest daily weight gain was in the 9th

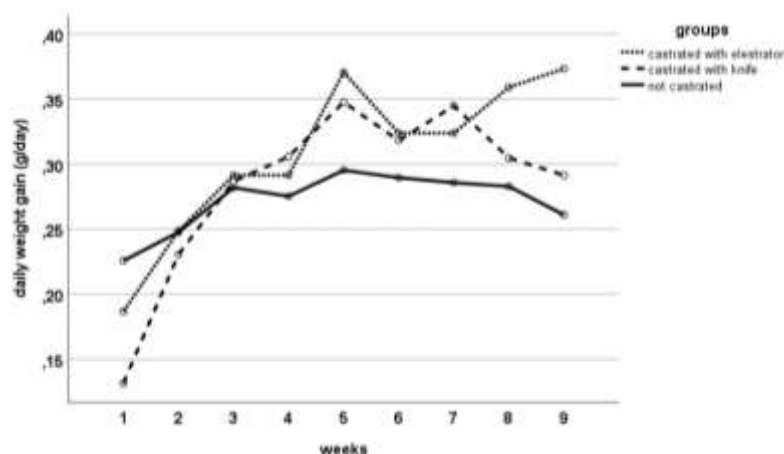
week after castration in the group of rams castrated with elastrator (373 g day⁻¹).

In the females' group, there were two remarkable values in daily weight gain.

Two weeks after castration, the "knife-castrated" group females and 5 weeks after castration, the "elastrator-castrated" group females had significantly higher weight gain compared to the others, respectively (*Table 7*).



Figure 3: The average daily weight gains of the rams (g day⁻¹) in different groups (castrated with elastrator, with knife or not castrated) between 1 and 9 weeks after treatment



Locomotion measurement

Based on locomotion measurement, there were significant differences in the weekly walking distance (km) of the castrated and the not-castrated groups. The non-castrated rams walked between 43.7 and 46.7 km/week, while the castrated rams walked significantly less (between 31.2 and 36.4 km week⁻¹) (Table 7 and

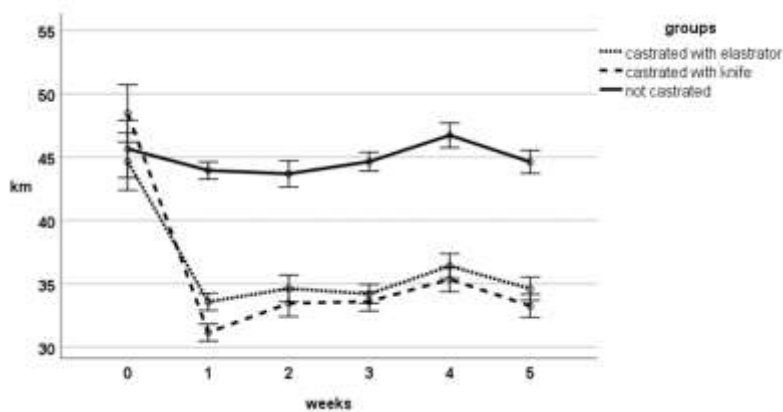
Figure 4). However, there were no statistically significant differences between the knives or the elastrator castrated ram’s movement activity. The knife-castrated ones moved about 2.5 km less in the first week after castration (31.2 ± 1.13 km week⁻¹) than the elastrator-castrated ones (33.6 ± 0.91 km week⁻¹).

Table 7: Weekly distance (km) done by the rams in different groups after treatments

Group		Weeks after treatment					
		0	1	2	3	4	5
Elastrator n=15	Average distance (km)	44.6	33.6	34.6	34.2	36.4	34.6
	SD ±	5.76	0.91	2.24	1.59	1.87	2.17
Knife n=15	Average distance (km)	48.5	31.2	33.5	33.6	35.4	33.3
	SD ±	2.30	1.13	2.08	0.75	2.25	1.66
Not castrated n=15	Average distance (km)	45.6	43.9*	43.7*	44.7*	46.7*	44.6*
	SD ±	4.26	1.70	1.66	1.73	1.38	1.32

*mark within a column denote statistically significant differences (P<0.05)

Figure 4: Weekly distance (km) done by the rams in different groups after treatments (0. time)



Organoleptic characteristics of the meat of the different groups

Table 8 shows that there was not any difference between the odor and texture of the meat of the slaughtered rams. The taste of the meat from not castrated animals was significantly less favorable for the panelist than the samples from the lambs castrated by elastator.

The elastator castrated ram’s meat was tasty, while the not castrated ones’ meat was only acceptable.

The chewiness of the meat was significantly worst than the not castrated ones. The meat from that not castrated group was not soft but not that chewy while the meat of the other groups was mainly soft.

Table 8: The organoleptic characteristics of the meat from the different groups

Group		Taste	Odor	Firmness	Texture
not castrated n=20	Average	3.24*	2.34	3.24*	3.54
	SD	1.12	0.87	0.77	1.73
knife n=20	Average	2.86	2.22	2.64	3.38
	SD	1.05	0.91	0.90	1.78
elastator n=20	Average	2.46*	2.04	2.52*	3.42
	SD	0.99	0.73	0.76	1.58

*mark within a column denote statistically significant differences (P<0.05)

DISCUSSION

In extensive sheep farming systems, castration of male lambs is a routine husbandry procedure performed throughout the world. Male lambs may reach puberty before slaughter. Castration of males is often a standard management procedure to prevent:

- disruption in the flock through the sexual activity of young males,
- unwanted pregnancies, and indiscriminate breeding (Melches, 2007);
- price reductions for undesirable characteristics;
- an increased risk of injury through fighting as dominance is established and maintained (FAWC, 2008).

Ram lambs are usually castrated for management reasons to avoid unwanted breeding, and meat from uncastrated rams is less acceptable to consumers due to taint (Animal Welfare Approved technical papers).

The surgical methods of castration are painful to the animals and predispose them to infections. Appropriate perioperative care, including analgesia, must be provided, such as systemic non-steroidal anti-inflammatory analgesics. Castration under three months depends on the operator's skill and pain relief (AVA, 2016). If the lamb is not milk-fed, it is recommended to starve him for 24 hours to reduce the stomach content before the surgical procedure. Because the abdominal wall of the lambs is thicker, it is necessary to fix it as long as the operator takes out the ductus deferens, so two people have to do the castration

procedure. Meanwhile, the elastator can insert one man alone.

The elastator method causes some stress especially for 10 to 15 minutes after the elastator band is applied due to discomfort. Daily checking of the animals is necessary to be sure that the rubber band is still around the neck of the scrotum and for signs of infection (Hamito, 2008).

Social relationships can affect many aspects of the reproductive process. The induction of ovarian activity in females in close proximity to males is the most evident effect, known as the "male effect." In the presence of rams, synchronization of the first mating has been described as well as the occurrence of the first oestrus two weeks earlier in prepubertal ewe-lambs (Valasi et al., 2012). Faster body growth during rearing will normally favor an earlier onset of the first oestrus (Dyrmondssorn, 1981).

The development of welfare control protocols contributes to a significant improvement in the quality level of the treatment of small ruminants. There are claims that the production of wool and sheep meat comes at an unacceptable welfare cost, factors that can influence consumers and international markets to choose alternative products created in environments that are perceived to be "cruelty-free." (Grant, 2004).

In this study, we investigated the effect of noninvasive castration method on weight gain, behavior and meat quality of ram lambs. We surveyed if Hungarian sheep farmers know or use the non-surgical elastator castration method.

We found many positive results regarding the use of the elastator method.

In male lambs, the ring castration method can be used from the first day after the testicles descend, thereby preventing the production of testosterone and the development of sexual behaviors. In this case, there is no need to separate the rams, which allows for less area requirement and more economical technological conditions.

Based on the survey results, 100% of farmers who used elastator had a positive experience and favorable opinion about this method.

Based on time requirement measurement, we concluded that the duration of traditional castration (with a knife) was 4–6 minutes, which caused more pain and longer-lasting stress and the elastator application took only 20–30 seconds and was stress-free.

Castration by the ring is bloodless, external damage does not occur, and there is no risk of infection. Based on our observations, the lambs gelded with ringing rested calmly after the procedure, whereas the rams castrated surgically pants from pain and stress as long as 30 minutes after the procedure. Surgical husbandry treatments resulted in increased abnormal postures and a reduction in activity.

The number of steps of animals gelded with ringing was higher after treatment than the ones castrated the traditional way they were under less stress and were not in pain after the intervention. The weight gains of individuals castrated by the ring were better in the first



four weeks after treatment. The knife-castrated ones had pain and stress at that time. In the following weeks, the difference in weight gain decreased slightly.

We found significant differences in weight gain of females belonging to the different groups of rams. The castrated rams don't steer or jump the female lambs, which also increases the daily weight gain of the female animals, shortens the time they reach slaughter weight, and keeps them more economical.

There were no specific examinations about feed conversion rate, but based on the farmer's opinion, the FCR was 3–10% better for rams castrated with elastrator than the other two groups. Further studies are needed in this area.

The palatability of the meat from the not castrated group was less favorable, and the chewiness of the ringed group was the best. It can be due to the less stress and the less activity of the animals. Other research results indicate that meat from not castrated male animals has a higher calpastatin activity 24 hr post-mortem which may decrease the quantity of

myofibrillar protein proteolysis thus resulting in less tender meat (Morgan et al., 1993).

We concluded that remarkable progress could be achieved in sheep breeding with the elastrator method since the daily weight gain is better, and the lambs reach slaughter weight sooner. Even the keeping technology is preferable, then with surgical or non-castrated rams. The non-surgical castration method is less stressful for the animals, and the risk of infection is also lower. The meat chewiness of the ringed group was the best from the examined groups.

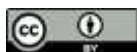
Finally, our results highlighted the noninvasive elastrator method in animal welfare aspects.

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