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Importance and Determination of Body Electric Current Pre and Post Feeding in Turkish Karayaka Sheep[#]

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ABSTRACT

Many scientific studies are conducted directly or indirectly with humans, animals, and plants. We believe that body electricity, which is generated and constantly present in the bodies of living beings, should be considered in scientific studies as an effective factor for production activity. We believe that body electricity should be included in the environment to bring the rumen fluids of sheep used in Daisy II rumen simulators closer to reality. In this way, the most realistic environment is created by adding the influencing factors of body electricity and many factors that can affect the outcome. The study was conducted on a total of 16 Karayaka ewes, including 4 lambs, 4 one-year-old ewes, 4 pregnant ewes and 4 lactating ewes. The data obtained in the study were collected by measuring the body electricity of the animals before and after grazing in 3 different periods for each group. At the end of the study, it was found that the value of body electricity of sheep determined at 0.12±0.001 v (volt) before feeding was higher than the value determined at 0.09±0.002 v after feeding. The difference between the two values was found to be statistically significant ($P<0.05$). However, it was found that the fact that the live weights of the animals in the groups were different and they were in different physiological periods did not cause a significant ($P>0.05$) difference in the electrical body currents before and after feeding (except in lambs ($P<0.05$)). It can be said that the measurements made in other periods and groups can change the electrical body currents after feeding and that the electrical body currents differ according to the animals fed in the barn, especially during the grazing period, before going to pasture and when returning to pasture.

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Introduction

In the past and in the present, studies have been conducted on many different uses of body electricity in plants, animals and humans. In the context of bioelectricity, the flow of electric currents through cell membranes and the ionic environments inside and outside cells is described (Mitcheson & Stanfield, 2013). There is evidence that bioelectric phenomena play a role in wound healing in animals, humans, and plants, as well as in the regeneration of an apical stem form even from cored stems (in plants), replacement of diseased or damaged tissue due to birth defects, Cancer, traumatic injury, degenerative diseases, in the treatment of diabetes, in tissue repair in organs, in the treatment of skin diseases, in muscle and nerve stimulation, in epilepsy, in nanorobot treatment, and in headaches in animals and humans (Tyler, 2017).

It suggests a new, effective approach, one involving a small direct electrical field mediated by a conductor, to regulate such cellular functions as viability, proliferation, gene expression, and protein production; this approach may well be highly significant for both tissue regeneration and other biotechnological applications (Shi et al., 2008). Bioelectrogenesis, also called bioelectricity, is the generation of electricity by a living organism. Bioelectrogenesis is present in almost all living organisms. Although most living organisms do not emit enough electricity to be noticed by a casual observer, electrical impulses help living things think and act. Some living things have evolved much stronger forms of bioelectricity (Mohn, 2016).

The effect of electric current on the function of organs is a phenomenon that is not given much attention and importance. However, it is a fact that conscious or unconscious physical or mental functions are supported by small amounts of electric currents (Atasoy et al., 2009; Koşalay, 2014; Suzuki, 2008).

All activities performed by the organism are controlled by the effectiveness of electrical signals in the body (Mohn, 2016; Geddes, 2014; Swanson, 2013). According to our knowledge of physics, everything is made of atoms. Atoms are made up of positively charged protons, negatively charged electrons, and neutral or uncharged neutrons. Depending on the difference between the charges, there is a flow from one atom to another (Becker & Selden, 1998). The flow of electrons or the formation of negative charges is often referred to as electricity, so that the body, because of its large atomic mass, is able to generate electricity.

Functions such as pain, muscle contraction and movement, nerve function, glandular secretion, healing and regeneration, brain activity, and perception are maintained by electrical currents (Martindale, 2004). A very weak electrical signal emanating from the heart can be used to assess the health of the heart, which is an important organ of the body of humans and animals. It is known that the irregularly working heart is regulated by the regular electrical impulses of the pacemakers (Mohn, 2016).

In addition, the brain is a supercenter that processes millions of messages every second in the form of electrical signals and in this way controls all the body's infrastructure systems (Mohn, 2016; Koşalay, 2014; Geddes, 2014; Layton, 2013). It is known that the human brain generates enough electrical current to power a light bulb that requires 15-20 watts of power. The electrical activity of the brain can be measured with the electroencephalogram (EEG), which is similar to the ECG (Mohn, 2016; Koşalay, 2014; Suzuki, 2008; Becker & Selden, 1998). Irregular electrical currents in the brain can cause neurotransmission disorders, abnormalities ranging from paralysis, lumbar palsy, epilepsy, and Tourette's syndrome to autism. Very weak electric currents are used in the treatment of Tourette's syndrome (Suzuki, 2008).

As far as the cell is concerned, very slight fluctuations in the balance between potassium and sodium ions inside and outside the cells generate electricity, with the sodium-potassium gates in the cell membrane playing an active role. Outside the cell, sodium ions predominate compared to potassium ions inside the cell. Since the potassium ions are negatively charged, the cell is also slightly negatively charged. The sodium ions are positively charged and just outside the cell membrane they are positively charged (Martindale, 2004). When the membrane gates are open, sodium and potassium ions can enter and leave the cell unimpeded. Potassium ions leave the cell and push the positively charged sodium ions outside the membrane into the cell (Layton, 2013; Swanson, 2013; Plante, 2016). Two types of ion exchange, which occur very rapidly, produce an electrical pulse, like a switch from 0-1. This pulse triggers the sodium-potassium gate in the other cell, and ion exchange occurs in the other cell and proceeds as follows (Alok, 2012).

Moreover, a multicellular pattern is usually described with chemical signals and concentration gradients to describe processes such as morphogenesis, regeneration, and carcinogenesis. In addition, the electrical state of the cell and intercellular coupling influence the transport of ions and signaling molecules responsible for downstream biochemical cascades and transcription processes. Genetic networks influence bioelectric signals and may in turn be influenced by them. A bioelectric signal is regulated by proteins that form ion channels in a cell membrane and gap junctions between cells. Genetic pathways are influenced by these signals through the transport and spatial accumulation of calcium and various signaling molecules, as well as through volume-gated channels activated by electrical signals. Genetic and epigenetic networks modulate transcription by regulating these proteins (Cervera et al., 2016).

Furthermore, in the nervous system, the transmission of messages from point a to point b occurs with an electrical charge that jumps from cell to cell. The electricity generated in the body is the key to maintaining life (Layton, 2013; Mohn, 2016). Electrical signals are transmitted at very high speed, a response to a message is instantaneous. Attempting to control the heartbeat consciously would result in death since one would not be able to keep up with the speed of these chemical reactions (Suzuki, 2008).

Moreover, the contraction of the heart muscles and the processing and interpretation of the perceptions of the sense organs take place in this way in the brain. Since the functioning of metabolism is based on these electrical signals, a disturbance in the body's electrical system causes major problems. Electrical shocks, such as electrocution, disrupt the normal functioning of the system.

The issues listed below are among those that are still being researched, and the question arises as to how the use of body electricity will come about.

- Will body electricity be considered in IVF applications, vaccine manufacturing, embryo and organ transplantation, and living tissue studies in a laboratory setting?
- Is body current considered in incubators, in vitro simulation studies, and microbiology applications?
- Very few studies have been done on electrical loading (cation-anion balance) of rations, but is there a study on the relationship with body-generated current?
- Have all possibilities been considered so that the studies conducted in artificial environment correspond to reality?
- In natural incubation, the chicken takes over the heat, moisture and rotation processes of the egg. However, has the question of whether body current is transferred from the breast skin to the egg by the breast feathers that the chicken sheds just before incubation coming into contact with the egg been studied?
- Are there studies on the body current to which the digestive organs are naturally exposed during in vitro digestion (e.g., enzyme method)?
- Have the effects of sheep, goats, or cattle on body electricity been investigated in studies using artificial rumen (Rusitec, Daisy Incubator, etc.)?

The effects of electric current on many topics such as the activation of in vitro matured porcine oocytes (Liu et al., 2015), the parthenogenetic development of rabbit oocytes (Ozil, 1990), the transmission of electric current in the human body and the effects on the natural healing of injuries (Fish & Geddes, 2009), the effects of grounding the human organism during sleep on physiological processes (Sokal & Sokal, 2011), the effects of electricity on fruiting body formation in mushroom cultivation

(Takaki et al., 2014), the effects of electrical stimuli on skin surface (Xu et al., 2021), the use of electrical pulses in tissue repair and replacement (Balint et al., 2013), the use in bone and muscle therapies (Koşalay, 2014), DNA damage and the use of electrical stimuli in cellular functions (Su et al., 2017), in vitro effects of electromagnetic fields on peripheral blood mononuclear cells (Atasoy et al., 2009), the parasitic effects of electricity on Leishmania major in vitro and in vivo (Hejazi et al., 2004), the use of electrosensing for object recognition in fish (Caputi et al., 2011), the use and transmission of electricity by electric eels (Finger et al., 2013), muscle contractions and nerve transmissions in frogs (Piccolino, 1998; Bresadola, 2008; Steinbach, 1950; Finger et al., 2013), the effect of electricity on the crispness and quality of animal meat (Yanar, 1996), the use of electrical stimulation to heal damaged muscles in mice (Dow et al., 2005) have all been studied and have contributed to science.

Despite the fact that most studies have been conducted in artificial environments, we believe that it is important to understand the significance of body electricity based on what has been observed in reality. On the other hand, when reviewing the scientific literature, one finds that no studies have been conducted on the body electricity in farm animals. Consequently, this study aims to determine body electricity in sheep before they are used in rumen simulators and to observe the effects of this change. This study would also provide an important basis for future research in this regard.

Materials and Methods

Animals and Measurements of Live Weight and Body Electricity

In the study, sixteen Karayaka sheep, including 4 lambs, 4 one-year-old ewes, 4 pregnant sheep and 4 lactating sheep, were used for the study. The live weights of the sheep and lambs were weighed using a 10 g sensitive scale. Body electrical currents were then measured in all animals before and after feeding. These measurements were repeated for two meals (morning and evening) and for the 3 periods indicated. Vetch straw, wheat straw, alfalfa straw as succulent roughage; sugar beet pulp, sugar beet pulp silage and concentrate; grain vetch, wheat, triticale was used as roughage in animal feed.

A multimeter was used to measure electrical currents in the body. Measurements were made in 3 periods, each of which covered 4 consecutive days. These periods were determined as follows. 10 days between the 1st inspection and the 2nd inspection, 20 days between the 2nd inspection and the 3rd inspection. At the 1st and 2nd inspections, measurements were taken in the morning before feeding and 4 hours after feeding. At the 3rd inspection, when the animals went out to pasture, measurements were taken in the morning before they left the pasture and, in the evening, when they returned to the pasture.

During the measurements, the animals were kept on an insulating platform, one probe of the multimeter was placed on the armpit of the animal where there was no fleece and which was moist, and the other probe was placed on the copper rod nailed to the floor (for grounding).

Statistical Analysis

Statistical analyzes of the data were performed using the SAS (2020) statistical software program. Analyzes were performed using the ANOVA procedure and the least squares method in SAS. For differences between groups, the Duncan multiple comparison test was used.

Results

When All Animals are Analyzed Together

As a result of the data obtained in the study, body electrical currents were determined before and after feeding for all animals, as shown in Table 1.

As can be seen in Table 1, the electrical body currents of all animals were determined to be 0.12±0.001 volts before feeding and 0.09±0.002 volts after feeding. It was found that the difference between these values was significant ($P<0.05$) and the value before feeding was higher.

As can be seen in Table 2, the mean values of body weight ranged from small to large; they were 19.41±0.48 kg in lambs, 28.01±0.39 kg in one-year-old ewes, 35.09±0.42 kg in lactating ewes, and 43.34±1.21 kg in pregnant ewes, and the differences between them were significant ($P<0.05$). It was found that the current values before feeding were the same in all animals (0.12±0.003 volts) and the current value was 0.08±0.004 volts only in lambs after feeding. This value was significantly lower than the current value (0.10±0.004 volts) found in the animals of the other groups ($P<0.05$).

Table 1. Body electrical currents of all animals before and after feeding

For all animals	Electric current (volts)
Before feeding	0.12± 0.001 a
After feeding	0.09±0.002 b

a, b; The difference between values with different letters in the same column is significant ($P<0.05$)

Table 2. Live weights and body electric current values of all animals included in the experiment

Animal groups according to their physiological periods	Live weight (kg)	Before Feeding (volts)	After Feeding (volts)
Lamb	19.41±0.48 d	0.12± 0.003 a	0.08±0.004 b
Yearling sheep	28.01±0.39 c	0.12± 0.002 a	0.10± 0.005 a
Pregnant sheep	43.34±1.21 a	0.12± 0.003 a	0.10± 0.004 a
Sheep in lactation	35.09±0.42 b	0.12± 0.003 a	0.10± 0.005 a

a, b, c, d; The difference between values with different letters in the same column is significant ($P<0.05$).

Table 3. Live weights and body electric current values of all animals in the specified periods

Periods	live weight (kg)	before feeding (volts)	after feeding (volts)
1st inspection	30.90±1.42 a	0.13± 0.002 a	0.07±0.002 c
2nd inspection	30.50±1.21 a	0.12± 0.003 a	0.08±0.003 b
3rd inspection	32.98±1.15 a	0.12± 0.003 a	0.13± 0.003 a

a, b, c; The difference between values with different letters in the same column is significant, P<0.05.

Table 4. Live weights and body electric current values of lambs according to periods

Lamb	live weight (kg)	before feeding (volts)	after feeding (volts)
1st inspection	17.17±0.6 c	0.14± 0.005 a	0.07±0.003 b
2nd inspection	19.32±0.8 b	0.11±0.006 b	0.08±0.007 b
3rd inspection	21.72±0. 6 a	0.13± 0.003 a	0.10± 0.007 a

a, b, c; The difference between values with different letters in the same column is significant, P<0.05.

Table 5. Body weights and body electric current values in yearling sheep according to periods

Yearling sheep	live weight (kg)	before feeding (volts)	after feeding (volts)
1st inspection	27.17±0.71 b	0.11±0.003 b	0.07±0.003 b
2nd inspection	26.70±0.50 b	0.12±0.005 ab	0.08±0.006 b
3rd inspection	30.15±0.51 a	0.13± 0.004 a	0.15± 0.005 a

a, b, ab; The difference between values with different letters in the same column is significant, P<0.05.

Table 6. Body weights and body electric current values in pregnant sheep according to periods

Pregnant sheep	live weight (kg)	before feeding (volts)	after feeding (volts)
1st inspection	45.41±2. 0 a	0.13± 0.006 a	0.08±0.006 b
2nd inspection	41.80±2. 2 a	0.12±0.007 ab	0.09±0.005 b
3rd inspection	42.80±2. 1 a	0.11±0.003 b	0.14± 0.003 a

a, b, ab; The difference between values with different letters in the same column is significant, P<0.05.

As shown in Table 3, the difference between the average live weights of all animals between the periods was not statistically significant (P>0.05). Regarding the number of animals, the live weight was higher in the 3rd inspection than in the other inspections. The difference between inspections was also not significant for electrical body current values before feeding (P>0.05). After feeding, the difference between inspections was significant (P<0.05). Accordingly, it was found that the highest electrical body current was at the 3rd inspection and the lowest current was at the 1st inspection.

When Animal Groups are Analyzed Separately

When Table 4 was examined, it was found that the differences between the values obtained by weighing the live weight of the lambs after inspection were significant (P<0.05). It is known that this difference is due to the fact that the lambs are in the growth and development age. Accordingly, the lowest body weight values were found at the 1st inspection and the highest body weight values were found at the 3rd inspection. The body current values before feeding were similar at the 1st and 3rd inspections, and the difference between them was found to be statistically significant at the 2nd inspection (P<0.05). The electrical body current values after feeding were similar at the 1st and 2nd inspection and reached the highest value at the 3rd inspection. This determined value was statistically significant (P<0.05).

However, in one-year-old ewes (Table 5), live weights were similar at the 1st and 2nd examinations, but significantly higher at the 3rd examination (P<0.05). When the electrical body current values were examined before feeding, the lowest current value was found at the 1st examination and the highest current value was found at the 3rd examination. The electrical body current values after feeding were similar at the 1st and 2nd examinations to those of lambs and at the 3rd examination to those of ewes. This situation was found to be statistically significant (P<0.05).

When the condition of the pregnant sheep was examined in Table 6, no statistically significant change in live weight was observed after inspection. However, the average live weight, which was 45.41±2.0 kg at the 1st inspection, decreased to 41.80±2.2 kg at the 2nd inspection and increased to 42.80±2.1 kg at the 3rd inspection. Electrical body current values before feeding were highest at the 1st inspection and lowest at the 3rd inspection (P<0.05). After feeding, similar body current values were obtained at the 1st and 2nd inspection. It was found that the value was higher at the 3rd inspection than at the other inspections. This situation was found to be statistically significant (P<0.05).

When the condition of sheep in lactation was studied (Table 7), it was found that the average body weight was lower in the first and second lactations and in the third lactation than in the first and second lactations. This situation proved to be statistically significant (P<0.05).

Table 7. Body weights and body electric current values sheep in lactation according to periods

Sheep in lactation	live weight (kg)	before feeding (volts)	after feeding (volts)
1st inspection	33.85±0.8 b	0.13± 0.004 a	0.07±0.004 c
2nd inspection	34.17±0.4 b	0.13± 0.005 a	0.08±0.006 b
3rd inspection	37.25±0. 6 a	0.12± 0.006 a	0.14± 0.004 a

a, b, c; The difference between values with different letters in the same column is significant, P<0.05.

The electrical body currents before feeding were similar in all three inspections. After feeding, differences between inspections were significant (P<0.05), with the lowest value at the 1st inspection (0.07±0.004 v) and the highest value at the 3rd inspection (0.14±0.004 v).

No studies measuring body electricity in livestock were found during the search. Therefore, no comparisons could be made between the data obtained.

Discussion

As mentioned earlier, no studies measuring body electricity in livestock were found during the search. For this reason, the data obtained in this study could not be compared with the data in other studies. However, it was concluded that the extent and cause of this change should be determined by more detailed studies such as age, sex, physiological age, feeding, physiological activity. The existence of billions of living creatures (bacteria, protozoa, etc.) in the rumen of ruminant animals is essential for the quality of life and animal digestion. It is a known fact that events such as hormones, enzymes and body electricity that affect digestion in the rumen are effective.

In order to obtain an environment closest to reality in the in vitro environment, these parameters must be transferred to the artificial environment. In other words, transferring the conditions in which the living things in the rumen show their best potential to the daisy incubator, called in vitro, will give us the opportunity to obtain the closest results to reality in digestive studies. How much current can be applied when using sheep rumen fluid in rumen simulators? It is not known how this current affects nutrient digestion in the rumen. Future studies will attempt to find an answer to this.

Conclusion

In this study, an attempt was made to determine the electrical body current of Karayaka sheep during different physiological periods. Accordingly, it was found that the electrical body current in ewes ranged from 0.07 to 0.15 volts. It was found that the different live weights of the sheep and their different physiological periods made no significant difference in the electrical body currents before and after feeding. It can be said that the measurements made during other studies and inspections can change the electrical body currents after feeding and that the electrical body currents vary according to the animals fed in the barn, especially during pasture inspection, before they go to pasture and when they return from pasture.

The live weights of one-year-old, pregnancy, and lactating sheep were found to be different during inspection. It is suggested that the reason for these differences could be due to housing conditions, stress of the animals, feeding situation, different physiological phases, grazing and adaptation to grazing conditions. It is known that the reason for the significant difference between inspections in lambs in terms of changes in live weight is that the lambs are at the age of growth and development. Despite the significant changes in live weight of the sheep during the different inspections, it was found that the changes in electrical body currents were insignificant. Since multicellular patterning is influenced by the interaction between genetic and bioelectrical signals, it is also necessary to consider both factors.

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