Introduction of digital technologies in beef breeding of the Republic of Sakha (Yakutia) on the use of smaxtec internal monitoring system for kalmyk bulls autumn fattening

I I Sleptsov, A A Martynov and Y S Vasiliev

Agrocultural technologies faculty, State Federal-Funded Educational Institution of Higher Professional Training the Arctic State Agrotechnological University, 3, Sergelyakhskoe shosse the 3 km, Yakutsk, 677007, Republic of Sakha (Yakutia), Russia

E-mail: andreymartinov@mail.ru

Abstract. The work includes research using the SmaXtec internal monitoring system for Kalmyk bulls fattening in the conditions of Yakutia. The indicators of the rumen pH-value, rumen temperature and animal physical activity were analyzed. The data of bulls health state weekly monitoring via bolus-sensors and natural and climatic factors in the fattening period are presented. We studied the Kalmyk bulls monitoring daily indicators (15–18 months) using the SmaXtec system. Digital technologies were used and remote information sourcing from farm livestock in real time mode was obtained for the first time in the region’s cattle breeding.

1. Introduction

The Ministry of Agriculture of the Russian Federation set a goal to introduce and develop digital technologies for agro-industrial complex of the country. New digital technologies have been actively used by large agricultural holdings of Russia for land husbandry and crop production. Large livestock farms have a positive experience of using internal monitoring system for animal health and their productivity in dairy breeding. The “Agrobiodata” company (Moscow) has been implementing the Austrian SmaXtec monitoring system in dairy livestock enterprises of the Russian Federation since 2017. Dairy farms ZAO “Pavlovskaya Niva” (Voronezhskaya region), peasant farm enterprise "Burkov" (Belgorodskaya district) successfully use the SmaXtec system.

The SmaXtec system is an innovative monitoring technology which allows to track the temperature and rumen pH-level from inside of animal's body. It tracks physical activity and detects possible changes in the body, thus, there is a constant monitoring of the cattle physiological state.

This system has not been applied in farms that specialize in raising meat stock. Yakutia is one of the first regions that decided to use the SmaXtec system in beef cattle breeding as a trial.

The Arctic State Agrotechnological University (rector Ivan Sleptsov) implemented the SmaXtec internal monitoring system on the basis of agricultural production cooperative "Soloosun" of the "Megino-Kangalassky district" on September-November of 2019 in the Republic of Sakha (Yakutia). The SmaXtec monitoring program was used for the experimental group of animals during research and industrial fattening.

The project “Introduction of adaptive technologies of keeping specialized livestock in the conditions of the Republic of Sakha (Yakutia)” was implemented as a part of state order of the Agriculture Ministry of the Republic of Sakha (Yakutia).
2. Materials and methods of research

2.1. Object of research
Kalmyk bulls at the age of 15 to 18 months. Animal care and experimental researches were performed in accordance with the instructions and recommendations of the Russian Regulations, 1987 (Order No. 755 on 12.08.1977 the USSR Ministry of Health) and "the Guide for Care and Use of Laboratory Animals (National Academy Press Washington, D.C. 1996)". There were efforts taken for animals suffering minimizing and reducing the number of samples while conducting the research.

2.2. Experiment scheme
We selected 50 bulls born in 2018 and 25 heads of the experimental and control groups in the production and research work. Animals were clinically healthy after health check and groups were formed on the pairs-analogues principle. Bulls were fed according to the diet developed by the Department of general animal science. Animals were kept free in specially equipped fences. Fattening lasted for 60 days. Agricultural production cooperative "Soloosun" is located in the Zarechnaya zone of Yakutia on the territory of the "Megino-Kangalassky district".

2.3. Equipment and technical means
SmaXtec system functions: rumen temperature monitoring; rumen pH level (within 150 days) and animal activity monitoring. The pH probe is calibrated in a buffer solution with pH 4 and pH 7 before the experiment. The bolus-sensor is inserted into the animal rumen with a metal applicator and it enters the second part of the ruminant stomach – the reticulum after swallowing. Therefore, it transmits information to the base station via radio waves using the ISM band (433 MHz). The base station was located in 10 meters from the feeding yard. Information from the base station is transmitted to the server via installed satellite antenna with Internet. The external memory chip collected and retained an information. Data capture from the animals rumen was performed regularly, more than 1-2 times a day according to the instructions. Fattening bulls were weighed using mechanical scales (VT.8908 for weighing animals) produced by OAO "Iglinsky weighing factory".

2.4. Statistical processing
We divided the period of bulls fattening into two weeks to make interpreting of obtained data easy. It took 8 weeks of research and production experience. The material was processed based on Department of General Animal Science of the Arctic State Agrotechnological University. Statistical analysis was conducted via Statistics 10 program.

3. Results of the research
Indicators were captured within 24 hours in daily basis with data transmission to the SmaXtec system base station in the farm. It included ability of monitoring in real time online in the city of Yakutsk via personal computer of the Department of General animal science or smartphone. It also allowed opportunity of data share while being located in any area with mobile Internet coverage during the trial period. It should also be emphasized that the research and production works were conducted on the opposite side of the Lena river from Yakutsk city (capital of the Republic of Sakha (Yakutia)), in a livestock farm located quite far from the locality. The research team was able to get data displayed in real time on a regular basis without going to the place of scientific work. We were able to analyze data remotely by receiving information about physiological state of a fattening herd of steers online on regular basis. Monitoring data got updated and were kept in SmaXtec Cloud system. Personalized files of every animal with bolus identifier in rumen with full information about fattening bull health condition were made and downloaded into the system.

Continuous monitoring of the rumen pH is the most effective method thus it allows to capture indicators within 24 hours a day. Continuous measurement methods of pH in the rumen were used for a series of scientific studies [1–6].
Table 1. Weekly monitoring (weekly averages) of fattening bulls health status via bolus-sensors

| Weeks | Rumen pH M±m | Rumen temperature M±m | Activity M±m |
|-------|---------------|-----------------------|--------------|
| 1     | 6.56±0.01     | 39.13±0.03            | 6.67±0.17    |
| 2     | 6.61±0.01     | 39.07±0.06            | 6.32±0.13    |
| 3     | 6.68±0.006    | 39.01±0.04            | 6.94±0.15    |
| 4     | 6.68±0.006    | 39.07±0.05            | 7.03±0.12    |
| 5     | 6.72±0.008    | 39.09±0.04            | 6.11±0.10    |
| 6     | 6.76±0.008    | 39.04±0.04            | 6.85±0.13    |
| 7     | 6.79±0.007    | 39.06±0.04            | 6.93±0.15    |
| 8     | 6.55±0.01     | 39.11±0.06            | 6.69±0.14    |

The pH-rumen indicators are located within the limits of the standard indicators of a healthy animal according to the results of computer processing of the obtained pH-rumen data during weekly monitoring (table 1). It is worth noting that adult cattle have pH of the rumen content – 6.5–7.3, [7, 8]. Researches showed that the pH level goes down if an animal does not get the necessary nutrients and sufficient energy.

Table 2. Natural and climatic factors (average indicators for a week) during the fattening period of bulls with bolus-sensors

| Weeks | t° air temperature at night | t° air temperature the morning | t° air temperature during a day | t° air temperature in the evening | Pressure mm Hg. | Natural factors |
|-------|-----------------------------|-------------------------------|---------------------------------|----------------------------------|-----------------|----------------|
| 1     | 1.1                         | 1                             | 5                               | 4.9                              | 746             | rain (17–20.09.) (22.09.) |
| 2     | 1.3                         | 1.5                           | 6.3                             | 5.0                              | 748             | sleet (28.09.)          |
| 3     | −2.6                        | −3.6                          | 2.0                             | 0.1                              | 748             | without precipitation  |
| 4     | −4.4                        | −4.4                          | −2.3                            | −3.3                             | 745             | snow (9–11.10.)         |
| 5     | −4                          | −4                            | −1                              | −2                               | 749             | without precipitation  |
| 6     | −7.7                        | −9.6                          | −6.1                            | −7.6                             | 753             | snow (25–26.10.)        |
| 7     | −11                         | −13                           | −9                              | −10                              | 748             | without precipitation  |
| 8     | −15.3                       | −17.0                         | −18.7                           | −19.3                            | 753             | without precipitation  |

Indicators for the internal monitoring of the SmaXtec. We compared the health status of steers on natural and climatic factors recorded during the fattening period (table 2). Rumen pH values are slightly reduced in rainy weather (17–20.09.2019 and 22.09.2019) and in significant cooling of the atmospheric air down to −18.7 during the day and −15.3 at night in the first decade of November in 8th week of fattening. We also recorded that the rumen pH indicators show an upward trend in the 5th week of fattening starting from 6.72±0.008...when stable sub-zero temperatures are established in the daytime and night, and during snowfalls. Temperature measurement allows to identify the detection of the disease in advance if the body temperature rises or falls. In our case, the animals show stable indicators of rumen temperature for the entire time of scientific and production work. That means animals are clinically healthy.

We observe the activity of steers in 4th week of fattening 7.03±0.12 and while stable cooling of the atmospheric air at temperature 0 degrees below. We also considered the daily indicators of monitoring bulls using the SmaXtec system (table 3). We observe a slight decrease in the rumen pH of 6.5±0.08 during the rest of period in the hours interval starting from 18.00 to 00.00. On the contrary, we note a noticeable decrease in the temperature in the rumen of the animal from 12.00 to 18.00. During this period, fattening bulls are most active 8.6±1.0. They go to water and consume concentrated feed. In
the process of research, we identified insufficient water consumption by experimental animals, which directly affects the fattening qualities of steers and, accordingly, the profitability of the meat herd.

The data obtained from the monitoring – rumen pH level (6.6±0.003), rumen temperature (39.1±0.022), and animal activity (6.7±0.061) correspond to the statutory indicators. Animal monitoring data received via SmaXtec system confirm that fattening bulls diet in the experimental and control group was developed optimally and made taking into account external natural factors (low air temperatures, rain and snow conditions, windiness of the terrain since the animals are located in an open area) that affect the physiological state of the animal.

Table 3. Daily monitoring indicators of (15–18 months) the Kalmyk bulls when using the SmaXtec system

| Time             | Rumen pH M±m | Rumen temperature M±m | Activity M±m |
|------------------|--------------|------------------------|--------------|
| 00.00–06.00      | 6.7±0.1      | 39.3±0.1               | 4.6±0.4      |
| 06.00–12.00      | 6.8±0.1      | 39.1±0.2               | 6.0±0.5      |
| 12.00–18.00      | 6.7±0.1      | 38.8±0.2               | 8.6±1.0      |
| 18.00–00.00      | 6.5±0.08     | 39.2±0.18              | 7.5±0.08     |

4. Conclusions

According to the results of the scientific and production work, we have come to the conclusion that the SmaXtec internal monitoring system is an effective tool to remote surveillance of cattle health physiological state in the natural-climatic and territorial conditions of Yakutia. The innovative technology can be successfully used in the fattening organization of bulls for meat production. Constant online changes monitoring in rumen indicators – pH including temperature and physical activity of animal allow to correct diet issues or animal husbandry. The research has proved that the SmaXtec system in beef cattle breeding has good prospects. It should be noted, that the SmaXtec developers offer to combine “1C:Enterprise 8 program, and selection in animal husbandry. KRS”. We believe there will be an increase of records management work efficiency including zoo - technical and breeding work of cattle breeding farms in such symbiosis. All this will allow to function cattle breeding enterprise without loss and have an economic effect from cattle breeding.

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