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STUDYING THE FORMATION OF BEEF CATTLE PRODUCTIVITY

Arkady Natyrov[1], Oksana Konieva[1], Sergey Shlykov[2], Ruslan Omarov[2], Dmitry Fedotov[3]
[1]Kalmyk State University, Elista, Russia, [2]Stavropol State Agrarian University, Stavropol, Russia, [3]Vitebsk State Academy of Veterinary Medicine, Vitebsk, The Republic of Belarus.

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Abstract:
There is a long-held assumption that the nutritional quality of beef decreases as animals grow older and tenderness becomes worse. However, with regard to the age group in which livestock is usually slaughtered in the beef market (usually between 12 and 36 months old), the situation is much less clear.

When feeding a diet with high energy value, the growth rate immediately before slaughter can be a more important determinant of meat tenderness than at the time when the animals were offered a diet with high energy value in the pre-slaughter period.

In support of these assumptions, that higher growth rates lead to more tender beef. Subsequent analysis of a similar Australian dataset showed that the most consistent relationships were an increase in the palatability of the loin with an increased growth rate in the final phase of production with less visible effect observed when considering growth rates in conventional production.

Alternatively, some authors have concluded that growth rates alone have little effect on beef quality or the characteristics of muscle fibers in British production systems.

However, in addition to production factors, there are a number of technological methods aimed at improving the quality characteristics of raw meat. All this would not be an acute problem if meat were not one of the most inconsistent and diverse products. Since the quality of beef is so variable, there is a special need to find ways to form it immediately after slaughter.

This confusing picture of scientific evidence with often conflicting research reports suggests that a few basic observations can be made:

a) the interaction of many factors determines the quality of meat and tenderness indicators of any particular animal in any particular production system

b) it is not clear which critical points relate to growth rates, age of slaughter or growth dynamics of cattle

c) significant discussions will continue across the industry until research has addressed these issues using production systems typical of those on production farms.

Keywords: *meat quality, tenderness, vitamin D3, electrical stimulation, beef, acid marination*

Corresponding author:
Arkady Natyrov
Kalmyk State University, Elista, Russia.

QR code

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INTRODUCTION:

There is a long-held suggestion that the nutritional quality of beef decreases as animals grow older and tenderness gets worse (Berry et al., 1974; Carroll, et al., 1976). There is evidence in the literature for a very wide range of beef cattle ages from calves to mature cows (Bouton, et al., 1981), possibly related to muscle collagen content (Lepetit, 2008). However, with respect to the age group in which livestock are usually slaughtered in the beef market (usually between the ages of 12 and 36 months), the situation is much less clear.

There is some evidence that changes in growth rate can affect muscle structure, enzyme activity, and composition (Oddy et al., 2001). Fishell, et al. (1985) report a positive relationship between the pre-slaughter growth rates and tenderness with faster-growing animals, which are estimated to be more gentle on the texture analyzer and tasters. When feeding a high energy diet, Aberle et al. (Aberle et al. 1981) suggested that the growth rate immediately before slaughter may be a more important determinant of meat tenderness than when the animals were offered a diet with a high energy value in pre - the slaughter period.

In support of these assumptions that higher growth rates lead to more tender beef, Thompson et al. (1999) found a weak but positive correlation ($r = 0.23$) between the taste score and the growth rate. A subsequent analysis of a similar Australian dataset showed that the most consistent relationships were an increase in the palatability of the loin with an increased growth rate in the final production phase, with less visible effect observed when considering growth rates in normal production (Perry and Thompson, 2005). In his review on meat tenderness management, Thompson (2002) reports a curvilinear relationship between finite growth rate and taste, which appeared on a plane with a growth rate of about 1.2 kg/day. Although he suggests that any impact of growth rates on beef tenderness may be relatively small, it remains a critical reference point for the production sector of the beef supply chain.

Alternatively, some authors have concluded that the growth rate itself has little effect on the quality of beef (Sinclair, et al., 2001) or the characteristics of muscle fibers (Maltin et al., 2001) in British production systems. Other studies point to more complex relationships that may arise due to changes in the rate of growth during the period before weaning. Allingham et al. (1998) suggest that animals that have experienced periods of compensatory growth after periods of nutrient restriction may exhibit altered connective tissue characteristics, which, in turn, may affect the tenderness of the meat. On the contrary, Bruce et al. (Bruce et al., 1991) report that meat tenderness, measured by transverse force, appears to depend primarily on energy consumption before slaughter and intramuscular fat, and not on the rate of compensatory growth.

Buyas et al. (2002) report that an increase in age from 8 to 10 months may be associated with less soft meat for cattle, grazing before slaughter on pasture. In contrast, Barton (2012) reports that older animals had higher rates of tenderness (more tender) than animals killed about 4 months younger (i.e. 18 months, rather than 14 months).

However, in addition to production factors, there are a number of technological methods aimed at improving the quality characteristics of raw meat. All this would not be an acute problem if meat were not one of the most inconsistent and diverse products. Since the quality of beef is so variable, there is a particular need to find ways to form it immediately after slaughter.

This confusing picture of scientific evidence with often contradictory research reports suggests that you can make a few basic observations:

a) the interaction of many factors determine the quality of meat and indicators of the tenderness of any particular animal in any particular production system

b) it is unclear which critical points relate to growth rates, slaughter age or cattle growth dynamics

(c) Significant discussions will continue throughout the industry until the studies that have been carried out address these problems using production systems typical of those on production farms.

This summary of the available information in this area revealed the need for a long-term study of beef production and the formation of its quality indicators, which focused on studying the relationship between alternative production systems and the technological methods used to improve the quality of beef.

MATERIALS AND METHODS:

Three alternatives "growing systems" are mainly characterized by the duration of production and are designated as:

1. Accelerated;
2. Average;
3. Long.

Slaughter of animals in the "Accelerated" system at the age of 12 to 16 months; “Medium” - at the age of

18 to 24 months, and "long" at the age of 28 to 36 months.

All calves and calves of the Kalmyk breed.
Keeping animals in an accelerated system indoors on a straw bedding on a diet is a commonly mixed ration containing: barley, rapeseed flour, straw, molasses, and minerals.

Keeping of animals according to the average growing system, with transfer to meadow feeding in spring. The grass is planned to be fertilized 3 times during the summer, a total of 125 kg of nitrogen/ha.

Keeping animals according to a long growing system means switching to unimproved pasture for meadow feeding in spring, and grass availability was maintained above 1,500 kg/ha for all times. At the autumn-winter stage, the animals will be transferred to the premises. In the winter, two diets will be offered. The first of silage, straw, and minerals during November-January, and the 2nd of barley, silage, rapeseed flour and minerals during February and April, then transferred to meadow fattening until October, then transferred to premises for maintenance before slaughter.

RESULTS AND DISCUSSION:

Changing trends in the meat industry is a decisive factor affecting various ways to improve or maintain product quality. Recently, the meat processing industry has evolved from marketable products into consumer products (Troy, 2006). Currently, consumers demand convenient, healthy, safe, tasty, homogeneous, biologically valuable, good appearance and varied raw meat and meat products. The need to meet consumer demand requires improved research and product development.

The traditions of subsidiary farming in Russia were such that they kept poultry, pigs, sheep, and milk for goats and cows to ensure meat. Old animals, unable to give more milk, were sent for slaughter. At this age, the meat of animals becomes hard, wiry and has a specific smell, which is reflected in its significantly low consumption in Russia. For example, in the UK, USA, Canada and Australia, cows, after they no longer give milk, are sent for industrial processing, for the production of canned meat, animal feed, etc.

Times change, the global trend of a healthy lifestyle determines the behavior of consumers. Along with the rejection of harmful habits, the progressive population moves to a healthy diet, reads the composition of products, tracks the number of proteins, fats, carbohydrates consumed and studies information about the effect of food ingredients on their health.

Beef is a unique source of proteins and amino acids, contains zinc and iron in abundance, is easily absorbed in the body, normalizes the level of acidity, neutralizing hydrochloric acid in the gastric juice and other stimuli. And also, despite the fact that beef is considered a dietary meat, it, due to its nutritional value, nourishes the body much faster than other products.

But despite all the advantages, tenderness remains one of the most important characteristics and is considered the main attribute of the quality of red meat. Research constantly supports this concept. Tenderness is highly correlated with consumer satisfaction with the product ($r = .85$), as well as the desirability of taste ($r = .86$). There is no doubt that tenderness is a critical characteristic of beef and a product that does not meet consumer expectations will certainly not be in demand. Accordingly, the development of specific methods and technologies is necessary to achieve the desired goal [1].

It can be assumed that the use of genetics to increase the tenderness of the whole beef will solve the problem, but it must be understood that biological variations will always exist, and even if it were possible to increase the tenderness genetically, there would still be cattle in the population whose meat would not meet on this indicator [6].

Understanding the biochemical mechanisms and factors underlying the increase in tenderness will determine the optimal solution. It has been established that the carcass temperature at which the carcass is aged to the stage of rigor mortis has a significant effect on the tenderness of the meat. Exposure of carcasses for 10 hours at 6, 8 or 10 ° C after slaughter resulted in varying degrees of tenderness. The lower the temperature, the greater the risk of cold burn. In addition, lower temperatures reduce the degree of destruction of meat protein.

The degree of pH also has a significant effect on the tenderness of the meat. If the meat has a very high pH value (above 6.3), then calpains (enzymes responsible for the breakdown of proteins during maturation) show maximum activity, which leads to an increase in tenderness. Intermediate pH values (5.8 - 6.3) give greater rigidity to the meat. A rapid decrease in pH allows for a more gentle beef than a slow decrease in pH. Meat raw materials with a low pH drop rate have shorter sarcomeres and a lower degree of proteolysis [5].

The method of hanging carcasses also has an effect on the tenderness of the meat, so the carcasses hung by the hip joint have greater tenderness compared to the traditional suspension for the Achilles tendon (hock).

At the initial stage, one of the main processing methods adopted in the meat industry to improve meat quality is electric carcass stimulation (ES), a practice in which electric current is supplied through the carcass of animals immediately after slaughter. During post-mortem glycolysis, the muscle undergoes a rigorous development, marked by a number of histological, physical and biochemical processes. Therefore, the modification of one or several processes may ultimately change the quality indicators of meat. The need to curb the variability of meat quality and improve sensory characteristics requires the use of ES. However, it is necessary to realize that the positive effects of ES can only be achieved if there is enough muscle glycogen before the animal is drained of blood. This is evident from a study conducted by Dutson et al. (1982), in which it is shown that ES does not affect pH, color, tenderness, and other sensory indices in the stage of rigor mortis. There are different opinions between different reports on the effect of ES on meat quality. Some authors have reported a positive effect (Mckenna et al., 2003; Cetin and Topcu, 2009; Nazli et al., 2010), others have no effect (Wiklund et al., 2001; Botha et al., 2009; Kim et al ., 2013) or in some cases undesirable and even harmful effects (Hector et al., 1992; den Hertog-Meischke et al., 1997; Simmons et al., 2008) ES on meat quality. These alleged paradoxes have not been completely resolved, despite partial information provided in recent reports. In this regard, there is a need to evaluate various reports in order to create a balance in the effective use of EC to optimize meat quality.

A more detailed analysis of the vacuum did not reveal any significant differences in the duration of storage on the tenderness of the meat.

Since tenderness is a decisive indicator for consumers, the meat industry should strive for a more consistent tender product. The texture of the meat is mainly determined by the moisture and fat content, as well as the types and amount of structural proteins (Aktas and Kaya 2001). Collagen is the main structural protein of intramuscular connective tissue, which plays an important role in the binding of myofibrils in order to provide structure. (Borg and Caulfield 1980, Chang and others 2010). It has been shown that muscle strength is proportional to its intramuscular collagen content (Aktas 2003). One possible method for increasing tenderness is acid pickling. Acid pickling involves immersing meat in a solution containing vinegar (Kijowski 1993, Kijowski and Mast 1993), wine or fruit juice (Arganosa and Marriott 1989; Burke and Monahan 2003), lactic acid (Aktas and Kaya 2001) or other acidifiers. A number of studies have been carried out on the use of weak organic acids to increase the tenderness of meat, both through physical weakening of muscle structures due to swelling of myofibrils (Rao and Gault 1990), and direct weakening of perimysial connective tissue (Lewis and others 1991) or indirectly, by activating proteolysis and isolation of cathepsins from lysosomes (Berge and others 2001). It has been established that acids increase tenderness, but a limited amount of documented work on the recommendation of acid strength and dosage to optimize tenderness, and the length of time during which the product will remain acceptable to consumers requires additional research.

The results of previous studies indicate the use of calcium salts (calcium ascorbate, calcium lactate or calcium chloride) (as a source of calcium ions) influences the processes of lipid oxidation and inhibition of microbial activity, autolysis of muscle tissue, reducing the period of post-mortem stiffness of muscle fibers, accelerating the onset of the process their post-mortem relaxation and deepening the destruction of myofibrils in the post-slaughter period. Introduction to the meat system of calcium ions in quantities exceeding the physiological concentration accelerates calcium-induced splitting of the main structure-forming proteins of muscle tissue - connectin and nebulin, which helps accelerate the process of meat tenderization. It has been established that the tenderness of beef is enhanced by adding calcium chloride. But despite the increase in tenderness, calcium chloride causes the appearance of bitter, metallic and liver aromas, as well as accelerates the degradation of color during storage. Thus, there is a need for technology ingredients that take advantage of the activation of calcium, without causing degradation of taste or color attributes.

Studies conducted (Hibbs et al., 1951; Hibbs and Pound en, 1955) on lactating dairy cows showed that oral administration of vitamin D3 at 5 × 106 μg per day for two weeks contributes to an increase in serum calcium. Injection of 1α hydroxyvitamin D3 also leads to an increase in serum calcium concentration (Bar et al., 1985, 1988; Sachs et al., 1987; Hoduett et al., 1992). The basic idea is that calcium activates muscle tenderization, i.e. increased calcium leads to the activation of μ- and m-calpain.

Calpains (EC 3.4.22.17; clan CA, family C2) are calcium-dependent proteinases responsible for the selective degradation of proteins in the cytosol of eukaryotic and possibly a number of prokaryotic cells (Rawlings et al., 2010). The term "calpain" reflects the sensitivity of these proteases to Ca2 + and their similarity with papain in the region of the catalytic domain. According to the modern classification of peptidases, developed by the creators of the MEROPS database (Rawlings et al., 2008) and taking into account the homology of amino acid sequences and the similarity of the structural organization, the calpains are separated into the individual C2 family of the cysteine peptidase CA. By now, 673 sequences encoding calpains and their homologs have already been identified. The affiliation of a protein to a family is determined by the similarity of its sequence in the region of the catalytic papain-like domain with a similar region of the molecule of a typical family protease - ccalpain2. (Nemova et al. 2010.)

Swanek et al. (1999) conducted a study assessing the use of vitamin D3 as an alternative method to increase the concentration of calcium in the muscles to activate calpains, thereby increasing the tenderness of the longest back muscle. They found that the administration of vitamin D3 reduces the cutting effort throughout autolysis, but the maximum increase in tenderness was noted on day 14.

But limited data on the concentration of injected vitamin, how many days before slaughter require additional research.

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b) it is unclear which critical points relate to the growth rate, age of slaughter or the growth dynamics of cattle
(c) Significant discussions will continue throughout the industry until the studies that have been carried out address these problems using production systems typical of those on production farms.

An analysis of the available information in this area revealed the need for a long-term study of the production of beef and the formation of its quality indicators, namely the study of the relationship between alternative production systems and the applied technological methods to improve the quality of beef.

CONCLUSION:

As a result of the project implementation, the approaches of world researchers in the field of developing highly productive and environmentally friendly animal husbandry technology and creating safe and high-quality, including functional, food will be adapted. Adaptation of world experience on the example of beef cattle breeding will allow integrating adapted approaches in other areas of animal husbandry such as first of all, pig breeding and sheep breeding.

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