УДК 636.59:546.15

EFFECTS OF LONG-TERM RELATIVELY HIGH AND LOW TEMPERATURE USE ON GROWTH PERFORMANCE AND MEAT QUALITY OF BROILERS

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The experiment aims to study the effects of long-term relatively high and low temperatures on growth performance and meat quality of broiler chickens. The experiment was carried out in Yunnan Academy of Animal Science, for determine the quality of meat used the laboratories of Henan Institute of Science and Technology. A total of experiment use 240 healthy 1-day-old Avian broiler chickens were randomly divided into three groups: relatively high temperature group, low temperature group and control group. The results of the experiment confirm that at low temperatures, when the energy consumption of the animal decreases, it leads to weight loss, which we can see in the low-temperature group, the average daily weight gain in this experiment was significantly lower than in the control group (P <0.05). It was found that low-temperature stress significantly increased the mortality of broilers, at the age of 42 days in the low-temperature group, the mortality of chickens was higher than in the control group, by 71.4%. Among all evaluated groups on the content of unsaturated fatty acids SFA, PUFA, MUFA and EFA in the muscles of the breasts of broilers, the lowest content was in the lower temperature group than in the control group, by 48.3%, 46.9%, 51.5% and 43.9%. Studies have shown that influence of high-temperature above 30°C causes disturbances in poultry behavior and physiology, leading to reduced production performance. Broilers aged 35-40 days experienced 31°C high-temperature stress and found that their performance and immunity decreased. Broilers feed intake and growth rate at 35°C high temperature were reduced by 13% and 32% than at 20°C. The results showed that: ① Relatively high temperature and low temperature for a long time reduced the growth performance and mortality of broilers, and long-term relatively low temperature decreased the slaughter performance of broilers. ② Relatively high and low temperatures for a long period of time reduced the levels of serine, glycine, SFA, PUFA, USFA, EFA and MUFA in broiler breast muscles negative effect on meat quality. ③ The long-term relatively low temperature has a greater adverse effect on broilers than the long-term relatively high temperature. The results provided some theoretical basis for accurately setting the broiler breeding environment temperature, improving broiler quality, maximizing broiler production performance, and increasing the economic benefits of the farm.

Key words: *broiler, relatively high temperature, relatively low temperature, growth performance, meat quality.*
DOI: https://doi.org/10.32845/bsnau.lvst.2020.2.2

Introduction. The breeding environment temperature has become one of the most important factors restricting the production efficiency of broiler chickens in large-scale breeding farms. Although, the poultry house environment has been systematically studied at home and abroad, and high-tech can be used to control the poultry house environment. However, In actual production, environmental control still faces many problems. At present, the research on broiler feeding environment temperature mostly focuses on acute or short-term high temperature and low temperature stress. There are few studies on the growth performance, slaughter performance and meat quality of broiler chickens in long-term relative high temperature and low temperature. Therefore, this experiment passed the research Relatively high temperature and low temperature affect the growth performance, slaughter performance and meat quality of broiler chickens, providing good environmental conditions for chickens, in order to obtain higher feed conversion rate, improve chicken quality, maximize broiler production performance, and increase breeding The economic benefits of the farm lay the foundation for the realization of healthy broiler breeding.

Materials and research methods. For research was select 240 healthy 1-day-old Avian broilers were selected using

a single-factor completely randomized group test. They were randomly divided into 3 groups of 80 each. According to the two-stage feeding of the NRC diet, they were divided into a relatively high temperature group, a control group and relatively low temperature group (hereinafter referred to as high temperature group, control group, low temperature group). The initial temperature was set to 36.5℃, 33.5℃ and 30.5℃. The ambient temperature of each group decreases by 0.5℃ with the age (the temperature remains the same during feed change), until 42 days each group drops to 22℃, 19℃ and 16℃. Other feeding conditions were the same, 6 broilers were slaughtered in each group at 7, 14, 21, 28 days, and 35 day, and 12 broilers were slaughtered in each group at 42 days.

The experiment was carried out in Yunnan Academy of Animal Science, and each broiler house has 7.20×3.50×3.50m. There are three broiler houses in total. The houses can automatically control temperature, humidity and ventilation. Each house provides four trough feeders and four automatic water feeders. Except for different temperatures in the house, other environmental conditions and feeding conditions are basically the same. Broilers are managed according to routine, routine immunization procedures free to eat and drink and Follow the immunization program.

For experimental was select 6 chickens in each group were randomly selected on 1day, 7days, 14 days, 28 days, 35 days, and 12 chickens were selected on 42 days, and weighed on an empty stomach. The feed intake of each group was accurately recorded, and the average weight and average daily gain (ADG) of each group were calculated.

Average daily gain = (average weight at the end of the test-average weight at the initial stage)/test days

At 42 days, 12 broilers were randomly selected from each group. The neck was bleed to death. The separated head, neck, wings, legs, thighs, calves, feet, abdominal fat, pectoral muscles, leg muscles, intestines, and stomach were weighed and collected. Amino acids and fatty acids were determined from the left thoracic muscle.

Determination of amino acid content: pre-column derivatization HPLC method.

Determination of fatty acid content: gas chromatography (GB / 5009.168-2016).

After the test data were processed with Excel 2007 and SPASS18.0, statistical analysis was performed by one-way ANOVA. The data was expressed as mean ± standard deviation, and Duncan's was used for multiple comparisons of the mean of the data. P>0.05 indicated no difference. Significant, P ＜0.05 means significant difference

Research results. As can be seen from Table 1, the average body weight of each group of broilers in each time period showed an upward trend. The body weight of broilers in the low temperature group at 14 and 42 days was significantly lower than that in the high temperature group and the control group (P <0.05). The weight of broilers in the 28 days high-temperature group was significantly lower than that in the control group (P <0.05). The body weight of broilers in the low temperature group at 42 days was 23.6% and 32.4% lower than that of the broilers in the high temperature group and the control group, respectively.

Table 1

Effects of relative high temperature and low temperature on the average body weight of broilers in different ages （kg）

Group	Age					
	7 day	14 day	21day	28 day	35 day	42 day
High	0.13±0.01	0.32±0.01^{a}	0.63±0.03	1.00±0.03^{b}	1.53±0.15	2.18±0.09^{a}
Control	0.13±0.02	0.34±0.03^{a}	0.64±0.02	1.07±0.03^{a}	1.57±0.07	2.25±0.16^{a}
Low	0.12±0.01	0.23±0.04^{b}	0.61±0.01	1.0±0.06^{ab}	1.60±0.10	1.72±0.11^{b}

Note: For the same index in the table, there is a significant difference between those with different letters on the right shoulder of peers (P<0.05), and those with the same letters are not significantly different (P>0.05). The following table is the same.

As shown in Table 2, the average daily gain of each group of broilers in each time period showed an upward trend, and the average daily gain of broilers in the low temperature group of 7-14 days and 35-42 days was significantly lower than that of the high temperature group and the control group (P<0.05). The average daily gain of broilers in the 21-28 days high temperature group was significantly lower than that of the control group (P<0.05), and the average daily gain of broilers in the 1-42 days (full period) high temperature group and control group was significantly higher than that of the low temperature group (P<0.05).

Table 2

Effects of relatively high and low temperature on the average daily weight gain of broilers at different ages (g/d)

Group	Age						
	1-7day	7-14 day	14-21day	21-28 day	28-35 day	35-42 day	1-42 day
High	11.26± 1.31	26.89± 2.07^{a}	86.78± 4.83	129.71± 4.7^{b}	200.36± 21.19	279.05± 16.78^{a}	49.98± 2.80^{a}
Control	10.50± 2.90	30.17± 4.41^{a}	87.11± 3.42	141± 4.86^{a}	204.11± 10.27	288.25± 9.41^{a}	51.79± 1.93^{a}
Low	9.17± 1.13	16.17±5.25^{b}	85.04± 1.35	134± 8.28^{ab}	208.32± 14.36	221.73± 18.83^{b}	40.37± 3.51^{b}

As shown in Table 3, during the whole experimental period, the number of dead poaching of broiler was in the order of low temperature group> high temperature group> control group. The number of dead poachers in the low temperature group was 71.4% higher than that in the control group and 57.1% higher than that in the high temperature group, while the rate of dead

poachers in the high temperature group was higher than the control group by 33.3%.

Table 3

Effects of relatively high and low temperature on the mortality rate of broilers

Group	High	Control	Low
Death rate	7.5	5.0	17.5

As shown in Table 4, the breast muscle weight, stomach weight, intestinal weight, head weight, neck weight, wing weight, leg weight, thigh weight, calf weight, and foot weight of the broilers in the 42 days low-temperature group were significantly lower than those in the high-temperature group and control group (P <0.05). Compared with broilers in high temperature group (21.1%, 14.3%, 22.2%, 16.7%, 20%, 25%, 19.6%, 16.2%, 33.3%, 50%), respectively, compared with control group broilers (21.1%, 14.3%, 22.2%, 16.7%, 11.1%, 28.6%, 21.3%, 18.4%, 33.3%, 33.3%). There was no significant difference in slaughter performance between broilers in high temperature group and control group (P> 0.05). There was no significant difference in the muscle weight of the three groups of broilers (P> 0.05).

Table 4

Effects of relatively high and low temperature on slaughter performance of 42 days broilers（kg）

Slaughter performance	Group		
	High	Control	Low
Breast muscle weight	0.38±0.04[a]	0.38±0.04[a]	0.30±0.06[b]
Leg muscle weight	0.11±0.02	0.12±0.01	0.11±0.02
Stomach weight	0.07±0.02[a]	0.07±0.01[a]	0.06±0.01[b]
Intestinal weight	0.09±0.02[a]	0.09±0.01[a]	0.07±0.02[b]
Head weight	0.06±0.01[a]	0.06±0.01[a]	0.05±0.01[b]
Neck weight	0.10±0.01[a]	0.09±0.01[a]	0.08±0.01[b]
Wing weight	0.20±0.01[a]	0.21±0.02[a]	0.15±0.03[b]
Leg weight	0.46±0.06[a]	0.47±0.05[a]	0.37±0.03[b]
Thigh weight	0.37±0.04[a]	0.38±0.04[a]	0.31±0.03[b]
Calf weight	0.03±0.01[a]	0.03±0.01[a]	0.02±0.01[b]
Foot weight	0.04±0.01a	0.03±0.01a	0.02±0.01b

As shown in Table 5, the total amino acids and umami amino acids in the breast muscle of broilers were highest in the control group and essential amino acids were highest in the low-temperature group, but the differences were not significant (P> 0.05). The contents of serine, glycine, cystine, leucine, histidine, and tyrosine in broiler breast muscle of high temperature group were significantly lower than those in control group (P <0.05). The contents of serine and glycine in the breast muscle of the low temperature group were significantly lower than those in the control group (P <0.05). The contents of arginine, cystine, leucine, phenylalanine, and tyrosine in the breast muscle of the low temperature group were significantly higher than those in the high temperature group (P <0.05).

Table 5

Amino acid content in broiler breast muscles（mg/100g）

Amino acids	Group		
	High	Control	Low
ASP	2.15±0.18	2.21±0.12	2.17±0.17
Glu	3.47±0.28	3.53±0.18	3.42±0.32
Ser	0.70±0.09[b]	0.8±0.04a	0.67±0.09b
Arg	1.53±0.11[b]	1.6±0.11ab	1.65±0.12a
Gly	1.04±0.06[b]	1.12±0.06a	1.04±0.08b
Thr	0.85±0.15	0.86±0.09	0.83±0.13
Pro	0.85±0.06	0.86±0.04	0.82±0.06
Ala	1.34±0.09	1.37±0.07	1.32±0.12
Val	1.27±0.07	1.28±0.09	1.24±0.17
Met	1.27±0.07	1.28±0.09	1.24±0.17
Cys	0.23±0.02[b]	0.28±0.02a	0.27±0.03a
Ile	1.25±0.08	1.25±0.06	1.38±0.31
Leu	2.14±0.14[b]	2.26±0.07a	2.24±0.05a
Phe	1.18±0.04[b]	1.21±0.09ab	1.27±0.07a
His	0.70±0.05[b]	0.78±0.08a	0.75±0.02ab
Lys	2.33±0.14	2.45±0.17	2.47±0.17
Tyr	0.85±0.04b	0.95±0.06a	0.91±0.07a
EAA	9.74±0.64	9.79±0.68	10.00±0.54
Umami amino acids	10.02±0.74	10.38±0.68	10.08±0.85
Total amino acids	22.62±1.42	23.28±1.18	22.99±1.36

As shown in Table 6, the content of various fatty acids in the breast muscles of the control group was the highest, followed by the high temperature group, and the low temperature group was the lowest. Among them, the breast muscles of the

control group had C14:0, C16:0, C18:0, C18:ln9c, C18:2n6c, C18:3n3, C20:2, C20:3n6, C20:3n3, C22:6n3, SFA, PUFA, USFA, EFA content were significantly higher than the low temperature group and high temperature group (P <0.05), the control group C14:1, C16:1, C20:0, C18:3n6, C20:1, MUFA content were significantly higher than the low temperature group (P<0.05), and the difference was not significant compared with the high temperature group (P>0.05). The C14:1 content of the high temperature group was significantly higher than that of the low temperature group (P<0.05).

Table 6

Fatty acid content in broiler breast muscle（mg/100g）

Fatty acid	Group		
	High	Control	Low
C14:0(C14H28O2)	1.62±0.27^{b}	2.37±1.15^{a}	1.21±0.35^{b}
C14:1(C14H26O2)	0.52±0.13^{a}	0.61±0.33^{a}	0.23±0.08^{b}
C15:0(C15H30O2)	0.42±0.18	0.46±0.23	0.27±0.14
C16:0(C16H32O2)	76.73±15.48^{b}	123.43±64.16^{a}	60.35±16.04^{b}
C16:1(C16H30O2)	17.45±5.23^{ab}	23.31±14.75^{a}	8.82±3.45^{b}
C17:0(C17H34O2)	0.55±0.01	0.88±0.33	0.49±0.22
C18:0(C18H36O2)	24.29±3.81^{b}	45.15±21.12^{a}	27.13±8.62^{b}
C18:ln9c(C18H34O2)	87.00±19.08^{b}	135.92±77.62^{a}	71.71±19.32^{b}
C18:2n6c(C18H32O2)	54.65±9.06^{b}	93.08±46.62^{a}	51.85±16.28^{b}
C20:0(C20H40O2)	0.51±0.21^{ab}	0.72±0.17^{a}	0.40±0.17^{b}
C18:3n6(C18H30O2)	0.85±0.16^{ab}	1.16±0.51^{a}	0.67±0.31^{b}
C20:1(C20H38O2)	2.36±0.43^{ab}	3.56±2.01^{a}	1.70±0.58^{b}
C18:3n3(C18H30O2)	1.01±0.22^{b}	1.54±0.78^{a}	0.92±0.21^{b}
C20:2(C20H36O2)	1.59±0.68^{b}	2.39±0.86^{a}	1.09±0.31^{b}
C20:3n6(C20H34O2)	3.64±0.82^{b}	5.9±1.60^{a}	2.68±0.58^{b}
C20:3n3(C20H36O6)	10.20±1.59^{b}	22.19±8.00^{a}	10.51±2.38^{b}
C22:6n3(C22H32O2)	2.02±0.74^{b}	3.41±1.21^{a}	2.01±0.45^{b}
Total SFA	103.13±19.5^{b}	172.55±26.52^{a}	89.24±24.53^{b}
Total PUFA	72.86±11.0^{b}	132.19±29.22^{a}	70.19±21.6^{b}
Total MUFA	107.64±24.58^{ab}	170.03±37.83^{a}	82.46±22.84^{b}
Total USFA	180.5±35.11^{b}	302.22±52.78^{a}	152.65±41.69^{b}
Total EFA	56.37±9.34^{b}	94.77±17.43^{a}	53.16±16.65^{b}

Note ： SFA - saturated fatty acid, PUFA - polyunsaturated fatty acid, MUFA - monounsaturated fatty acid, USFA - Unsaturated fatty acid, EFA -Essential fatty acids.

Discussion. When the animal is in a low temperature environment, the gastrointestinal motility slows down, resulting in a decrease in feed intake (Li Shaoyu et al. 2014). Under low temperature conditions, the animal's energy intake changes from maintaining production to maintaining body temperature, resulting in weight loss (Wang Mi et al. 2007). This is consistent with the results of the 42-day low-temperature group's average body weight and average daily weight gain in this experiment are significantly lower than the control group (P <0.05). At the same time, the low-temperature stress significantly increased the mortality of broilers (Li Lijuan et al.2009), which is consistent with the result that the 42d low-temperature chicken death rate in the test was higher than the control group by 71.4% (Liao Man et al 2016). Reported that broilers grown in low-temperature environments, when eating equal feeds, lacked energy, protein, vitamins, minerals and other nutrients, which would lead to reduced production performance . The results of this experiment show that the low temperature environment not only reduces the growth performance of broilers but also causes a decline in slaughter performance. Compared with the control group, the breast muscle weight, stomach weight, intestine weight, head weight, neck weight, wing weight, leg weight, thigh weight, calf weight and foot weight of broilers in the low temperature group were reduced by 21.1%, 14.3%, 22.2%, and 16.7 %, 11.1%, 28.6%, 21.3%, 18.4%, 33.3%, 33.3%, compared with the high temperature group, they also decreased by 21.1%, 14.3%, 22.2%, 16.7%, 20%, 25%, 19.6%, 16.2%, 33.3%, 50%. At the same time, the test results also show that the effect of low temperature environment on the slaughter performance of broilers is higher than that of high temperature environment. The results of this experiment showed that the low temperature environment reduced the average body weight and average daily gain of broilers, the mortality rate increased, and the slaughter performance decreased. Compared with the high temperature environment, the low temperature environment had a greater impact on the growth performance of broilers.

Studies have shown that high-temperature stress above 30°C causes disturbances in poultry behavior and physiology, leading to reduced production performance (Hu Chunhong et al. 2015). Broilers aged 35-40 days experienced 31°C high-temperature stress and found that their performance and immunity decreased. Broilers feed intake and growth rate at 35°C high temperature were reduced by 13% and 32% than at 20°C. Poor performance of lower poultry may be due to decreased protein synthesis and degradation metabolism in the body, resulting in increased mortality(Zuo J et al. 2015). In this experiment, the death rate of broilers in the high-temperature group was higher than that of the control group by 33.3%, indicating that the high-temperature environment increased the mortality of broilers, which was also reported by (Deaton et al. 1984, Leeson et al. 1992) and others. The results of increased mortality are consistent. In addition, their research also showed that daily circulating high temperature reduced the final weight of broilers, average daily weight gain, average daily feed intake and serum total protein content.In this experiment, although the average body weight and average daily weight gain of 42-day high-temperature broilers were lower than those of the control group, there was no significant difference (P>0.05), indicating

that the high-temperature environment had little effect on the weight gain of broilers under this test condition. Studies have shown that compared with the low temperature (15.6°C) and moderate ambient temperature (21.1°C), the 56-day broilers has a negative impact on growth performance and slaughter performance (Olanrewaju H. A. et al. 2010). The high temperature has no negative effect on the slaughter performance of broilers, which is inconsistent with the previous results. This reason may be related to the different intensity of high temperature stress.

Cold stress can change the body's antioxidant function and induce oxidative stress, leading to increased free radicals in the body, causing damage to the body and causing meat quality to decline (Su Yingying 2014). Muscle amino acids, fatty acids, protein, water and intermuscular fat are indicators of evaluating the nutritional value of meat quality (Xi Pengbin et al. 2006). Consumers' acceptability of meat depends on the physical and chemical characteristics of meat, and the chemical composition of meat is closely related to nutritional value. Fatty acid is an important chemical substance that constitutes fat and an important factor that affects the flavor of meat. The content of unsaturated fatty acids (USFA) plays a key role in the formation of flavor substances. The higher the proportion of unsaturated fatty acids in the entire fat structure, the greater the proportion of soft fat in meat, and the more aroma substances produced during cooking, the better the palatability. USFA can be divided into monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA), of which PUFA is an important precursor of meat flavor and an indispensable nutrient for the human body (Wang Mingyuan 2015). In this experiment, the content of SFA, PUFA, MUFA, and EFA in the breast muscle of the low temperature group was significantly lower than that of the control group by 48.3%, 46.9%, 51.5%, and 43.9%. The results showed that the low temperature environment affected the fatty acid content of broiler muscles and could reduced the breast muscles, flavor and meat quality. In the breast muscle amino acid composition, the content of serine and glycine in broilers in the low temperature group was significantly reduced, but there was no significant effect on the content of other amino acids ($P>0.05$), indicating that the low temperature environment had little effect on the amino acid composition of broiler breast muscles.

High temperature stress is one of the important environmental factors affecting meat quality, which can accelerate the glycolysis metabolism after death, and cause the chicken to be pale and exudative meat, which is the characteristic of PSE meat (Huang.C et al. 2015). The oxidation and reduction of poultry products under high temperature stress and the oxidation of fat are the main reasons for the deterioration of meat quality, and may lead to a reduction in the function, sensory and nutritional value of meat products (Bou R et al. 2004), which will require correction with the help of additional technological methods in the further processing of meat as antioxidants. In this experiment, the content of SFA, PUFA USFA and EFA in the breast muscles of the high temperature group was significantly lower than that of the control group, 40.2%, 40.3%, 44.9% and 40.5%, which showed the same trend as the broilers in the low temperature environment, but the content was slightly higher than the broilers in the low temperature group. In addition, the results of this test also showed that the content of serine, glycine, cystine, leucine, histidine and Tyr in the high temperature group was significantly lower than that in the control group ($P<0.05$), indicating that the high temperature environment also could reduced the flavor and nutritional value of chicken, but the degree of impact is lower than in low temperature environments.

Conclusion: 1. Long-term relative high and low temperature reduced the growth performance and mortality of broilers, and long-term relative low temperature will reduce the slaughter performance of broilers.

2. The relatively high and low temperature for a long time reduced the content of serine, glycine, SFA, PUFA, USFA, EFA and MUFA in the breast muscle of broilers, negative effect on meat quality.

3. Long-term relative low temperature has a greater adverse effect on broilers than long-term relative high temperature.

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Ефективність використання довготривалої відносно високої і низкої температури на показники росту та якість м'яса бройлерів

Метою наших досліджень було вивчення впливу довготривалих відносно високих та низьких температур на показники росту та якість м'яса курчат-бройлерів. Експеримент проводився в Юньнаньській академії тваринництва, для визначення якості м'яса використовували лабораторії Хенаньського науково-технічного інституту. Всього у експерименті було використано 240 здорових курчат одноденного віку випадковим чином розподілених на три групи: групу високої температури, групу низької температури та контрольну групу. Результати експерименту підтверджують, що при низьких температурах, коли споживання енергії твариною зменшується, це призводить до втрати ваги, що ми й спостерігаємо у низькотемпературній групі де середньодобовий приріст маси тіла був значно нижчим, ніж у контрольній групі (P<0,05). Було встановлено, що у низькотемпературній групі стрес значно збільшив показники смертності бройлерів, так у віці 42 днів у низькотемпературній групі смертність бройлерів була вищою, ніж у контрольній групі на 71,4%. Серед усіх оцінених груп за вмістом ненасичених жирних кислот SFA, PUFA, MUFA та EFA у грудному м'язі бройлерів найнижчий вміст був у групі з низькою температурою, ніж у контрольній групі, на 48,3%, 46,9%, 51,5 % та 43,9% відповідно. Дослідження показали, що вплив високих температур вище 30°C спричиняє порушення поведінки та фізіології птиці, що призводить до зниження продуктивності бройлерів. Встановлено, що бройлери у віці 35-40 днів які зазнали стресу при температурі 31°C мали зниження показників продуктивності та імунітету. Кількість спожитого корму та швидкість росту бройлерів при температурі 35°C зменшились на 13% та 32%, ніж при температурі 20°C. Результати досліджень показали, що: ① відносно висока та низька температура протягом тривалого часу знижує показники приросту живої маси та підвищує показник смертності бройлерів, а довготривала відносно низька температура знижує ефективність показників забою. ② Відносно високі та низькі температури протягом тривалого періоду часу знижують рівень серину, гліцину, SFA, PUFA, USFA, EFA та MUFA у грудних м'язах бройлерів, що негативно впливає на якість м'яса. ③ Тривала відносно низька температура має більший негативний вплив на бройлерів, ніж довготривала відносно висока температура. Результати наших досліджень дають теоретичну основу для точного встановлення температури середовища розведення бройлерів, поліпшення якості продукції, максимізації продуктивності виробництва та збільшення економічних вигод птахоферми.

Ключові слова: *бройлер, відносно висока температура, відносно низька температура, продуктивність росту, якість м'яса.*

Дата надходження до редакції: 08. 09.2020 р.