DOI: 10.21005/AAPZ2024.72.4.3

FOLIA POMERANAE UNIVERSITATIS TECHNOLOGIAE STETINENSIS
Folia Pomer. Univ. Technol. Stetin., Agric., Aliment., Pisc., Zootech. 2024, 373(72)4, 27–36

Received 8 Jul 2024
Revised 18 Aug 2024
Accepted 29 Aug 2024

Michał KMIECIK[1], *Zuzanna SIUDAK*[2], *Sylwia PAŁKA*[1],
Ewelina TROJANOWSKA[1]

MEAT QUALITY OF RABBITS KEPT UNDER VARIOUS HOUSING SYSTEMS

[1] Department of Genetics, Animal Breeding and Ethology, University of Agriculture in Kraków, Poland
[2] Department of Small Livestock Breeding, National Research Institute of Animal Production, Balice, Poland

Abstract. The aim of this study was to determine the effect of the housing and feeding system on the quality of rabbit meat. The study material was Termond White rabbits. Rabbits were weaned at 56 days of age and randomly assigned to a control group (n = 23) and a research group (n = 24). The control group was maintained in battery cages and the research group was maintained in portable cages on pasture. The animals were fed *ad libitum* a commercial complete feed with 16.5% total protein, 14% digestible fibre and 10.2 MJ metabolisable energy. The research group had unlimited access to forage. Rabbits were slaughtered at 90 days of age and muscle pH and colour were measured 45 min and 24 h post mortem and loin samples were taken for testing. Shear force measurements and texture profile analysis were performed. Statistical analysis was performed with the SAS statistical package, using PROC GLM. The significance of differences between means was tested using the Tukey–Kramer test. The pH values measured 45 min after slaughter were statistically higher in the meat of rabbits from the study group. L*45 values measured on the loin showed highly significant differences between the groups (61.99 and 57.40). After 24 h, the values of the L* parameter measured on the hind leg showed highly significant differences (56.17 and 52.50). Significant differences were found for springiness and chewiness parameters. The housing system influenced meat quality.

Key words: housing system, rabbit, meat quality, pH, colour, texture analysis.

INTRODUCTION

Rabbits are versatile farm animals. Their great adaptability to different environmental and living conditions has led to representatives of this species being used in several industries, most commonly for the production of slaughter material and, in smaller numbers, for fur production. In addition, they make a very good model for laboratory animals, and are kept as companion animals (Lukefahr et al. 2022).

The predominant form of rabbit breeding is rearing for meat. When buying meat products, consumers are increasingly paying attention to the housing conditions of the animals. Intensive breeding of meat rabbits involves keeping them in cages, which is often associated with

Corresponding author: Zuzanna Siudak, Department of Small Livestock Breeding, National Research Institute of Animal Production, Krakowska 1, 32-083 Balice, Poland, e-mail: zuzanna.siudak@iz.edu.pl.

inadequate welfare. In addition, there is growing interest in organic animal husbandry and rearing with increased welfare (Combes et al. 2010; Loponte et al. 2018; Petracci et al. 2018).

For the rabbit farmer, as for breeders of other livestock species, the most important thing is to keep the animals in such a way that, at the lowest cost, he can obtain as many animals for slaughter as possible in the shortest possible time (Kryński et al. 2018; Szendrő et al. 2020). Depending on the possibilities available and the quality and quantity of the stock the farmer wants to obtain, different rabbit rearing variants are possible (Bernacka and Święcicka 2015).

One of the housing systems used in rabbit livestock production is outdoor rearing. This system does not require a livestock enclosure and is used by hobby rabbit breeders as it does not generate a high income. It is held outdoors in free-standing single- or multi-tier cages with slatted or bedded floors. It is an extensive housing system, which means that females have limited opportunities for reproduction, especially at low temperatures. An important issue with this type of husbandry is the proper protection of the cages from predators and adverse weather conditions (Kryński et al. 2018). Another way is to keep rabbits indoors with access to an enclosure. This is a very good solution for organic farms, so that the rabbits can consume wet roughage in addition to a mixture of cereals and hay. However, this type of husbandry requires adequate protection of the enclosure so that individuals do not have the opportunity to dig a hole under and possibly escape (Kryński et al. 2018).

Another option is the rearing of rabbits in boxes on deep litter. This type of husbandry allows the created space in the livestock buildings to be used at low cost, while the animals are given the opportunity to perform natural behaviours such as digging in the litter, scratching, biting or nest building. Therefore, there is no need for a nest box and breeding and rearing of young is possible at any time of the year. Litter is cheap and relatively easy to obtain, plus the rabbits readily eat it, thus making up for the lack of dietary fibre. This system is a very good solution for organic rearing (Barabasz and Bieniek 2003; Bernacka and Święcicka 2015; Kryński et al. 2018).

The most intensive system of keeping rabbits is indoor cage rearing, which, given the right conditions, can produce up to eight litters per year from a single female. In this method, single- or multi-tier cages (so-called battery system) are most commonly used, made of metal mesh with a mesh size of approximately 20 mm × 15 mm in the floor part and 20 mm × 40 mm in the other parts. The cages must be equipped with feeders and automatic drinkers. In addition, stalls for females intended for breeding should be equipped with nesting boxes. This system allows for rapid growth of youngsters and facilitates the work of the breeder through the possibility of introducing automation, ease of disinfection and protection against unfavourable environmental conditions and pests (Barabasz and Bieniek 2003; Bernacka and Święcicka 2015; Kryński et al. 2018).

The scientific research conducted confirms that alternative livestock housing methods have an impact on the production results obtained, but also on the quality of the product obtained (Fàbrega et al. 2011; Lebret et al. 2011; Zita et al. 2018; Englmaierová et al. 2021; Starčević et al. 2022). The aim of this study was to determine the influence of the housing and feeding system on the quality of rabbit meat.

MATERIAL AND METHODS

The experiment was carried out at the Experimental Station of the Department of Animal Genetics, Breeding and Ethology in Przegorzały belonging to the University of Agriculture in Kraków. The rabbits used for the study were the Termond White breed (n = 47).

Rabbit rearing conditions

Until weaning, young rabbits were kept with their mothers in wooden cages standing in a facility equipped with water, lighting and forced ventilation. The rabbits were weaned at 56 days of age, vaccinated and marked with an ear tattoo. Animals were randomly allocated to a control and an experimental group. After weaning, the rabbits were fed *ad libitum* a commercial complete feed with 16.5% total protein, 14% digestible fibre and 10.2 MJ metabolizable energy. The experimental group additionally had unlimited access to forage in field cages.

Rabbits housed in 40 cm × 60 cm × 35 cm commercial rearing cages in a closed room (n = 23; 12 = ♀; 11 = ♂) constituted the control group. Three individuals were allocated to each cage. The animals in the test group (n = 24; 16 = ♀ and 8 = ♂) were kept outdoors in three specially prepared cages from which they could independently take forage from the pasture. Each cage contained 8 individuals. The cages, measuring 100 cm × 120 cm × 50 cm, were constructed of metal mesh with meshes of different sizes. The meshes at the bottom of the cage allowed the rabbits to chew on the green fodder. The cages contained a feeder and, in addition, a box was placed in the cages to allow the rabbits to take shelter when the weather outside was unfavourable. The cages were equipped with 4 nipple drinkers, each with a capacity of 1,000 ml, which were refilled on a regular basis to ensure constant access to water. Equipping the cages with wheels streamlined the change of paddocks in the pasture, making it easier for the animals to access the new, uneaten section. To protect the rabbits from the sun and rainfall, the cages were roofed.

Slaughter and obtaining material for research

The rabbits were slaughtered at 90 days of age, after being starved for 24 h with constant access to water. The animals were stunned, bled and skinned, after which the carcasses were eviscerated. The carcasses were subjected to 24-hour chilling at 4°C, after which time they were divided into three basic cuts: the front part, the loin and the hind part, and dissected according to the methodology given by Barabasz and Bieniek (2003). After slaughter, the pH and colour (45 min/24 h post mortem) of the muscles of the loin (*m. logissimus lumborum*) and hind leg (*m. biceps femoris*) were measured. During dissection, a section of loin muscle (*m. longissumus lumborum*) in the form of a cylinder measuring 4 cm long × 1 cm high × 1 cm wide was taken from all females in each group, which were frozen for 72 h then defrosted and heat-treated in a water bath at 80°C for 40 min, according to the methodology reported by Kozioł et al. (2016). Twelve specimens from the test group and 11 specimens from the control group were analysed from test females only, to avoid measurement errors due to gender.

Measuring acidity and meat colour

Acidity measurements were taken twice using a Consort C561 pH-meter on the loin muscle (*m. longissimus lumborum*) and the hind leg muscle (*m. biceps femoris*). The first measurement was taken 45 min after slaughter (pH_{45}) and the second 24 h after slaughter (pH_{24}). Meat colour was determined on warm cuts 45 min after slaughter and on chilled cuts 24 h after slaughter according to the Minolta technique, using a CR-410 reflectance colourimeter (Minolta, Osaka, Japan). The parameters obtained determined the meat colour lightness (L*), as well as the chromaticity coordinates: redness (a*) and yellowness (b*).

Measurement of shear force and texture profile analysis

Shear force was measured using prepared cylinder-shaped meat samples (4 cm long × 1 cm high × 1 cm wide) from the loin. The tests were carried out using a TA.

XTplus texturometer (Stable Micro Systems), equipped with a Warner-Bratzler blade with a triangular notch. The shear force value (kg/cm^2) of 10 mm × 10 mm samples was measured at a blade speed of 2 mm/s, transverse to the muscle fibres, until the sample was fully cut. Texture profile analysis was determined using the same texturometer equipped with an attachment, which was a 50 mm diameter cylinder. Parameters such as hardness (kg), springiness, cohesiveness and chewiness (kg) were measured. The test specimens were cut in the form of a cube with a side of 10 mm, carrying out a double compression test to 75% of their height (along the muscle fibres), with a cylinder speed of 5 mm/s and an interval between pressures of 5 s. The measurement of each sample was taken three times. The obtained shear force results and texture profile analysis parameters were calculated automatically using Exponent for Windows 6.6.10.0 (Stable Micro Systems).

Statistical analysis of the results

Based on the data obtained, statistical analysis was performed with the SAS statistical package (2014), using the GLM procedure. The model included a fixed effect of dietary group and a regression on litter size. The significance of differences between means was tested using the Tukey–Kramer test at a significance level of $p \leq 0.05$ and $p \leq 0.01$.

RESULTS

The meat acidity of the individual carcass cuts is shown in Table 1. The pH values of both muscles tested appeared to be higher for the rabbits kept in the pasture. Statistically significant differences were shown for the acidity measurement on the leg and loin muscles after 45 min. The acidity of the meat after 24 h in the test and control group was at a similar level for both cuts. No statistically significant differences were found.

Table 1. Effect of housing system on mean acidity values of leg (*m. biceps femoris*) and loin muscles (*m. logissimus lumborum*) 45 min and 24 h after slaughter (mean ± SD)

Acidity	Rearing system	
	pasture (n = 12)	battery (n = 11)
m. biceps femoris:		
pH_{45}	6.05 ± 0.05^a	5.87 ± 0.05^b
pH_{24}	5.83 ± 0.02	5.79 ± 0.02
m. longissimus lumborum:		
pH_{45}	6.17 ± 0.04^b	6.02 ± 0.04^a
pH_{24}	5.82 ± 0.02	5.78 ± 0.02

a, b – values marked with different letters are highly significantly different at $p \leq 0.05$.

The results showing the effect of the housing system on the colour of the leg and loin muscles are shown in Table 2. The value of the L* parameter measured on the leg and loin after 45 min was higher for the meat of rabbits from the test group. The measurement made on the loin muscle showed statistically highly significant differences between the test groups, in contrast to the measurement of the hind leg. After 24 h, the L* values measured on the hind leg and the loin of the test groups were lower, with the test group having higher values than the control group. When measured on the hind leg, highly significant statistical differences were shown, with a higher value recorded in the test group. The a* values after 45 min measured on the hind leg appeared to be at a similar level for both groups, while for the loin muscle the value was statistically higher for the control group. Twenty-four hours after slaughter, the values on the hind leg and the loin increased, but were still at a similar level for both groups. The parameter b* after 45 min measured on the hind leg and the loin was higher for the control group. The analysis carried out showed that these were highly significant discrepancies. After 24 h, the parameter increased and reached slightly higher values for the test group, but these differences were not statistically significant.

Table 2. Effect of housing system on mean values of muscle colour parameters of the leg (*m. biceps femoris*) and loin (*m. logissimus lumborum*) 45 min and 24 h after slaughter (mean ± SD)

Colour	Rearing system	
	pasture (n = 12)	battery (n = 11)
m. biceps femoris:		
L^*_{45}	53.96 ± 0.81	51.42 ± 0.94
a^*_{45}	3.50 ± 0.42	3.26 ± 0.36
b^*_{45}	−2.32 ± 0.53A	1.14 ± 0.61^{B}
L^*_{24}	56.17 ± 0.64^{A}	52.50 ± 0.68^{B}
a^*_{24}	3.91 ± 0.39	3.35 ± 0.41
b^*_{24}	3.31 ± 0.39	2.61 ± 0.41
m. longissimus lumborum:		
L^*_{45}	61.99 ± 0.86^{A}	57.40 ± 1.00^{B}
a^*_{45}	1.94 ± 0.77	5.84 ± 0.90
b^*_{45}	−3.35 ± 0.81^{A}	1.22 ± 0.94^{B}
L^*_{24}	54.66 ± 0.93	51.85 ± 0.98
a^*_{24}	4.82 ± 0.52	4.84 ± 0.55
b^*_{24}	1.47 ± 0.61	1.17 ± 0.65

A, B – values marked with different letters are highly significantly different at $p \le 0.01$.

Table 3. Effect of housing system on mean values of shear force and texture profile analysis of loin muscle (*m. logissimus lumborum*) (mean ± SD)

Parameter	Rearing system	
	pasture (n = 12)	battery (n = 11)
Shear force [kg/cm^2]	2.42 ± 0.16	2.19 ± 0.17
Hardness [kg/cm^3]	11.10 ± 1.00	14.00 ± 1.05
Springiness	0.40 ± 0.01^{a}	0.45 ± 0.01^{b}
Cohesiveness	0.45 ± 0.01	0.48 ± 0.02
Chewiness [kg/cm^3]	2.01 ± 0.33^{a}	3.24 ± 0.35^{b}

a, b – values marked with different letters are highly significantly different at $p \le 0.05$.

Table 3 shows the values of the shear force and meat texture profile analysis parameters of the tested rabbits. The shear force for the test group showed a higher value than for the control group. This result indicates greater muscle fibre growth in rabbits with access to pasture, but the difference was not confirmed statistically. The experiment showed that the meat of rabbits with access to pasture had a lower value for the hardness parameter compared to the meat of rabbits kept in the battery system. Springiness and cohesiveness were characterized by lower values in the test group than in the control group. For the first trait, the statistical significance of the differences was confirmed. For chewiness, a significantly higher value was observed for the control group compared to meat from rabbits with access to forage.

DISCUSSION

Meat quality assessment consists of a number of parameters to which appropriate weight is attached depending on the intended use. In general terms, the characteristics can be divided into: sensory traits, physiological and nutritional indicators, and technological characteristics. Sensory traits include colour, flavour and aroma of the meat, as well as marbling and texture. Physiological and nutritional parameters determine the content of the most important chemical compounds, such as fats, proteins, carbohydrates, ash, vitamins and trace elements, total digestibility and biological value. On the other hand, the characterization of technological traits takes into account the amount of connective tissue, tendons and fascia, as well as the content and type of fats (Pisula and Popiech 2011).

When characterizing sensory attributes, attention should be paid to colour, firmness, aroma, palatability and the basic components of texture, which include tenderness, juiciness, hardness and springiness. The colour of the meat is determined by its myoglobin content – the more myoglobin there is in the muscle fibres, the darker the meat. Hence, the colour of the meat is influenced by breed, age, sex, type and activity of the muscle, as well as housing and nutrition. It should be noted here that males tend to have darker meat than females, and that rabbits from traditional breeding, fed with farm feeds, have lighter meat colour compared to rabbits from intensive breeding, fed with complete feed mixtures (Pisula and Pośpiech 2011; Kozioł et al. 2015). Sensory attributes are subjectively evaluated by consumers and one of the main tasks of the farmer is to provide the most valuable product on the market (Loponte et al. 2018).

An important parameter affecting meat quality is the pH index, whose values change from slaughter to consumption. These changes are due to the chemical processes that take place, leading to physical and structural changes in the muscle. The acidity of meat depends on a number of genetic and environmental factors and influences many characteristics that determine meatiness, such as water holding capacity, colour, storage life and flavour. This parameter allows the normal course of glycolysis to be determined, as well as providing information on meat defects. Immediately after slaughter, the pH value should be between 6.10 and 6.80. Lower values make the meat watery and have poorer processing properties. Twenty-four hours after slaughter, the pH should be 5.60–5.85 (Jurczak 2005; Pisula and Pośpiech 2011; Kozioł et al. 2015).

Most studies determining quality traits and meat texture profile analysis (TPA) of rabbits are carried out within breeds, interbreed crosses, mixed-breed animals and synthetic lines. In scientific papers describing meat quality changes (caused by various types of nutritional additives), the authors usually restrict the study area to one breed/synthetic line in order to limit the number of factors influencing the outcome of the experiment. The analysis of the quality characteristics of rabbit meat depending on the heat treatment or lack thereof is also the subject of research by many authors (Chwastowska-Siwiecka et al. 2011; Kozioł et al. 2016, 2017; Daszkiewicz and Gugołek 2020).

Kmiecik et al. (2017) studied the effect of season and diet on the meat quality of Popielno White rabbits. In the experiment, the herd was divided into two groups, the first being does rearing their young in the autumn-winter period, from mating to weaning of the rabbits fed intensively with complete pellets, and the second being rabbits kindling in the summer-autumn period and fed extensively with a mixture of oats, wheat and maize with the addition of meadow hay provided *ad libitum*. After the young were weaned, their feeding did not change. The researchers showed that in the group fed with farm feed during the autumn-winter period, the pH_{45} and pH_{24} of the loin muscle was 6.64 and 5.64, respectively, while for the thigh muscle it was 6.40 and 5.98. These results were similar to the values obtained in our own research with regard to the values obtained for the loin muscle, while in the case of the leg muscle pH, the cited authors recorded higher values. In the case of rabbits reared in the summer-autumn period, fed with complete pellets, the acidity was at a similar level, but the pH values measured on the thigh and loin muscle after 45 min fluctuated above 6.70. The colour parameters for both groups were at a similar level in the case of the thigh muscle. However, significant differences were observed in the b* coordinate measured on the loin muscle after 45 min and 24 h. Higher values for chewiness and hardness were recorded in rabbits fed a complete mixture. The hardness parameter was 8.64 kg/cm^3 for the intensively reared rabbits and 5.45 kg/cm^3 for the rabbits fed with farm feed, while for chewiness these values were 1.65 and 0.93. The values of the subsequent analysis traits were as follows: springiness 0.46 and 0.50; cohesiveness 0.38 and 0.37. Comparing the results presented above to the results of our experiment, it appears that the values of the hardness and chewiness traits were lower by 5.36 and 5.65 kg/cm^3, and 0.36 and 2.31, respectively. On the other hand, for the traits springiness and cohesiveness, the results were higher by 0.06 and 0.05, and 0.07 and 0.11, respectively.

Kozioł et al. (2017), investigating the effect of breed and sex on rabbit meat texture, showed that White Termond rabbits were characterized by a shear force of 1.970 kg/cm^2, hardness of 12.06 kg/cm^3, springiness of 0.46, cohesiveness of 0.42 and chewiness of 2.45 kg/cm^3. These values are similar to the results obtained in our own study. Rabbits of breeds such as Grey Flemish Giant, Californian Black, New Zealand White and Popielno White were characterized by lower texture parameters compared to the Termond White breed.

Pałka et al. (2018), investigating the acidity and colour of meat from rabbits kept in a battery system and in boxes with bedding, showed that the pH of the loin muscle in rabbits kept in boxes was 6.92 after 45 min, while it dropped to 5.92 after 24 h. For acidity measured on the leg, the values were 6.86 after 45 min and 6.08 after 24 h. Similar measurements were shown for meat samples from rabbits kept in a battery system. The acidity measurements are similar to the results obtained in the present study. For the colour of the leg muscle from rabbits kept in boxes, the value of L^*_{45} was 53.11 and L^*_{24} increased to 57.88. The values of the colour parameter L^*_{45} and L^*_{24} were higher by 2.12 and 5.09 respectively than the results obtained in the experimental group (L^*_{45} = 50.99; L^*_{24} = 52.79) of the presented work. The same authors recorded values of 2.67 and 3.63 for the colour coordinates a^*_{45} and a^*_{24}, respectively, while values of 0.01 and 3.41 for the colour parameter b* measured at the same time. The results obtained differ from those of the present work. The analysis of loin colour for rabbits kept on deep litter, at 45 min and 24 h after slaughter, showed L* = 60.66 and 57.31; a* = 1.34 and 4.31; and b* = −4.19 and 1.77, respectively. The values differ from the presented results by: L* = 9.67 and 4.52; a* = −2.27 and 0.25; and b* = −8.39 and −2.66, respectively. In the experiment analysed, the rabbits of the test group showed a lighter colour of the meat of the loin and leg (L^*_{45}; L^*_{24}) compared to the rabbits kept in boxes.

Combes et al. (2010) studied the effect of the type of housing of rabbits on their meat quality. The animals, depending on the allocated group, were kept in cages (6 rabbits per cage), small pens (10 rabbits per pen) or large pens (60 rabbits per pen). The researchers showed that the pH value measured on the *longissimus dorsi* and *biceps femoris* muscle varied significantly according to the housing system of the rabbits. The lowest and, at the same time, most favourable values from a technological point of view were recorded for rabbits kept in large pens, while the highest value of the parameter in question was from small pens. Measurement of meat colour indicated significant differences between groups in the values of the a and b coordinates measured on the surface of both muscles examined. The highest value of the a* and b* parameters measured on the thigh muscle was characteristic of the group of animals from the large pens and the lowest from the small pens. In the case of the *longissimus dorsi* muscle, the relationship described above was maintained for the b* coordinate, while the highest value of the a* parameter was also recorded for rabbits from large pens and the lowest for animals kept in cages.

An assessment of the physico-chemical parameters of meat was also undertaken by Chwastowska-Siwiecka et al. (2011). They investigated the effect of keeping New Zealand White and Californian rabbits in wooden cages on deep litter in the open air on the acidity and colour of meat. The pH values measured after 45 min and 24 h were found to be 6.79 and 5.97 for Californian rabbits and 6.76 and 5.90 for New Zealand White rabbits, respectively. The values recorded by the authors of the cited paper were higher in both cases compared to the results obtained in our experiment. There were no significant differences between the colour lightness values in the two groups, while the thigh muscles were characterized by a higher value of the red colour coordinate (a* = 4.65) in New Zealand White rabbits compared to Californian rabbits (a* = 2.61). However, the difference in rearing length between the breeds must be taken into account here.

Dalle Zotte et al. (2015) determined the effect of genotype, housing system and supplementation of the ration fed to rabbits with hay on meat quality including acidity and colour.

Daszkiewicz and Gugołek (2020), analysing the meat parameters of Californian and Grey Flemish Giant rabbits kept outdoors in metal cages with a slatted floor, fed only complete pellets, showed an L* value of 61.00–62.50 for both breeds, while pH values ranged from 5.90 to 6.14. The measured colour parameters are characterized by higher values in relation to our own study, taking into account that the measurement was made 28–30 h post mortem, which could have influenced the values presented. In the case of pH values, the results obtained by the authors of the present study were similar to those obtained in the cited paper, while it is not possible to state conclusively which values were better because the time of measurement was not clear.

CONCLUSIONS

Choosing the right rabbit housing system not only translates into the subsequent management of the herd, its productivity and the profitability of production, but can also affect the quality of the product obtained. The experiment carried out showed that the meat of rabbits kept in a pasture-based system was characterised by a statistically higher pH value measured 45 min after slaughter on the leg and loin muscles. In addition, the effect of the animal rearing system was found to affect the colour components of rabbit meat. It was also shown that the meat of animals from the research group was characterised by a statistically lower value of the springiness and chewiness parameter.

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JAKOŚĆ MIĘSA KRÓLIKÓW UTRZYMYWANYCH W RÓŻNYCH SYSTEMACH ODCHOWU

Streszczenie. Celem pracy było określenie wpływu systemu utrzymania i sposobu żywienia na jakość mięsa króliczego. Materiał badawczy stanowiły króliki rasy termondzkiej białej. Króliki odsadzono od matek w wieku 56 dni i losowo przydzielono do grupy kontrolnej (n = 23) i grupy badawczej (n = 24). Grupę kontrolną utrzymywano w bateriach, a grupę badawczą w przewoźnych klatkach na pastwisku. Zwierzęta były karmione *ad libitum* komercyjną paszą pełnoporcjową zawierającą 16,5% białka całkowitego, 14% włókna strawnego i 10,2 MJ energii metabolicznej. Grupa badawcza miała nieograniczony dostęp do paszy. Króliki poddano ubojowi w wieku 90 dni, zmierzono pH i barwę mięśni 45 min i 24 h po uboju oraz pobrano próbki mięśnia combra do dalszych analiz. Przeprowadzono pomiar siły cięcia oraz profilową analizę tekstury. Analizę statystyczną przeprowadzono za pomocą pakietu statystycznego SAS przy użyciu PROC GLM. Istotność różnic między średnimi zbadano za pomocą testu Tukeya–Kramera. Wartości pH mierzone 45 min po uboju były statystycznie wyższe w mięsie królików z grupy badawczej. Wartości L*45 mierzone na mięśniu combra wykazały wysoce istotne różnice między grupami (61,99 i 57,40). Po 24 h wartości parametru L* mierzone na mięśniu nogi wykazywały wysoce istotne różnice (56,17 i 52,50). Istotne różnice stwierdzono dla parametrów sprężystości i żujności. System utrzymania miał wpływ na jakość mięsa.

Słowa kluczowe: system utrzymania, królik, jakość mięsa, pH, barwa, analiza tekstury.