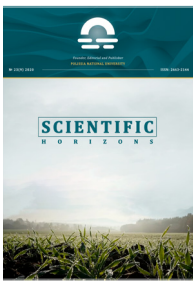
SCIENTIFIC HORIZONS

Journal homepage: https://sciencehorizon.com.ua

Scientific Horizons, 24(4), 33-39



UDC 636.92
DOI: 10.48077/scihor.24(4).2021.33-39

Comparative Analysis of Rabbit Meat Quality when Using Modular Raising Technologies and Eco-Farm

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Article's History:
Received: 25.07.2021
Revised: 29.08.2021
Accepted: 01.10.2021

Suggested Citation:
Kotsiubenko, H., Pirotskyi, A., Udod, A., Salamatina, O., & Trybrat, R. (2021). Comparative analysis of rabbit meat quality when using modular raising technologies and eco-farm. *Scientific Horizons*, 24(4), 33-39.

Abstract. The nutritional value and organoleptic evaluation of rabbit showed that the meat of rabbits raised on the eco-farm and in the modular rabbit house did not differ from each other and had the best nutritional and biochemical qualities, indicating the prospects of using modular farms to produce high quality products. A high percentage of fresh meat yield was found – 53.6 and 53.9% in rabbits raised in the module and on the eco-farm. Rabbit carcasses from the module had more fat by 1.1% and slightly enlarged kidneys due to the peculiarity of the equipment. Changes in the chemical composition – a slight increase in moisture and fat content (by 0.2%) in the meat, which was obtained by raising in the modular rabbit house compared to the meat of rabbits raised on the eco-farm – were founded. At the same time there was 0.3% less protein and 0.1% less sol. In general, the difference in chemical composition was insignificant, which indicated the identity of the analyzed samples. The organoleptic characteristics of rabbit meat in the carcass at slaughter and after heat treatment were studied. Muscle consistency was dense, elastic, when pressed the formed hole was quickly leveled; fat was dense. The aroma was specific for fresh meat. All samples taken from sampling of "Hy-plus" hybrid rabbits raised in the modular rabbit house and those raised on the eco-farm had the highest scores. The studied samples by organoleptic evaluation did not differ from each other and corresponded to high quality rabbit. Carcasses of hybrids in the experimental groups had a high content of saturated, monounsaturated and polyunsaturated fatty acids and the lowest content of cholesterol (0.04 g/100 g). The difference between the amino acid composition of meat and the lipid composition of fat in the study groups was insignificant

Keywords: rabbit, carcass, aroma, color, consistency, biochemical composition

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INTRODUCTION

Providing the population with high quality foodstuff at the present stage of society evolution is one of the most important tasks. The main role in solving this problem is played by the intensive development of animal husbandry, including rabbit breeding. Rabbit breeding is one of the most promising branches of animal husbandry, which allows to provide the population with high-quality raw meat in a short time. The high content of sustainable proteins and extracts, a small amount of fat and cholesterol favorably distinguishes rabbit from beef, pork and lamb. Rabbit protein is absorbed by the human body by 90%. Cholesterol in rabbit meat is 2.4-2.7 times less than in chicken and veal [1]. Therefore, rabbit meat is considered a high-value dietary product, its consumption helps to prevent cardiovascular and gastrointestinal diseases [2].

Rabbit meat is characterized by a delicate texture, finely-fibred structure with evenly spaced thin layers of adipose tissue, which gives the meat marbling. Fat is deposited mainly in the abdomen, near the kidneys, stomach, as well as on the neck between the shoulder blades. Fat is almost not deposited on the surface of the carcass. The carcass of a fattened rabbit (mainly in the abdomen) can contain up to 400-500 g of fat, rabbit belongs to the white meat, the color of which is pale pink [3].

The biological value of rabbit meat is determined by a high content of sustainable proteins (myosin, globulin) and a favorable ratio of amino acids. The largest amount of sustainable protein and reserve fat is found in the meat of 100-120-day-old rabbits [4]. With the increase in fat, the caloric content of rabbit meat increases. Rabbit carcasses contain sufficient and at the same time moderate amount of lipids. Meat does not lose moisture during cooking [5].

The meat productivity of rabbits is determined primarily by heredity, as well as a number of paratypic factors, which primarily include raising technology. Recently, there is a growing demand for dietary meat, which includes rabbit, so much attention should be paid not only to quantitative but also qualitative features [6]. The quality of meat is assessed by consumer on such indicators as color, water-absorbing capacity, succulence, texture and tenderness, taste and smell. Rabbit meat has a high nutritional value. The high content of digestible sustainable protein and essential amino acids distinguishes it from other types of meat. The meat productivity of rabbits is significantly affected by many factors – breed characteristics, direction of breeding, breeding method, housing conditions, intensity and duration of fattening, time and age of slaughter of rabbits [7; 8].

The development of meat productivity is different at different ages in different breeds of rabbits. Rabbits of specialized meat breeds have the highest meat productivity. In their researches, A.O. Pohorielova and G.A. Kotsiubenko [9], proved that rabbits change the amount of meat and internal fat with age. The ratio of the specific weight of physiological systems of the body is almost unchanged during the life of the animal. Regarding the study of the morphological composition of carcasses in animals of different sexes, the advantages of female rabbits over male rabbits should be noted. They probably outscore them in fresh meat yield and internal fat for all studied age periods up to 120 days of age. The ratio of physiological systems does not differ significantly.

Most often, the results of organoleptic evaluation become decisive and final in determining the nutritional value of livestock products, but important in this case biochemical studies are not conducted because they are considered expensive and long [10]. Rabbit muscle tissue proteins are complex. They are diverse in structure, physico-chemical properties and biological functions. The most biologically valuable are proteins of the myogen group A and B, which perform mainly enzymatic functions. With the age of rabbits, the level of oxyproline in the muscles increases (most intensely up to 120 days of age). There is also a tendency to decrease the content of arginyl, alanine, glycine, proline and increase histidine, phenylalanine, norleucine, tyrosine and aspartic acid [11; 12].

The biological value of rabbit meat is primarily due to its high protein content and has advantages over other animals [13]. The amino acid composition can vary significantly. The protein-quality index (the ratio of oxyproline and tryptophan amino acids) of 4-5-month-old rabbits reaches maximum values, and then gradually decreases [14]. High productivity in rabbit breeding can be provided by hybrid young animals, which have higher growth energy in the first months of life, which is used in broiler and intensive rabbit breeding [15]. The chemical composition and quality of rabbit meat depend on the breed, conditions and intensity of rabbit breeding [16]. At different ages, the ratio of internal, subcutaneous and intramuscular fat is different, adults have an excess of adrenal fat [17].

Many scientists are studying the quality of meat, since intensive selection for early maturity shows some deterioration. The quality of meat deteriorates even if the technological conditions are not observed [18]. The significant impact of raising technology on the quality of rabbit meat emphasized G.A. Kotsiubenko and O.I. Petrova [19], in their researches. Of the three technologies studied, eco-technology was recognized as the best for obtaining the highest quality rabbit. The worst indicators of rabbit quality were found in industrial technology (mechanized rabbit house).

Considering the application of these technologies from an economic point of view, industrial technology is more profitable than raising rabbits on eco-farms. Specialists of Mykolayiv national agrarian university developed technology of rabbit raising on modular farms which combined all the best elements of both technologies. Therefore, the main objective of the research was to compare the meat quality of "Hy-plus" hybrid rabbits raised in the module and on the eco-farm.

MATERIAL AND METHODS

The material of the research was carcasses of rabbits slaughtered at the age of 90 days (10 rabbits raised in the modular rabbit house (Fig. 1) developed by the specialists of Mykolayiv NAU and 10 ones raised on the eco-farm "Rabbitax-8" (Fig. 2).

***Figure 1**. Modular rabbit house*

***Figure 2**. Eco-farm "Rabbitax-8"*

Young animals were slaughtered mechanically (with a struck on the back of the head with a stick) after a mandatory 12-hour fasting. The following weights were taken into account (to within 0.01 g): live body weight before slaughter, weight of fresh carcass with and without offal, head, ears, paws, tail, heart, kidneys, lungs, liver, spleen, fat mass (intermuscular, intra-abdominal), the mass of the offal and the mass of the gastrointestinal tract with chyme. In all cases, the hind and forelegs were separated from the carcass (front by elbow, and hind by hocks). Weighing was performed on electronic scales (MK-15.2-AB20) with a measurement accuracy of ± 1 g.

The morphological composition of the carcasses was determined by separating the muscle tissue together with the connective tissue from the bone. When viscerating carcasses of rabbits raised by various technologies, identified the most valuable parts of them – meat, viscerating products and fat. The weight of the viscera was estimated by weighing on electronic scales (MK-15.2-AB20) with a measurement accuracy of ± 1 g. Post-slaughter inspection of carcasses was controlled in accordance with the requirements of the "Rules of Veterinary Inspection of Slaughter Animals and Veterinary and Sanitary Examination of Meat and Meat Products" [4].

The chemical composition of meat, such as moisture, fat, protein, sol, was determined. For laboratory analysis, the flesh obtained by separating the muscle tissue together with the connective tissue from the bone was mechanically grinded twice in a meat grinder, then thoroughly mixed and the average sample was taken for chemical analysis. The quality of meat was determined in the regional sanitary-veterinary laboratory for assessing the quality of feed and products of animal origin in Mykolayiv. The chemical composition (mass fraction of dry matter, fat was determined according to State Standard GOST 23042-86, mass fraction of protein was determined according to State Standard GOST 25011-85, water content was determined according to the Method of Crau R., Hamm F.) was indicated [7].

Qualitative and quantitative amino acid composition of the protein was determined by ion exchange chromatography on the automatic analyzer AAA-339. The calculation of the quantitative content of amino acids was performed on the calibration scale constructed using a mixture of standard solutions. Fatty acid composition in g per 100 g of protein in muscle tissue was determined on the automatic analyzer according to conventional methods.

Meat was evaluated on the basis of organoleptic characteristics: color, aroma, texture of rabbit meat. Whole rabbit carcasses were used for cooking without stripping from surface fat. When assessing the quality of cooked meat and broth, the carcasses were placed in a pan with cold water (ratio of water and meat was 1:3), covered, brought to a boil and cooked for 1.5 hours. After cooking, the meat was removed from the broth and cooled to 30-40°. The cooled meat was cut into pieces of 50 g for each taster. All the results of the evaluation were entered in special tasting forms, which were distributed to the members of the tasting commission before the tasting. The number of tasters for evaluation on a 9-point scale was ten people.

Amino acid and fatty acid composition was determined in g per 100 g of muscle protein (hip cut) in the laboratory of biochemical analysis of livestock products in Mykolayiv.

RESULTS AND DISCUSSION

The average percentage of the rabbits' carcass components are shown in Table 1.

***Table 1**. Yield of slaughter products of rabbits raised under different conditions, (n=10)*

Product name	Yield, % to the carcass weight of rabbits	
	Eco-farm	Modular rabbit house
Fresh meat including:	53.9	53.6
Internal fat	7.1	8.2
Kidneys	0.6	0.7
Head	7.0	6.9
Skin	13.5	13.4
Ears, paws, tail	4.8	4.5
Blood	2.0	2.0
Liver	3.5	3.4
Offal	1.2	1.2
Entrails	6.4	6.3
Illiquid waste	8.7	8.7

Based on the data in Table 1, it should be noted that there is the high yield of fresh meat – 53.6 and 53.9%. Although this figure is 0.3% higher in the carcasses of the rabbits raised in the module, the difference is insignificant. There was also no significant difference in the amount of illiquid waste and offal of rabbits raised in different conditions.

The carcasses of rabbits from the module had 1.1% more fat and slightly enlarged kidneys. This can be explained by the peculiarities of the equipment. The size of the cages in the standard module is 80×40 cm to keep 6 rabbits, and the size of the eco-farm is 100×50 cm for 6 rabbits. The animals in the module move less due to the small space and accumulate fat. Therefore, this fact must be taken into account when improving the modular farm. Namely, increase the size of the cages. The chemical composition of meat determines its nutritional value. High quality rabbit depends on the optimal balance of protein, fat, sol elements, moisture and other substances.

We studied the chemical composition of meat of the rabbits raised under different conditions. Research data are shown in Table 2.

***Table 2**. Chemical composition of rabbit, (%)*

Indexes	Eco-farm	Modular rabbit house
Moisture	73.0	73.2
Fat	3.0	3.2
Protein	22.7	22.4
Sol	1.3	1.2

The analysis of the obtained results shows changes in the chemical composition – a slight increase in moisture and fat content (by 0.2%) in the rabbit meat, which was obtained by raising rabbits in the modular rabbit house compared to the rabbit meat obtained by raising rabbits on the eco-farm. At the same time there was 0.3% less protein and 0.1% less sol. In general, the difference in chemical composition was insignificant, which indicates the identity of the analyzed samples.

It was found that on the surface of rabbits' carcasses in all experimental groups after maturation a drying crust of pale pink color was formed in time, the serous membrane of the thoracic and abdominal cavities remained moist and shiny for some time. Subcutaneous and internal adipose tissues were white. The serous membranes of the thoracic and abdominal cavities were moist and shiny. The muscles in the cross-section of the rabbits' carcasses were slightly moist (leaved no wet spots on the filtered paper), pale pink with a red tinge. Their consistency was dense, elastic, when pressed the formed hole was quickly leveled; fat was dense. The aroma was specific for fresh meat. Therefore, the studied samples by organoleptic evaluation did not differ from each other and corresponded to high quality rabbit meat. More complete information about the organoleptic qualities of rabbit meat was obtained after cooking. The results of the tasting evaluation of meat and broth are shown in Table 3.

***Table 3**. Tasting evaluation of meat and broth*

Indexes	Rising technology	
	Eco-farm	Modular rabbit house
	M±m	M±m
	Rabbit meat	
Appearance	8.7±0.22	8.6±0.31
Aroma	8.3±0.18	8.5±0.21
Taste	9.0±0.19	9.0±0.23
Consistency	7.9±0.28	7.8±0.11
Succulence	7.8±0.15	7.7±0.24
General assesment	8.3±0.19	8.3±0.26
	Broth	
Appearance	8.5±0.24	8.5±0.34
Aroma	8.0±0.28	8.1±0.26
Taste	8.4±0.22	8.3±0.25
Richness	8.9±0.21	8.9±0.21
General assesment	8.5±0.24	8.5±0.29

The general tasting evaluation of meat and broth from hybrid rabbit carcasses raised on the eco-farm and in the modular rabbit house showed fairly high scores (meat – 8.3 points, broth –8.5 points on a 9-point scale). The top rating for meat was taste – 9.0 points, and for broth it was richness (8.9 points) according to the technology. The lowest score of meat was given to succulence – 7.8, 7.7 points respectively.

When evaluating the broth, the lowest score was given to aroma – 8.0, 8.1 points. It was noted that the appearance of rabbit resembles chicken meat. The consistency of all samples' meat was characterized as tender. The tasting evaluation of rabbit meat raised indoors (in the modules) was probably no different from the evaluation of hybrids' meat raised on the eco-farm. The broth during cooking was clear, flavorful, with nice smell. The quality of the broth was very good on all indicators and was rated quite high.

The biological value of rabbit meat proteins was assessed by the amino acid composition in which the presence of all essential amino acids was established. Research data are shown in Table 4.

***Table 4**. The content of essential amino acids in muscle tissue (g per 100 g of protein)*

Amino acids	Research groups	
	Eco-farm	Modular rabbit house
Valine	1.098	1.088
Isoleucine	0.982	0.989
Leucine	1.678	1.652
Lysine	1.789	1.698
Methionine + cystine	0.745	0.699
Threonine	1.099	1.089
Tryptophan	0.427	0.415
Phenylalanine	0.995	0.988

The data in Table 4 indicate the high quality of carcasses of rabbits raised under both housing conditions. Thus, the high content of lysine (1.789, 1.698), valine (1.098, 1.088), threonine (1.099, 1.089), phenylalanine (0.995, 0.988) and isoleucine (0.982, 0.989) indicates the protein value of meat of rabbits raised by means of the studied technologies without the use of growth stimulants during fattening. The difference in amino acid composition between the experimental groups was insignificant.

Obtaining information about the chemical, amino acid, lipid composition of rabbit meat allows us to substantiate feasibility of the most complete use of meat products of high biological value. The lipid composition of rabbit meat is characterized by a high content of polyunsaturated fatty acids: linoleic, linolenic, arachidonic. It should be noted that the cholesterol content in rabbit meat is much lower than in other species of farm animals.

Data on the lipid composition of carcasses of rabbits raised under different conditions are shown in Table 5.

Table 5. *Fatty-acid composition of meat of the rabbits raised by different technologies*

Indexes	Content, g per 100 g of product	
	Eco-farm	Module
Cholesterol	0.04	0.04
Fatty acids	2.78	2.71
Saturated, including:	1.33	1.28
Myristic	0.09	0.08
Pentodecanoic	0.04	0.03
Palmitic	0.71	0.69
Margaric	0.03	0.03
Stearic	0.46	0.45
Monounsaturated, including:	1.19	1.18
Myristoleic	0.17	0.16
Palmitoleic	0.11	0.13
Oleic	0.91	0.89
Polyunsaturated, including:	0.26	0.25
Linoleic	0.09	0.09
Linolenic	0.09	0.08
Arachidonic	0.08	0.08

Saturated fatty acids are in the lead. In percentage terms, their composition is almost 45-48%. Polyunsaturated acids occupy 8-9% of the total. Thus, the carcasses of hybrids from the experimental groups have a high content of saturated, monounsaturated and polyunsaturated fatty acids and the lowest content of cholesterol (0.04g/100g).

CONCLUSIONS

Thus, the nutritional value and organoleptic evaluation of rabbit showed that the meat of rabbits raised on the eco-farm does not differ from the meat of rabbits raised in the modular rabbit house and has the best nutritional and biochemical qualities, indicating the prospects of using modular farms to produce high quality products. The rabbits raised in the module and on the eco-farm showed an almost equal percentage of fresh meat yield – 53.6 and 53.9%. Rabbit carcasses from the module had 1.1% more fat and slightly enlarged kidneys due to the particular equipment. The difference in chemical composition was insignificant, which indicated the identity of the analyzed samples. The carcasses of the hybrids of the experimental groups had a high content of saturated, monounsaturated and polyunsaturated fatty acids and the lowest cholesterol content (0.04g/100g). The difference between the amino acid composition of meat and the lipid composition of fat in the study groups was insignificant.

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Порівняльний аналіз якості м'яса кролика при використанні технологій модульного вирощування та екоферми

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Анотація. Харчова цінність та органолептична оцінка кроликів показали, що м'ясо кроликів, вирощене на екофермі та в модульному кролятнику, не відрізняється одне від одного і має найкращі харчові та біохімічні якості, що вказує на перспективи використання модульних ферм для виробництва продукції високої якості. Виявлено високий відсоток виходу свіжого м'яса – 53,6 та 53,9 % у кроликів, вирощених у модулі та на екоферме. Тушки кроликів з модуля мали більше жиру на 1,1 % і дещо збільшені нирки через особливості обладнання. Спостерігаються зміни хімічного складу – незначне збільшення вологості та вмісту жиру (на 0,2 %) у м'ясі, що було отримано шляхом вирощування в модульному кролятнику порівняно з м'ясом кроликів, вирощеним на екоферме. Водночас було на 0,3 % менше білка і на 0,1 % менше золю. Загалом, різниця в хімічному складі була незначною, що вказувало на ідентичність аналізованих зразків. Досліджено органолептичні характеристики м'яса кролика в туші під час забою та після термічної обробки. М'язова консистенція була щільною, еластичною, під час натискання утворений отвір швидко вирівнювався; жир був щільним. Аромат був специфічним для свіжого м'яса. Усі зразки, взяті з вибірки гібридних кроликів «Ну-plus», вирощених у модульному кролячому будиночку, та тих, які вирощені на екоферме, мали найвищі бали. Досліджені зразки за органолептичною оцінкою не відрізнялися один від одного і відповідали кролику високої якості. Тушки гібридів в експериментальних групах мали високий вміст насичених, мононенасичених та поліненасичених жирних кислот і найнижчий вміст холестерину (0,04 г/100 г). Різниця між амінокислотним складом м'яса та ліпідним складом жиру в досліджуваних групах була незначною

Ключові слова: кролик, тушка, аромат, колір, консистенція, біохімічний склад