**BULLETIN** OF NATIONAL ACADEMY OF SCIENCES
OF THE REPUBLIC OF KAZAKHSTAN
ISSN 1991-3494
Volume 4, Number 386 (2020), 62 – 69 **https://doi.org/10.32014/2020.2518-1467.105**

UDC 664.94, 636.5/.6

**N. N. Kuzmina[1], O. Yu. Petrov[1], V. G. Semenov[2], D. A. Baimukanov[3], A. I. Lyubimov[4], Kh. A. Aubakirov[5]**

[1]Mari State University, Yoshkar-Ola, Mari El Republic, Russia;
[2]Chuvash State Agricultural Academy, Cheboksary, Chuvash Republic, Russia;
[3]Non-Commercial Joint-Stock Company «Kazakh National Agrarian University», Almaty, Kazakhstan;
[4]Izhevsk State Agricultural Academy, Izhevsk, Udmurt Republic, Russia;
[5]M. H. Dulati Taraz State University, Taraz, Kazakhstan.
E-mail: kuzmina221995@mail.ru,tmspetrov@yandex.ru, semenov_v.g@list.ru, dbaimukanov@mail.ru, rector@izhgsha.ru, hamit_a57@mail.ru

# STUDY OF THE EFFICIENCY OF NATURAL ANTIOXIDANTS IN STORING POULTRY RAW MATERIAL PROCESSING

**Abstract.** The efficiency of using dihydroquercetin as an antioxidant, which increases the duration of storage of poultry processing raw materials, is investigated.

A comparative assessment of the effectiveness of the natural antioxidants of vitamins E, C, rutin, and dihydroquercetin was carried out for the duration of storage of minced meat from the fillet, meat of deboned meat and skin from broiler carcasses. The introduction of antioxidants in the experimental samples of raw materials ensured, during 28 days of storage, a lower value of the indicators of oxidative spoilage: the acid number by an average of 74%, and the peroxide number by 1.5-1.7 times, relative to these indicators in the control sample antioxidants.

The use of dihydroquercetin in experimental samples of frozen mechanically deboned meat for long-term storage, in the studied concentrations, ensured after 1 month of storage a lower value of the oxidative spoilage indicators: the acid number was 2–10% lower, and the peroxide number was 1.5 and 1.7 times lower, relative to these indicators in the control sample.

The results confirm the high efficiency of the use of dihydroquercetin as an active antioxidant, which makes it possible to use it along with existing analogues.

**Key words:** poultry processing, skin from broiler chicken carcasses, mechanically deboned meat, filet of chilled broiler chicken carcasses, natural antioxidants, vitamins E, C, rutin, dihydroquercetin, oxidation products, storage life.

**Introduction.** Currently, in the meat industry, the creation and production with a functional orientation with a prolonged shelf life are actual. The consumption of such products allows us to stabilize the metabolism in the body and to improve human health. This is an important aspect for the consumer, and the manufacturer, at the same time, gets the opportunity to produce products of guaranteed quality, taking into account unforeseen situations associated with the deviation of temperature conditions of storage, transportation, and sale [1]. But one of the problems in the production of food, in particular, meat, is the extension of the shelf life while maintaining their quality.

The processes of fat oxidation have a negative effect not only on food, but also on the human body, the most dangerous being the appearance and accumulation of free radicals that contribute to the emergence of a number of specific diseases [2]. The ability of dihydroquercetin to bind and intercept such radicals prevents the development of these diseases.

Most modern synthetic antioxidants and their effects on the human body are not well studied, which leads to ambiguous consequences, and their use is inappropriate since the body has its own antioxidant system. In the body, this function is performed by enzymes (catalase, superoxide dismutase, peroxidase, glutathione peroxidase, ubiquinone), albumin and a number of other proteins, including sulfur-containing and selenium-containing, high-density lipoproteins, steroid hormones, bilirubin, uric acid. These substances are helped by exogenous antioxidants - vitamins that enter the body with food. Therefore, one

of the modern trends in meat production for healthy nutrition is the orientation to the use of natural food additives, which can have a pronounced positive effect on the human body. In this regard, safe natural antioxidants deserve much attention, which not only significantly inhibit the oxidation in meat products during storage, but also serve as the active principle of therapeutic and prophylactic products, which makes their use relevant in formulations of a wide range of products.

Dihydroquercetin is one of the most active antioxidants of natural origin used in food production; recognized dihydroquercetin is a natural compound isolated from Siberian larch wood [3]. Russia, in turn, is the only country in the world that has its unique natural resources in volumes suitable for industrial and cost-effective production.

Dihydroquercetin has the highest activity. Antioxidant activity is an indicator that reflects the ability to inactivate free oxygen radicals. The antioxidant activity of dihydroquercetin manifests itself at its concentrations of 10-4 - 10-5. This is the lowest concentration of a substance with antioxidant properties relative to all known exogenous antioxidants, including vitamins A, B, C, D, E, K, β-carotene [4,5].

Adding of dihydroquercetin provides food with additional competitive advantages [4,6].

In addition, the use of natural antioxidants in the production of meat products is due to certain difficulties at the stages of the technological process. Natural antioxidant vitamins easily lose their activity and their structure is destroyed under the influence of various factors: contact with a metal surface, exposure to open sunlight and oxygen, high-temperature treatment (except vitamins A, E, K, and carotenoids) [4,5].

Research conducted at the Sechenov Moscow Medical Academy confirmed that dihydroquercetin is non-toxic, physiologically harmless to human health, does not impart any taste or smell to extraneous products, does not change their color when used. The additive is resistant to temperature (from minus 50 to plus 180 °C), mechanical stresses, and processes occurring in the manufacture of products, that is, it meets all the requirements for whole food additives and, in particular, antioxidants. This compound is included in the list of food additives that do not have a harmful effect on human health when used for cooking food (SanPiN 2.3.2.1078-01 "Hygienic requirements for food safety and nutritional value") [7].

Conducted by relevant Russian institutes (All-Russian Scientific Research Institute of the Dairy Industry, Scientific Research Institute of Storage Problems of the Federal Agency for State Reserves, Kemerovo Technological Institute of Food Industry, All-Russian Research Institute of Meat Industry named after V.M. Gorbatov, All-Russian Scientific Research Institute of Butter making and Cheesemaking, etc.), the studies allowed to develop new technologies and products using dihydroquercetin as a natural antioxidant. Its recommended volume, depending on the fatty acid composition, is 0.005-0.03% by weight of the canned product.

**Methods of research.** In the first series of studies, during 28 days of storage in a cooled state, in laboratory conditions, comparative studies of the most common natural antioxidants were conducted according to their ability to inhibit the formation of lipid fraction oxidation products in experimental samples of raw materials used in the production of poultry meat products. Antioxidants were added to the experimental finely divided, homogenized samples of raw materials, in accordance with the recommended dosage indicated in table 1.

Table 1 – Dosage options for natural antioxidants in experimental samples of poultry processing raw materials

| Antioxidant | Rate of hydration | Raw material | | |
|---|---|---|---|---|
| | | fillet | Mechanically deboned meat | Skin |
| Rutin, mg/kg | 1:3 | 0.59 | 0.57 | 0.56 |
| Vitamin C, mg/kg | 1:2 | 0.57 | 0.56 | 0.53 |
| Vitamin E, mg/kg | – | 0.57 | 0.56 | 0.52 |
| Dihydroquercetin, mg/kg | 1:3 | 0.62 | 0.58 | 0.57 |

After 7, 14, 21, and 28 days of storage at a temperature of 3±1 °C, there was a determination in a 3-fold repetition of the content of oxidation products in the control and experimental samples according to acid and peroxide numbers, by common methods.

The use of these antioxidants is regulated by the Methodological Recommendations of the State Sanitary and Epidemiological Regulation of the Russian Federation No. 2.3.1.1915-04 of 2004 "Recommended levels of consumption of food and biologically active substances", establishing adequate and upper acceptable levels of dihydroquercetin (DHQ) consumption in the amount of 25 and 100 mg per

day, vitamin C - 70 and 700 mg per day, vitamin E - 15 and 100 mg per day, rutin - 30 (transferred to rutin) and 100 mg (transferred to rutin), in the food industry [7,8].

Antioxidant preparations, with the exception of vitamin E, were hydrated before being added to the samples for more uniform distribution in the raw material. In the process of storing control and experimental samples in a cooled state, the intensity of accumulation of oxidation products in them was studied weekly according to acid and peroxide numbers by common methods. The results are processed by methods of mathematical statistics.

The second series of studies was to confirm the effectiveness of the antioxidant action of dihydroquercetin during the long-term storage of the mechanically deboned meat in a frozen state. Mechanical boned broiler meat contains skin that, due to its fat content, is significantly susceptible to oxidative spoilage; therefore, it is important to reduce the degree of its influence on the formation of oxidation products in raw materials [2].

The preparation was added to the experimental samples of mechanically deboned meat at a dose of 0.50; 0.75; and 1.00 kg per 100 kg of raw material, in hydrated form. During 6 months of storage at a temperature of –18±1 °C, a monthly determination of the content of oxidation products — acid and peroxide numbers was also carried out in 3-fold repetition in the control and experimental samples.

In accordance with the aim and objectives of the study, the objects of the research were:

- as antioxidants - “Dihydroquercetin” (DHQ), “Ascorbic acid”, “Tocopherol” and “Rutin” [7,8,9,10];
- fillet of chilled carcasses of broiler chickens with pH24 6.2 – 6.5, according to GOST R 52702-2006 [13];
- mechanically deboned meat of broiler chickens according to GOST 31490-2012 [14];
- skin from carcasses of broiler chickens.

**Research results.** The issue of storage meat products is especially relevant in poultry farming [11] and in beef breeding [12] in view of the wide range of products for the mass consumer.

The comparative analysis and comprehensive assessment of the content of oxidation products in the samples fairly testify to the effect of antioxidants on the reduction of oxidative spoilage of raw materials, but with different efficiencies (table 2).

Table 2 – Change in the acid number of samples, mg KOH/g

| Raw material | Control | Vitamin E | Vitamin C | Rutin | DHQ |
|---|---|---|---|---|---|
| *At the beginning of the experiment:* | | | | | |
| Skin | 0.196±0.020 | | | | |
| MDM | 0.178±0.030 | | | | |
| Fillet | 0.112±0.040 | | | | |
| *After 7 days of storage:* | | | | | |
| Skin | 0.936±0.03 | 0.248±0.01 | 0.233±0.01 | 0.218±0.01 | 0.210±0.01 |
| MDM | 0.798±0.24 | 0.247±0.02 | 0.223±0.02 | 0.195±0.01 | 0.180±0.01 |
| Fillet | 0.668±0.57 | 0.134±0.04 | 0.122±0.03 | 0.116±0.04 | 0.112±0.04 |
| *After 14 days of storage:* | | | | | |
| Skin | 1.028±0.03 | 0.820±0.01 | 0.743±0.03 | 0.603±0.01 | 0.530±0.01 |
| MDM | 0.839±0.10 | 0.572±0.44 | 0.443±0.02 | 0.395±0.01 | 0.348±0.07 |
| Fillet | 0.719±0.01 | 0.554±0.01 | 0.422±0.03 | 0.321±0.03 | 0.262±0.03 |
| *After 21 days of storage:* | | | | | |
| Skin | 2.153±0.04 | 1.895±0.02 | 1.782±0.01 | 1.691±0.06 | 1.619±0.08 |
| MDM | 1.985±0.10 | 1.836±0.15 | 1.652±0.03 | 1.616±0.03 | 1.524±0.03 |
| Fillet | 1.974±0.09 | 1.793±0.04 | 1.593±0.07 | 1.543±0.07 | 1.438±0.02 |
| *After 28 days of storage:* | | | | | |
| Skin | 2.542±0.02 | 2.389±0.01 | 2.125±0.07 | 1.925±0.04 | 1.705±0.04 |
| MDM | 2.306±0.06 | 2.194±0.05 | 1.897±0.03 | 1.803±0.04 | 1.694±0.03 |
| Fillet | 2.200±0.08 | 2.122±0.02 | 1.822±0.04 | 1.794±0.06 | 1.525±0.03 |

When studying the antioxidant activity of preparations, in parallel with the acid number, the peroxide number was determined - an indicator that characterizes the amount of primary lipid oxidation products (hydroperoxides and peroxides) in experimental samples of raw materials (table 3).

Table 3 – Change in the peroxide number of samples, mmol (SO2)/kg

| Raw material | Control | Vitamin E | Vitamin C | Rutin | DHQ |
|---|---|---|---|---|---|
| *At the beginning of the experiment:* | | | | | |
| Skin | 0.008±0.0008 | | | | |
| MDM | 0.007±0.0012 | | | | |
| Fillet | 0.004±0.0004 | | | | |
| *After 7 days of storage:* | | | | | |
| Skin | 2.346±0.20 | 0.131±0.02 | 0.098±0.01 | 0.063±0.01 | 0.033±0.01 |
| MDM | 2.138±0.22 | 0.118±0.02 | 0.086±0.01 | 0.043±0.01 | 0.025±0.01 |
| Fillet | 1.154±0.09 | 0.078±0.01 | 0.033±0.01 | 0.025±0.01 | 0.013±0.01 |
| *After 14 days of storage:* | | | | | |
| Skin | 3.459±0.09 | 2.911±0.12 | 1.443±0.06 | 0.903±0.08 | 0.473±0.08 |
| MDM | 3.038±0.72 | 2.708±0.59 | 1.141±0.34 | 0.808±0.08 | 0.360±0.19 |
| Fillet | 2.765±0.06 | 2.078±0.01 | 1.033±0.01 | 0.715±0.01 | 0.313±0.14 |
| *After 21 days of storage:* | | | | | |
| Skin | 4.422±0.08 | 4.192±0.10 | 3.948±0.07 | 3.822±0.05 | 3.719±0.04 |
| MDM | 4.387±0.09 | 4.106±0.52 | 3.903±0.03 | 3.721±0.06 | 3.659±0.15 |
| Fillet | 4.072±0.09 | 3.922±0.01 | 3.872±0.08 | 3.715±0.02 | 3.595±0.09 |
| *After 28 days of storage:* | | | | | |
| Skin | 5.620±0.03 | 4.368±0.09 | 4.232±0.03 | 4.152±0.09 | 3.870±0.02 |
| MDM | 5.494±0.09 | 4.284±0.06 | 4.162±0.03 | 4.091±0.03 | 3.829±0.05 |
| Fillet | 5.452±0.04 | 4.219±0.05 | 4.105±0.08 | 3.986±0.06 | 3.729±0.07 |

In the control skin sample from broiler carcasses, after 7 days of storage of raw materials, the peroxide value reached 2.3459 mmol (SO2)/kg, which characterizes the sample by this indicator as fresh, but not subject to storage. The introduction of antioxidants into experimental samples of raw materials inhibits the formation of lipid oxidation products, therefore, the peroxide number in them was significantly less.

So, with the addition of vitamin E, the peroxide value in the experimental samples was 1.3 times lower than in the control ones. With the introduction of vitamin C, rutin and dihydroquercetin as antioxidants, this indicator in the samples of raw materials was even lower - respectively 1.6; 1.7 and 1.9 times.

The introduction of antioxidants into experimental samples of raw materials in the studied concentrations ensured within 28 days of storage, a lower value of the indicators of oxidative spoilage: the acid number by an average of 74%, and the peroxide number by 1.5-1.7 times, relative to these indicators in the control sample.

To confirm the effectiveness of the antioxidant action of dihydroquercetin during long-term storage of mechanically deboned meat, the second series of studies was held.

The comparative analysis and comprehensive assessment of the accumulation of oxidation products in the control and experimental samples during long-term storage indicates a significant inhibitory effect of dihydroquercetin on the rate of formation of substances that cause oxidative spoilage of mechanically deboned meat of broiler chickens.

The acid number indicates the formation of free fatty acids in raw materials resulting from hydrolytic spoilage of fat. In the studied meat samples, after 1 month of storage, this indicator had the highest value in the control sample that did not contain an antioxidant preparation (0.3873 mg KOH/g). After 6 months of storage, the acid number increased and reached 0.3896 mg KOH/g, which exceeded this indicator in

experimental samples of raw materials at dihydroquercetin levels, respectively: 0.50 kg/100 kg - by 0.0071 mg KOH/g; 0.75 kg/100 kg - per 0.0253 mg KOH/g and at preparation concentration of 1.0 kg/100 kg - 0.0368 mg KOH/g (table 4).

Table 4 – Change in the acid number of mechanically deboned meat during storage (mg KOH/g)

| Shelf life | Control | Dihydroquercetin concentration, kg/100 kg | | |
|---|---|---|---|---|
| | | 0.50 | 0.75 | 1.00 |
| 1 month | 0.3873±0.0199 | 0.3799±0.0122 | 0.3624±0.0129 | 0.3470±0.0093 |
| 2 month | 0.3876±0.0201 | 0.3800±0.0120 | 0.3626±0.0193 | 0.3473±0.0094 |
| 3 month | 0.3878±0.0157 | 0.3803±0.0207 | 0.3629±0.0162 | 0.3476±0.0017 |
| 4 month | 0.3881±0.0230 | 0.3807±0.0143 | 0.3633±0.0134 | 0.3482±0.0192 |
| 5 month | 0.3889±0.0210 | 0.3812±0.0621 | 0.3638±0.0267 | 0.3495±0.0815 |
| 6 month | 0.3896±0.0308 | 0.3825±0.0932 | 0.3643±0.0384 | 0.3528±0.0631 |

While testing, it was established that the antioxidant activity of dihydroquercetin is also effective in the formation of primary lipid oxidation products characterized by the peroxide number (table 5).

Table 5 – Change in the peroxide number of mechanically deboned meat during storage (ммоль($^1/_2O_2$)/кг)

| Shelf life | Control | Dihydroquercetin concentration, kg/100 kg | | |
|---|---|---|---|---|
| | | 0.50 | 0.75 | 1.00 |
| 1 month | 0.0083±0.0008 | 0.0066±0.0018 | 0.0058±0.0092 | 0.0049±0.0012 |
| 2 month | 0.0084±0.0027 | 0.0068±0.0046 | 0.0060±0.0005 | 0.0052±0.0032 |
| 3 month | 0.0086±0.0078 | 0.0069±0.0026 | 0.0061±0.0015 | 0.0055±0.0063 |
| 4 month | 0.0089±0.0088 | 0.0071±0.0226 | 0.0063±0.0505 | 0.0057±0.0612 |
| 5 month | 0.0092±0.0042 | 0.0074±0.0066 | 0.0065±0.0071 | 0.0060±0.0045 |
| 6 month | 0.0095±0.0065 | 0.0077±0.0417 | 0.0068±0.0731 | 0.0063±0.0921 |

The introduction of the dihydroquercetin antioxidant in the composition of the experimental samples in the studied concentrations ensured, after 1 and 6 months of storage, a lower value of the indicators of oxidative spoilage: the acid number by 10%, and the peroxide number by 1.5-1.7 times, relative to these indicators in the control sample.

**Н. Н. Кузьмина[1], О. Ю. Петров[1], В. Ғ. Семенов[2], Д. А. Баймұқанов[3], А. И. Любимов[4], Х. А. Аубакиров[5]**

[1]Марийск мемлекеттік университеті, Йошкар-Ола, Марий Эл Республикасы, Ресей;
[2] Чуваш мемлекеттік ауылшаруашылық академиясы, Чебоксары, Чуваш Республикасы, Ресей;
[3]«Қазақ ұлттық аграрлық университеті» коммерциялық емес акционерлік қоғамы, Алматы, Қазақстан;
[4]Ижевск мемлекеттік ауылшаруашылық академиясы, Ижевск, Удмурт Республикасы, Ресей;
[5]М. Х. Дулати атындағы Тараз мемлекеттік университеті, Тараз, Қазақстан

## ҚҰС ӨҢДЕУ ШИКІЗАТЫН САҚТАУДА ТАБИҒИ АНТИОКСИДАНТТАРДЫҢ ТИІМДІЛІГІН ЗЕРТТЕУ

**Аннотация.** Өңделген құс шикізатының сақтау мерзімін ұлғайту үшін антиоксидант ретінде дигидрокверцетинды қолданудың тиімділігі зерттелген. Табиги антиоксидентті дәрумендер Е, С, рутин және дигидрокверцетиннің шайналған ет, механикалық өңделген ет және терісімен бірге балапан – бройлер ұшасының сақталуына ұтымды әсер етудің салыстырмалы бағалауы жасалды. Тәжірибиелі үлгілерге антиоксидантарды енгізу шикізатқа 28 тәулік бойы тотығу көрсеткішінің аз мәнін, қышқылдану 74%, ал ашу санын 1,5-1,7 есе төмендетті.

Алынган нәтижелер дигидрокверцетинді аналогтарымен қатар, қолданудың жогары тиімді екендігіне көз жеткізді.

Үлгілердегі тотығу өнімдері мөлшерінің салыстырмалы талдауы және комплексті бағалауы үлгілерде антиоксидат әсерінен шикізаттың тотыға бұзылуына әсер ететіндігін көрсетеді, алайда түрлі тиімділікпен жүзеге асырылады.

Антиоксидантарды бақылау үлгідегі шикізатқа қосу оның айтарлықтай тотыға бүліну үдерісін тоқтатады. Е дәруменін ендіргенде 28 тәулік сақтау барысында қышқылдану саны 0,84 мг КОН/г орташа төмен болады, С дәруменін, рутин және дигидрокверцетинді сәйкесінше бақылау үлгімен салыстырганда 1,27; 3,52 және 3,61 мг КОН/г көрсетеді.

Тәжірибиелі үлгілердің құрамына дигидрокверцетин қосқанда оның тотыға бүліну үдерісін тоқтатады. Антиоксидантты негізгі шикізатқа 0,5 кг/100 кг деңгейінде қосу, бір ай сақтаудан кейін бақылаумен салыстырганда, қышқылдану 2%, сәйкесінше 0,75 және 1,0 кг – 6 және 10 %, төмендейді. Тәжірбие барысында және 6 ай сақтаудан кейін үлгілерде бақылаумен салыстырганда сәйкесінше 2, 6 и 9 % төмен көрсетті.

Бақылау және тәжірбие үлгілеріндегі тотығу өнімдерінің жинақталуын салыстырмалы талдау және комплексті бағалау дигидрокверцетинттің механикалық өңделген балапан – бройлерлерді ұзақ сақтау барысында тотыға бүлінуді түзетін заттардың тежелуіне айтарлықтай әсер етеді.

Алынган мәліметтер дигидрокверцетин, басқа табиги антиоксидантармен салыстырганда, өңделген құс шикізатында тотығу өнімдерінің түзілуін тиімді тежейді. Атап айтқанда, ірі қара ет өндірісінде келесідей жұмыстарды жүзеге асыруга мүмкіндік береді: сақтау мерзімі ұзақ өнімдерді өндіру; агзадағы бос – радикалды үдерістерді тежейтін антиоксиданттармен қамтамасыз ету; функционалды багыттагы азық өнімдерінің ассортиментін кеңейту.

Өңделген құс өиімдерінің сақтау мерзімін ұзартуда дигидрокверцетиннің антиоксиданттық белсенділігі жогары екендігі анықталды, тотығу өнімдерінің жинақталуын тежейді.

**Түйін сөздер:** құс өңдеу, балапан-бройлер ұшаларының терісі, механикалық етті сүйектен айыру, балапан-бройлердің салқындатылган сүбесі, табиги антиоксидант, Е, С дәрумеиі, рутин, дигидрокверцетин, тотығу өнімдері, сақтау ұзақтыгы.

**Н. Н. Кузьмина[1], О. Ю. Петров[1], В. Г. Семенов[2],**
**Д. А. Баймуканов[3], А. И. Любимов[4], Х. А. Аубакиров[5]**

[1]Марийский государственный университет, Йошкар-Ола, Республика Марий Эл, Россия;
[2]Чувашская государственная сельскохозяйственная академия,
Чебоксары, Чувашская Республика, Россия;
[3]Некоммерческое акционерное общество
«Казахский национальный аграрный университет», Алматы, Казахстан;
[4]Ижевская государственная сельскохозяйственная академия,
Ижевск, Удмуртская республика, Россия;
[5]Таразский Государственный университет им. М.Х. Дулати, Тараз, Казахстан

## ИССЛЕДОВАНИЕ ЭФФЕКТИВНОСТИ ПРИРОДНЫХ АНТИОКСИДАНТОВ ПРИ ХРАНЕНИИ СЫРЬЯ ПТИЦЕПЕРЕРАБОТКИ

**Аннотация.** Исследованы эффективность использования дигидрокверцетина в качестве антиоксиданта, способствующего увеличению продолжительности хранения сырья птицепереработки.

Проведена сравнительная оценка эффективности действия природных антиоксидантов витаминов Е, С, рутина и дигидрокверцетинана продолжительность хранения образцов фаршей из филе, мяса механической обвалки и кожи с тушек цыплят-бройлеров. Введение антиоксидантов в опытные образцы сырья обеспечило в течение 28 дней хранения меньшее значение показателей окислительной порчи: кислотного числа в среднем на 74 %, а перекисного числа – в 1,5–1,7 раза, относительно этих показателей в контрольном образце без добавления антиоксидантов.

Применение дигидрокверцетина в опытных образцах замороженного мяса механической обвалки для длительного хранения в исследуемых концентрациях обеспечило уже через 1 месяц хранения меньшее значение показателей окислительной порчи: кислотного числа на 2–10 %, а перекисного числа – в 1,5 и 1,7 раза, относительно этих показателей в контрольном образце.

Полученные результаты убеждают в высокой эффективности применения дигидрокверцетина в качестве активного антиоксиданта, что обеспечивает возможность его использования наряду с имеющимися аналогами.

Сравнительный анализ и комплексная оценка содержания продуктов окисления в образцах объективно свидетельствуют о влиянии антиоксидантов на снижение окислительной порчи сырья, но с разной эффективностью.

Добавление антиоксидантов в контрольные образцы сырья способствовало существенному торможению его окислительной порчи. При введении витамина Е, кислотное число за 28 дней хранения оказалось ниже в среднем на 0,84 мг КОН/г, при добавлении витамина С, рутина и дигидрокверцетина, соответственно, на 1,27; 3,52 и 3,61 мг КОН/г - по сравнению с контрольным образцом.

Добавление дигидрокверцетина в состав опытных образцов способствовало торможению его окислительной порчи. При введении антиоксиданта на уровне 0,5 кг/100 кг основного сырья после 1 месяца хранения кислотное число оказалось меньше, чем в контрольном образце на 2 %, при добавлении 0,75 и 1,0 кг – на 6 и 10 %, соответственно. Подобная закономерность прослеживалась в течение всего периода эксперимента и после 6 месяцев хранения, значения этого показателя в опытных образцах оказались меньше контроля на 2, 6 и 9 %, соответственно.

Полученные результаты свидетельствуют, что дигидрокверцетин, по сравнению с другими природными антиоксидантами, наиболее эффективно ингибирует образование продуктов окисления в сырье птицепереработки, что обусловливает возможность его применения при производстве мясных продуктов, в частности в мясном скотоводстве, и создает условия для: производства продуктов с пролонгированным сроком годности; обеспечения организма антиоксидантами, предотвращая свободно-радикальные процессы в нем; расширения ассортимента продуктов питания функциональной направленности.

Объективно установлено, что дигидрокверцетин проявляет высокую антиоксидантную активность, препятствуя накоплению продуктов окисления, и способствует значительному увеличению сроков хранения сырья птицепереработки.

**Ключевые слова:** птицепереработка, кожа с тушек цыплят-бройлеров, мясо механической обвалки, филе охлажденных тушек цыплят-бройлеров, природные антиоксиданты, витамины Е, С, рутин, дигидрокверцетин, продукты окисления, продолжительность хранения.

**Information about the authors:**

Kuzmina Nadezhda Nikolayevna, Assistant Faculty, Department of Technology of Meat and Dairy Products, Mari State University, Yoshkar-Ola, Mari El Republic, Russia; kuzmina221995@mail.ru; https://orcid.org/0000-0002-8552-6364

Petrov Oleg Yuryevich, Doctor of Agricultural Sciences, Associate Professor of the Department of Technology of Meat and Dairy Products, Mari State University, Yoshkar-Ola, Mari El Republic, Russia; tmspetrov@yandex.ru; https://orcid.org/0000-0002-3647-5345

Semenov Vladimir Grigorievich, Doctor of Biological Sciences, Professor, Honored Scientist of the Chuvash Republic, Professor of the Department of Morphology, Obstetrics and Therapy of the Chuvash State Agricultural Academy, Cheboksary, Chuvash Republic, Russia; semenov_v.g@list.ru; https://orcid.org/0000-0002-0349-5825

Baimukanov Dastanbek Asylbekovich, Corresponding Member of the National Academy of Sciences of the Republic of Kazakhstan, Doctor of Agricultural Sciences, Professor of the Department of Physiology, Morphology, and Biochemistry named after academician N.U. Bazanova, NJSC “Kazakh National Agrarian University”, Almaty, Kazakhstan; dbaimukanov@mail.ru; https://orcid.org/0000-0002-4684-7114

Lyubimov Alexander Ivanovich, Doctor of Agricultural Sciences, Professor, Honorary Worker of the AIC of Russia, Honored Worker of Agriculture in the Russian Federation, Head of the Scientific School “Development of Breeding and Technological Methods of Intensification of Livestock Production”, Head of the Laboratory “Breeding, Reproduction and Prevention of Diseases of Farm Animals”, Rector of the Izhevsk State Agricultural Academy, Izhevsk, Udmurt Republic, Russia; rector@izhgsha.ru; https://orcid.org/0000-0001-5369-6249

Aubakirov Khamit Abilgazievich, Candidate of Agricultural Sciences, Associate Professor of the Department of Biotechnology, M.H. Dulati Taraz State University, Taraz, Kazakhstan; hamit_a57@mail.ru; https://orcid.org/0000-0003-2670-4834

**REFERENCES**

[1] Denisovich Yu.Yu., Borozda A.V., Mandro N.M. (2012) Development of technology of enriched meat products of a functional orientation // Bulletin of the Altai State Agrarian University. Barnaul. N 6 (92). P. 83-87 (in Russ.).

[2] Antipova L.V., Glotova I.A. (2006) The use of secondary collagen-containing raw materials of the meat industry. SPb. GIORD. 384 p. (in Russ.).

[3] Mandro N.M., Borozda A.V., Denisovich Yu.Yu. (2009) Development of technology for minced meat using a natural antioxidant // Bulletin of the Altai State Agrarian University. Barnaul. N 5 (55). P. 72-75 (in Russ.).

[4] Aniksevich O.N. (2011) Dihydroquercetin in the meat processing industry. Food industry: science and technology. N 3 (13). P. 38-42 (in Russ.).

[5] Borozda A.V., Denisovich Yu.Yu. (2009) New aspects in the use of dihydroquercetin in the production of semi-finished meat products. Agrarian science - to agriculture. Proceedings of IV International scientific - practice. conf. Barnaul. P. 25-27 (in Russ.).

[6] Recommended levels of consumption of food and biologically active substances (2004) Methodological recommendations of the State Sanitary and Epidemiological Regulation of the Russian Federation N 2.3.1.1915–04 of 2004 (in Russ.).

[7] SanPiN 2.3.2.1078-2011 "Hygienic requirements for safety and nutritional value of food products (as amended on July 6, 2011)" (in Russ.).

[8] TR 9100–241–21428156–2011 "Dihydroquercetin biologically active food supplement".

[9] MP–003326 dated 23.11.2015 Alpha-Tocopherol Acetate (Vitamin E).

[10] MP–000043 dated 13.04.07 Ascorutin.

[11] Alekseev I.A., Semenov V.G., Baimukanov D.A., Alekseev V.A., Evdokimov N.V., Yakimov A.V., Obukhova A.V. (2019). Basulifor probiotic supplement, its impact on body and productivity of young quails // Bulletin of the National Academy of Sciences of the Republic of Kazakhstan. Vol. 4, N 380 (2019), 27-37. ISSN 2518-1467 (Online), ISSN 1991-3494 (Print). https://doi.org/10.32014/2019.2518-1467.89

[12] Baimukanov D.A., Pristupa V.N., Kolosov Yu.A., Donnik I.M., Torosyan D.S., Kolosov A.Yu., Orlova O.N., Yuldashbayev Yu.A., Chylbak-ool S.O. (2019) Improvement of breeding and productive traits of Kalmyk cattle breed // Bulletin of the National Academy of Sciences of the Republic of Kazakhstan. Vol. 2, N 378 (2019), 128-145. ISSN 2518-1467 (Online), ISSN 1991-3494 (Print). https://doi.org/10.32014/2019.2518-1467.51

[13] GOST R 52702-2006 "Chicken meat (carcasses of chickens, broiler chickens, and parts). Technical conditions (in Russ.).

[14] GOST 31490-2012 "Mechanically deboned poultry meat. Technical conditions.