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CONTENT

BOTANY

Palamarchuk I., Kibziy A.
SELECTION OF WINTER SHOOTING GARLIC VARIETIES FOR GROWING IN THE CONDITIONS OF THE FOREST-STEPPE OF THE RIGHT BANK OF UKRAINE 3

Palamarchuk I.
DYNAMICS OF FRUIT OF SQUASH PLANT (*CUCURBITA PEPO VAR. MELOPEPO L.)* DEPENDING ON VARIETY, HYBRID IN THE CONDITIONS OF FOREST STEPPE OF THE RIGHT BANK UKRAINE.....8

Tomchuk V.
PRE-SOWING AND INTER-ROW TILLAGE OF INDUSTRIAL CROPS 11

PHYSIOLOGY OF ANIMALS

Zotko M., Nikolaeva A., Stadnik D.
MODERN MICROBIOLOGICAL APPROACHES TO THE REMEDIATION OF BREEDING BULLS SPERM 23

Ovsiienko S.
THE OF FEED ADDITIVES EFFECT ON THE SOWS' REPRODUCTIVE QUALITIES 35

Palamarchuk V., Syrovatko K.
FISHERY-BIOLOGICAL SUBSTANTIATION FOR THE PROJECT OF A FULL-SYSTEM FISHERIES FOR THE CULTIVATION OF CHANNEL CATFISH IN POLYCULTURE IN THE CONDITIONS OF THE FH "RURENKO" OF THE NEMIROVSKY DISTRICT 40

Farionik T.
METHODS OF DETERMINATION OF TRICHINELOSIS IN ANIMAL ORIGIN.....47

Farionik T.
EFFECT OF CHELATE COMPOUNDS OF MICROELEMENTS ON THE ORGANISM OF AGRICULTURAL ANIMALS.....53

Chudak R., Poberezhets Y.
CHEMICAL AND MINERAL COMPOSITION OF QUAIL LIVER AND MEAT USING PHYTOBIOTICS 62

DNA damage and mutagenicity induced by cysteine / iron / S. U. Yoon, Y. H. Koh, R. A. Floyd, J. W. Park. // Mutation Researn. – 2000. – Vol. 448, № 1. – P. 97–104.

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CHEMICAL AND MINERAL COMPOSITION OF QUAIL LIVER AND MEAT USING PHYTOBIOTICS

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Abstract

The usage of biologically active additives in animal diets provides maximum use of nutrients, it has a positive effect on digestion. Therefore, it contributes to the rational and economical use of feed, it increases its productivity, and livestock farming becomes economically feasible. It has been proved that using dry extract of Echinacea Pallida for the feeding quails of meat breed Pharaoh helps to increase protein accumulation and reduce fat loss in the chest muscles.

Additional introduction of phytobiotic additives to the diet of quails contributes to the higher accumulation of dry matter by 1.57% ($p < 0.001$), fat by 20.83% ($p < 0.001$), ash by 1.11% ($p < 0.001$), calcium by 42.8% ($p < 0.05$), magnesium by 60.0% ($p < 0.01$), iron by 37.8% ($p < 0.001$), copper by 64.3% ($p < 0.001$) and manganese 1.7 times ($p < 0.001$) in the liver.

The aim of the study was to research the physical and chemical parameters of the quails meat of the Pharaoh breed. To accomplish this goal an experiment was carried out on quails of the Pharaoh meat breed in accordance with generally accepted methods. Forming poultry groups, we took into account the live weight, age, sex, breed, productivity, conditions of maintenance and feeding. According to the research results, it was found that feeding quails by the extract of Echinacea Pallida increases the percentage of dry matter in white meat of quails by 0.51% ($P < 0.001$), the protein content is increased by 3.46% ($P<0.001$), the amount of fat is increased by 1.27% ($P < 0.001$) compared with the control group. The use of phytobiotics for poultry feeding increases the level of dry matter in the femoral muscles by 0.25% ($P < 0.01$), fat by 4.05%, and extractives without nitrogen by 1.72% ($P < 0.001$) compared with benchmark. The additional consumption of the phytobiotic additive increases the content of phosphorus by 10.7% ($P < 0.001$), calcium by 0.51 g per kg ($P < 0.001$), manganese by 44.8% ($P < 0.01$) and copper by 7.3 mg per kg ($P<0.001$) in the quails pectoral muscles compared with the first control group. The content of calcium increased by 22.4% ($P < 0.001$), iron by 55.7% ($P < 0.001$), zinc by 50.1% ($P<0.001$), manganese by 68.9%

(P <0.001) and copper by 3.27 mg per kg (P <0.001) under the action of Echinacea pallida extract in the femur of the bird, relative to the control sample.

Keywords: quails, feeding, mixed fodder, phytobiotics, meat quality, Echinacea pallida.

Introduction

Recently scientists have found that numerous feed additives are used for feeding animals but they do not always have a positive effect on the quality of products. Meat products deterioration has been observed even the production technology has been carefully observed. Under current production conditions, this issue becomes important, it is connected with the introduction of advanced technologies for the new fodder products use, the use of products of chemical and microbiological synthesis in feeding animals [3, 13, 14, 17, 20, 25].

Pollution-free and quality food products play an important role for the normal functioning of vital functions of the human body. Recently, foreign and domestic scientists have shown increased interest in the feed additives of natural origin research and use for animal feeding [1, 10, 21, 22].

Phytogenous supplements (phytobiotics) are natural growth stimulants, they are of particular importance nowadays. They are derived from herbs, spices and plant extracts; they possess flavor and curative properties; they are used both in modern medicine and feeding farm animals [2, 9, 12].

Echinacea pallida is especially important among phytogenous supplements because it has the balanced content of biologically active substances, i.e. polysaccharides, nitrogen-containing substances, organic acids, glycosides, alkaloids, flavonoids, saponins, amara, essential oils, resins, tannins, minerals and phytomelanins. It has antioxidant, antimutagenic, antimicrobial, immunostimulant, radioprotective properties, it also increases the body's resistance, activates metabolism and improves the assimilation of nutrients and minerals feed [8, 15, 18, 24].

The roots of Echinacea angustifolia and Echinacea pallida contain phytomelanin that has important pharmacological properties i.e. antioxidant, antiradical, antimutagenic, radioprotective and immunomodulatory. The amount of phytomelanin in the roots of Echinacea angustifolia and Echinacea pallida is 1.8% [4, 16, 19, 23].

However, Echinacea pallida as a fodder additive for quails has not been researched yet; it causes the need for this research work.

Therefore, the research to determine the optimal dose of Echinacea pallida extract for the feeding of quails is relevant and has an important theoretical and practical value.

The aim of the study was to research the physical and chemical parameters of the quails meat of the Pharaoh breed.

Material and methodology of researches

To accomplish this goal an experiment was carried out on quails of the Pharaoh meat breed in accordance with generally accepted methods [6, 7]. Forming poultry groups, we took into account the live weight, age, sex, breed, productivity, conditions of maintenance and feeding. We have used zootechnical, physiological, morphological, hematological, biochemical and statistical methods of research.

Fodder additive of Echinacea pallida dry extract is a brown powder of homogeneous composition with a characteristic smell and specific bitter taste. It is very soluble in water, slightly soluble in ethanol, and insoluble in etcitelene. This additive is gained from underground part of the plant, that is, its roots. The researched additive of Echinacea pallida dry extract was obtained on the basis of LLC Experimental Plant of State Scientific Center of Medicines in Kharkiv. The main biologically active substances of this additive are polysaccharides i.e. fructosans, phenolic compounds such as hydroxycinnamic acids that has anti-inflammatory, antimicrobial and adaptogenic actions [19].

Fodder additive of Echinacea pallida dry extract was added to the basic diet of quails of meat breed Pharaoh in the experiment (table 1).

Table 1

Experimental Scheme

Group	Number of animals in group, head	Duration of the experiment, days	Feeding habit
1-control	50	56	BD (mixed fodder)
2-experimental	50	56	BD + Echinacea pallida (6 mg per kg of live weight)
3- experimental	50	56	BD + Echinacea pallida (12 mg per kg of live weight)
4- experimental	50	56	BD + Echinacea pallida (18 mg per kg of live weight)

*BD – basic diet

Two hundred one-day age quails of meat breed Pharaoh were selected for experiment. Four groups of poultry (1 control and 3 experimental) were formed by analogues principle; each group had 50 heads, a live weight of quails was 8.0-8.1 g. Duration of the experiment was 56 days. Thirty-day age quails were divided into females and males (25 females and 25 males). The first control group received the basic diet during the experiment, and quails of experimental groups were fed different doses of Fodder additive of Echinacea pallida dry extract in addition to the basic diet. Control slaughter of experimental animals was conducted at the end of research.

The chemical, mineral composition and physical and chemical properties of meat were investigated by

selecting samples from the thoracic and femur parts of the carcass; they were prepared by separating the skin, fat and connective tissue and thoroughly crushed.

The findings of the studies have been processed biometrically [11]. The indicators of the probability criterion by Student-Fisher were used at three levels *P < 0.05, **P<0.01, ***P<0.001.

Research results and their discussion

The liver plays an important role in the digestion and metabolism processes. It also synthesizes various organic substances, i.e. proteins, glycogen, fats, phosphatides and others. The bulk of its dry residue consists of proteins represented mainly by globulins (13%), albumins (1%), and iron-containing proteins.

The research results indicate a significant effect of Echinacea pallida dry extract of on the chemical composition of the liver (Table 1).

Table 1

Chemical composition of quail liver, % (M ± m, n=4)
(in air-dry substance)

Item	Group			
	1–control	2–experimental	3–experimental	4–experimental
Dry matter	89,75±0,01	90,58±0,01***	91,32±0,01***	89,22±0,01***
Protein	59,46±0,02	58,26±0,02***	45,09±0,01***	60,59±0,01***
Fat	12,23±0,02	15,29±0,02***	33,06±0,01***	12,29±0,01*
Ash	3,72±0,01	4,30±0,01***	3,96±0,01***	4,83±0,01***
NFE	14,33±0,03	12,72±0,03***	9,20±0,03***	11,51±0,03***

The poultry of the 2nd and 3rd experimental groups were fed by the researched additive, the dry matter content in their liver increases by 0.83% and 1.57% (p <0.001). However, this indicator is less than control by 0.53% (p <0.001) in the 4th group.

It should be noted that there is an increase in protein content by 1.13% (p <0.001) in the quails of the 4th group. This figure decreases by 1.2% and 14.37% (p <0.001) for the birds of the 2nd and 3rd experimental groups than in the first control group.

It is worth noting that the amount of fat increased by 3.06% in the 2nd group, by 20.83% (p <0.001) in the 3rd group, and by 0.06% (p <0.05) in the 4th group. The amount of ash increased by 0.58%, 0.24% and 1.11% (p <0.001) in the second, third and fourth groups respectively.

There is a probable decrease in nitrogen-free extractives in poultry of all experimental groups, respectively by 1.61%, 5.13% and 2.82% (p <0.001) relative to the control indicator.

Feeding quail by Echinacea pallida extract affected the mineral composition of the liver in different ways (table 2).

Thus, the content of calcium in the liver exceeded the control analogues by 42.8% (P <0.05) in the third experimental group.

Table 2

Mineral content in the quail liver
(in air-dry substance)

Mineral elements	Group			
	1–control	2–experimental	3–experimental	4–experimental
Ca, g/kg	0,14±0,01	0,17±0,01	0,20±0,02*	0,16±0,01
Mg, g/kg	0,20±0,01	0,29±0,01***	0,32±0,02**	0,18±0,01
Fe, mg/kg	316,4±2,56	436,3±4,39***	363,0±13,95*	357,8±7,68**
Zn, mg/kg	222,7±1,22	234,4±3,28*	56,4±2,41***	53,8±2,19***
Mn, mg/kg	4,23±0,04	6,11±0,07***	7,06±0,08***	7,44±0,12***
Cu, mg/kg	16,49±0,29	27,1±0,37***	11,0±0,16***	11,10±0,15***

The magnesium accumulation level increased by 45% (p <0.001) and 60% (p <0.01) in quails consumed the minimum and average dose of the additive. However, its maximum dose decreases the magnesium accumulation level by 10%. The probable difference with control is not established.

It should be noted that the amount of iron in quail liver increased in all experimental groups by 37.8% (p <0.001), 14.7% (p <0.05) and 13.1% (p<0.01), respectively.

The highest content of zinc and copper by 5.3% (p <0.05) and 64.3% (p <0.001) was observed in poultry in the 2nd experimental group, respectively, and its lowest content by 74.6% and 75.8% (p <0.001) was recorded in the 3rd and 4th groups compared to the first control group.

It is known that quail meat has dietary properties; it is characterized by a gentle consistency, juicy, aromatic, high flavoring qualities, and slight bitterness. It has more vitamins, essential amino acids, macro- and microelements than chicken. It also contains 22% of protein and 3 % of fat.

According to the research results, it was found that feeding quails by the extract of Echinacea Pallida had a positive impact on the quality of quail meat (table 3).

Table 3

Chemical composition of quails pectoral muscles, %, (M ± m, n=4)
(in air-dry substance)

Item	Group			
	1–control	2–experimental	3–experimental	4–experimental
Dry matter	89.56±0.01	87.95±0.009***	90.07±0.01***	86.67±0.01***
Protein	63.97±0.35	66.27±0.06***	67.10±0.12***	67.43±0.05***
Fat	11.59±0.01	9.71±0.01***	12.86±0.01***	9.65±0.009***
Ash	5.26±0.01	4.87±0.01***	4.74±0.01***	4.94±0.01***
NFE	8.74±0.35	7.10±0.09**	5.41±0.12***	4.70±0.05***

Thus, if the average dose (12 mg per kg of live weight) of feed supplement is fed the dry matter amount in white quail meat is increased by 0.51% (P <0.001). If we use the minimum and maximum doses (6 to 18 mg/kg), this item decreases by 1.61% and 2.89%, respectively (P <0.001) than in the control group.

It is known that white meat is better digested in the human gastrointestinal tract because it contains less connective tissue and more protein than red one.

It was found that the protein content in quails pectoral muscles of all experimental groups increased by 2.3%, 3.13% and 3.46% (P <0.001) than the first group.

Fat of poultry meat contains a large number of triglycerides with unsaturated fatty acids. That's why it is more efficiently digested.

The fat amount in quails muscle tissue of the third experimental group increased by 1.27% (P <0.001). However, the poultry of the second and fourth groups have decreased this indicator by 1.88% and 1.94% respectively (P <0.001) than control group.

It should be noted that the ash content in the 2nd, 3rd and 4th experimental groups decreased by 0.39%, 0.52% and 0.32% (P <0.001) respectively.

It should be mentioned that the various doses of the researched fodder additive reduces the NFE content by 1.64% (P <0.01), 3.33% and 4.04% (P <0.001), respectively in white quail meat.

Chemical composition of quails femoral muscles is presented in table 4.

Table 4

Chemical composition of quails femoral muscles, %, (M ± m, n=4)
(in air-dry substance)

Item	Group			
	1–control	2–experimental	3–experimental	4–experimental
Dry matter	91.54±0.05	91.18±0.02***	91.79±0.007**	91.77±0.009**
Protein	62.02±0.04	59.97±0.01***	60.25±0.08***	60.06±0.06***
Fat	18.03±0.01	18.24±0.009***	22.08±0.01***	20.00±0.007***
Ash	4.49±0.01	4.24±0.01***	3.99±0.01***	4.22±0.01***
NFE	7.04±0.05	8.76±0.02***	5.49±0.09***	7.53±0.10**

The use of phytobiotics for poultry feeding increases the level of dry matter by 0.25% and 0.23% (P <0.01) in the third and fourth group, respectively; in the second group this indicator decreases by 0.36% (P <0.001) in comparison with the first control group.

In all experimental groups the level of protein deposition was significantly less than the control sample has, respectively by 2.05%, 1.77% and 1.96% (P <0.001).

The ash content decrease in the red quail meat of the groups fed by different doses of the extract of Echinacea Pallida by 0.25%, 0.5% and 0.27% (P <0.001) was also observed.

It should be mentioned the fat amount in the femur muscle predominates in the second group by 0.21%, in the third by 4.05%, and in the fourth by 1.97% in comparison with the first control group.

The minimum (second group) and the maximum (third group) doses of the researched additive increases the part of nitrogen free substances by 1.72% (P <0.001) and 0.49% (P <0.01), respectively.

The research results have shown that changes in the mineral composition of pectoral muscles occur when we use different doses of Echinacea Pallida extract (table 5).

Table 5

Mineral content of quails pectoral muscles, (M ± m, n=4)

Mineral elements	Group			
	1–control	2–experimental	3–experimental	4–experimental
P, g/kg	10.3 ± 0.06	11.4 ± 0.02***	10.4 ± 0.12	11.0 ± 0.12**
Ca, g/kg	0.84 ±0.009	0.55 ±0.014***	1.35 ± 0.007***	0.69 ± 0.012***
Mg, g/kg	0.72 ± 0.007	0.73 ±0.007	0.62 ±0.009***	0.66 ± 0.007***
Fe, mg/kg	103.5 ± 1.00	99.5 ±0.83*	92.8 ±0.32***	94.2 ±0.52***
Zn, mg/kg	101.5±0.21	98.5±0.49**	95.1 ±0.76***	94.0 ±0.39***
Mn, mg/kg	9.6 ±0.25	13.9 ±0.73**	1.9±0.40***	0.8±0.01***
Cu, mg/kg	3.7 ±0.03	8.5 ±0.27***	11.0 ±0.29***	10.4 ±0.07***

Thus, about 10% of the total phosphorus content in the body is deposited in the poultry muscles. Meat products contains from 170-200 mg of this element per 100 g of raw product.

The researched additive increased the content of phosphorus by 10.7% (P <0.001) and 6.8% (P <0.01) in the quails white meat of the second and fourth groups. However, in the third the group it was at the same level with the control one.

It should be noted that poultry of the third group has an increase in calcium in the pectoral muscles by 0.51 g per kg (P <0.001). At the same time, the poultry of the second and fourth experimental groups has lower calcium content in the pectoral muscles than the control analogues, respectively by 0.29 g/kg and 0.15 g/kg (P <0.001).

It is known that magnesium is calcium antagonist in many muscles processes. If the quails are fed by Echinacea Pallida extract the content of magnesium decreased by 13.9%, in the third group and by 8.3% (P<0.001) in the fourth group in accordance with the control parameters.

Iron is an integral part of proteins among which the muscle tissue myoglobin is the most important because is 3 to 5% of the dry weight of the tissue. It also plays an important role in the processes of tissue respiration and nutrition contributing to the live weight increase and the preservation of young animals.

It was investigated that the iron content in white meat decreased by 3.9% (P <0.05), 10.3% and 8.9% (P<0.001) in the birds of the second, third and fourth experimental groups compared with first group.

Zinc has a wide range of physiological effects, i.e. it participates breathing, it is a catalyst in oxidation-reducing processes, it also increases the activity of vitamins and enhances phagocytosis.

Due to the effects of various doses of the researched additive zinc decreases in the pectoral muscles of quails of all experimental groups, respectively, by 2.9% (P <0.01), 6.3% and 7.4% (P < 0.001) in comparison with the control sample.

Manganese facilitates the growth of young animals, affects the processes of hematopoiesis, tissue respiration and improves the hydrocarbon, protein and copper metabolism.

It was found that the second sample had the highest amount of manganese in white meat, it was by 44.8% (P<0.01) more than the control one has. However, the third and fourth samples have reduced manganese proportion by 80.2% and 91.7% (P <0.001).

Copper engages in hemogenesis and promotes the formation of hemoglobin in the blood, as well as is necessary for the normal development of the skeleton and improving meat productivity.

It should be mentioned that usage of Echinacea Pallida extract facilitates the copper accumulation in white quail meat; it was 4.8 mg/kg, 7.3 mg/kg and 6.7 mg/kg (P <0.001), respectively, in comparison with the first control group.

The mineral content of quails femoral muscles also had certain features (Table 6).

Table 6

Mineral content of quails femoral muscles, (M ± m, n=4)

Mineral elements	Group			
	1–control	2–experimental	3–experimental	4–experimental
P, g/kg	9.3 ±0.02	9.1 ±0.22	10.1 ±0.05***	9.9 ±0.05***
Ca, g/kg	0.58 ±0.009	0.53 ±0.009**	0.71 ±0.01***	0.62 ±0.01*
Mg, g/kg	0.60 ±0.01	0.55 ±0.01*	0.59 ±0.009	0.56 ±0.009*
Fe, mg/kg	62.1 ±0.41	63.1 ±0.46	96.7 ±0.60***	59.5 ±0.57**
Zn, mg/kg	62.6 ±0.24	61.5 ±0.15**	94.0 ±0.89***	59.8 ±0.19***
Mn, mg/kg	8.7 ±0.39	13.2 ±0.28***	14.7 ±0.09***	14.3 ±0.02***
Cu, mg/kg	0.85 ±0.06	4.12 ±0.24***	1.94 ±0.12***	1.38 ±0.24

Thus, the phosphorus amount in red meat of poultry from third and fourth groups increases by 8.6% and 6.4% (P <0.001) respectively. However, the second group had a tendency to decrease this indicator by 2.1% compared to the control.

It should be noted that the poultry of the third and fourth group had increase in calcium content by 22.4% (P <0.001) and by 6.9% (P <0.05). However, the poultry of the second group has this indicator lower by 8.6% (P <0.01) than the control group has.

The amount of magnesium in all experimental groups slightly decreased in comparison with the control parameters, i.e. by 8.3% (P <0.05) in the second group, by 1.7% in the third group, and by 6.7% (P <0.05) in the fourth group.

The iron content of quails femoral muscles increases by 55.7% (P <0.001) in the third experimental group. However, this indicator decreases by 4.2% (P <0.01) in the fourth group.

The level of zinc significantly increased by 50.1% (P <0.001) in the third experimental group. However it was less than control by 1.7% (P <0, 01) and 4.5% (P <0.001) in the second and fourth groups respectively.

It was found that the use of Echinacea Pallida extract facilitates an increase of manganese percentage in the red meat of the second group quails by 51.7%, the third – by 68.9%, and the fourth by 64.3% (P <0.001) than the control sample.

It should be noted that the consumption of minimum and average dose of additive by poultry increases the level of accumulation of copper in the femoral muscle, respectively, in the second group by 3.27 mg/kg and in the third group by 1.09 mg / kg (P <0.001) compared to control.

Therefore, different doses of Echinacea Pallida extract as a part of poultry feeds increases productivity; it also improves the quality of the quails meat production of.

Conclusions

1. Additional introduction of phytobiotic additives to the diet of quails contributes to the higher accumulation of dry matter by 1.57% ($p < 0.001$), fat by 20.83% ($p < 0.001$), ash by 1.11% ($p < 0.001$) in the liver.

2. It was found that the different doses of the researched additive increases the accumulation of calcium by 42.8% ($p < 0.05$), magnesium by 60.0% ($p < 0.01$), iron by 37.8% ($p < 0.001$), copper by 64.3% ($p < 0.001$) and manganese 1.7 times ($p < 0.001$) in the liver.

3. It was found that feeding quails by the extract of Echinacea Pallida increases the percentage of dry matter in white meat of quails by 0.51% ($P < 0.001$), the protein content is increased by 3.46% ($P<0.001$), the amount of fat is increased by 1.27% ($P < 0.001$) compared with the control group.

4. The use of phytobiotics for poultry feeding increases the level of dry matter in the femoral muscles by 0.25% ($P < 0.01$), fat by 4.05%, and extractives without nitrogen by 1.72% ($P < 0.001$) compared with benchmark.

5. The additional consumption of the phytobiotic additive increases the content of phosphorus by 10.7% ($P < 0.001$), calcium by 0.51 g per kg ($P < 0.001$), manganese by 44.8% ($P < 0.01$) and copper by 7.3 mg per kg ($P<0.001$) in the quails pectoral muscles compared with the first control group.

6. The content of calcium increased by 22.4% ($P < 0.001$), iron by 55.7% ($P < 0.001$), zinc by 50.1% ($P<0.001$), manganese by 68.9% ($P < 0.001$) and copper by 3.27 mg per kg ($P < 0.001$) under the action of Echinacea pallida extract in the femur of the bird, relative to the control sample.

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