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Effect of *Echinacea pallida* supplementation on the amino acid and fatty acid composition of Pharaoh Quail meat

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The purpose of the research was to investigate the effect of *Echinacea pallida* extract effect on the amino acid and fatty acid content of Pharaoh Quail meat. We proved that the amount of essential amino acids was greater by 1.31% in the pectoral muscles of Quails that consumed 12 mg/kg of *Ehinacea pallida* dry extract. This increase was caused by the better accumulation of lysine, arginine, threonine, leucine, and phenylalanine. The amount of essential amino acids was the highest in the thigh muscles of the control group. We found that the quality of fatty acid composition of the pectoral muscles was better due to the greater accumulation of linoleic, γ-linolenic, and α-linolenic acids. The accumulation rate of linoleic, γ-linolenic, and arachidonic fatty acids was higher in thigh muscles of the experimental Quail.

Keywords: Quails; Phytobiotics; *Echinacea pallida;* Amino acids; Meat; Fat acids

Introduction

In recent years, feed additives of natural origin have been extensively used in animal husbandry. Their wide usage explained by the accessibility, absence of adverse reactions, and the wide range of positive biological effects (Cross & Hillman, 2004; Grashorn, 2010; Podolian, 2016.). The antibiotics' application in European countries has been forbidden. This triggered the search for natural additives of natural origin containing biologically active substances that increase productivity, strengthen immunity and improve digestive processes (*Ibatullin et al., 2017;* Podolian, 2017).

Phytobiotics are increasingly used in animal feeding. They are the phytocorrectors modifying the digestive glands work and providing the conditions for competitive growth of beneficial microflora, which stabilizes acidity and enhances the processes of nutrient absorption (Bauer & Wagner, 1991; Chudak *et al.,* 2018; Magomedaliev et al., 2019). Feed additives of plant origin ncluded into the farm animals diets help to increase productivity; improve the gut microflora; improve the taste of feed; stimulate salivation and secretion of digestive juices due to the rapid passage of feed and absorption of nutrients, and the nutrient system (Aituan & Wanyu, 2009; Bohmer & Salisch 2009).

Recently, foreign and domestic scientists have become interested in the study and application of the genus Echinacea species (Bauer *et al.,* 1988; Dehkordi & Fallah, 2011). They have very valuable medicinal, fodder properties, and their chemical composition contains a large number of biologically active substances. They are carbohydrates, nitrogenous substances, organic acids, lipids, vitamins, polyphenolic compounds (coffee derivatives, flavonoids, and tannins), isoprenoids, saponins, essential oils, alkaloids and minerals (Nazir & Grashorn, 2010; Barnes *et al., 2005;* Samorodov *et al.,* 2013).

Echinacea pallida is becoming very popular in veterinary as therapeutic and prophylactic medicine and plant feed additive (Allen, 2003; Diakonova 2009; Chudak *et al.,* 2019). It has a mild action, low toxicity, and high content of vital substances affecting the animals' metabolism (Bauer & Wagner, 1990; Mamchur *et al., 1993;* Pospelov *et al., 2007*).

The purpose of the research was to investigate the effect of *Echinacea pallida* extract on the fatty acid and amino acid content of the Pharaoh Quail meat.

Methods

We performed the study of *Echinacea pallida* feed additive at the research farm of Vinnytsia National Agrarian University. The scientific experiment was conducted on poultry by groups-analogues method taking into account live weight, age, sex, breed, productivity, and conditions of keeping and feeding (*Ibatullin et al., 2017*). The duration of the experiment was 56 days. Four groups of one-day-old Pharaoh meat Quail were selected for the experiment, 50 birds in each group. The control group consumed a basic diet (BD), i.e., complete feeds of the Multigain trademark. The experimental groups were additionally fed by different doses of *Echinacea pallida* feed additive extract (Table 1).

Table 1. Feeding patterns.

Group	Feeding characteristics
Control	BD (complete feeds)
II	BD + *Echinacea pallida* (6 mg/kg)
III	BD + *Echinacea pallida* (12 mg/kg)
IV	BD + *Echinacea pallida* (18 mg/kg)

The researched phytobiotics was homogeneous, powdered and dry extract of *Echinacea pallida* roots. This was brown powder with a characteristic smell and a specific bitter taste. The manufacturer of the extract from *Echinacea pallida* is LLC Kharkiv Research Plant, Ukraine. The main active biologically substances are polysaccharides, i.e., fructosans, phenolic compounds, hydroxycoric acids having anti-inflammatory, antimicrobial and adaptogenic activities. We have researched the fatty acid composition by gas chromatography. The meat amino acid composition was determined in the Laboratory of the Biochemistry Research Institute named after O.V. Paladin (Kyiv) by TTT 339 automatic analyzer using LG ANB cation exchange resin with SO_3 active group. The Tables data are presented as mean and standard deviation, the amino acid content is calculated in percent per 100 mg.

Results and Discussion

We found that different doses of *Echinacea pallida* feed additive extract could determine the amino acid content in the Quail meat (Table 2). We also revealed that the poultry consuming the researched supplement had a higher lysine content in the white meat compared to the control. This content was by 0.45% ($P<0.001$) higher in group III and by 0.12% ($P<0.001$) in group IV. However, the content of amino acids in the meat of Quails from group II was lower by 0.31% ($P<0.001$).

The highest content of histidine was in the pectoral muscles of the group II, it was higher by 0.29% ($P<0.001$); the content of arginine in the pectoral muscles of the group III was higher by 0.37% ($P<0.001$) compared to control data. The content of aspartic acid increased by 0.65% ($P<0.001$) in the pectoral muscles of group III, and glutamic acid increased by 0.27% ($P<0.001$) in the pectoral muscles of group IV.

Table 2. Amino acid composition of Quail pectoral muscles.

Amino acid	Groups			
	Control	II	III	IV
Lysine	9.29 ± 0.007	8.98 ± 0.012***	9.74 ± 0.005***	9.41 ± 0.014***
Histidine	3.26 ± 0.024	3.55 ± 0.013***	3.37 ± 0.014**	3.50 ±0.002***
Arginine	6.64 ± 0.037	6.94 ± 0.022***	7.01 ± 0.012***	6.72 ± 0.029
Aspartic acid	6.50 ± 0.005	6.17 ± 0.003***	7.15 ± 0.012***	6.61 ± 0.010***
Threonine	4.89 ± 0.019	5.12 ± 0.014***	4.91 ± 0.009	4.48 ± .014***
Serine	4.19 ± 0.014	4.40 ± 0.003***	4.21 ± 0.009	4.20 ± 0.002
Glutamic acid	16.77±0.030	16.42±0.040***	15.38 ±0.017***	17.04±0.027***
Proline	5.06 ± 0.058	4.35 ± 0.077***	3.55 ± 0.036***	4.36 ± 0.051***
Glycine	4.72 ± 0.012	4.85 ± 0.002***	4.96 ± 0.003***	4.74 ± 0.007
Alanine	6.26 ± 0.007	6.39 ± 0.010***	6.49 ± 0.003***	6.07 ± 0.009***
Cystine	1.19 ± 0.029	1.31 ± 0.017*	1.25 ± 0.012	1.39 ± 0.015***
Valine	5.36 ± 0.025	5.56 ± 0.020***	5.60 ± 0.007***	5.52 ± 0.008***
Methionine	2.88 ± 0.011	2.75 ± 0.013***	2.89 ± 0.010	2.98 ± 0.017**
Isoleucine	5.01 ± 0.016	5.21 ± 0.030**	5.17 ± 0.014***	5.11 ± 0.007**
Leucine	9.12 ± 0.031	9.27 ± 0.035*	9.49 ± 0.007***	9.06 ± 0.020
Tyrosine	4.15 ± 0.036	4.05 ± 0.042	4.04 ± 0.012*	4.09 ± 0.030
Phenylalanine	4.65 ± 0.025	4.61 ± 0.021	4.73 ± 0.009*	4.67 ± 0.009
Essential acids amount	51.10	51.99	52.41	51.45
Substitutable acids amount	48.84	47.94	47.03	48.50

The threonine and serine content in the pectoral muscles of the Quail exceeded by 0.23% and 0.21% ($P<0.001$) in II group fed by researched additive. It was found that the highest content of glycine and alanine was observed in II and III groups; it was higher by 0.13%, 0.24% and 0.13%, 0.23% ($P<0.001$) respectively than control one. The cystine content increased in pectoral muscles of II and IV groups by 0.12% ($P<0.05$) and 0.20% ($P<0.001$) respectively than control one. It was researched that additional feeding by *Echinacea pallida* dry extract to the Quail causes increase of methionine in group IV by 0.10% ($P<0.01$). The highest proportion

of phenylalanine was recorded in the group III; it was by 0.08% (P<0.05) higher than control one. The researched additive causes lysine increasing in Quail red meat in group II by 0.68% (P<0,001) respectively than control one (Table 3).
It should be mentioned that the histidine level in the third poultry group was less than the control analogues by 0.1% (P<0.001). It was found that the amount of histidine and arginine decreases in the femur muscles of the experimental groups compared to the control one. The content of aspartic acid in the poultry thighs outweighed the control sample in group IV by 0.83% (P<0.001) and glutamic acid by 2.26% (P<0.001) in group III. The amount of threonine in the poultry muscles of the group IV increased by 0.05% (P<0.01).

Table 3. Amino acid composition of Quail femur muscles.

Amino acid	**Groups**			
	Control	**II**	**III**	**IV**
Lysine	9.07 ± 0.011	9.75 ± 0.005***	9.22 ± 0.019***	9.66 ± 0.008***
Histidine	2.79 ± 0.004	2.76 ± 0.014	2.69 ± 0.008***	2.79 ± 0.007
Arginine	6.88 ± 0.004	6.57 ± 0.024***	6.71 ± 0.030**	6.73 ± 0.014***
Aspartic acid	6.60 ± 0.009	7.22 ± 0.011***	7.30 ± 0.002***	7.43 ± 0.009***
Threonine	5.08 ± 0.008	5.00 ± 0.007***	4.98 ± 0.002***	5.13 ± 0.007**
Serine	4.40 ± 0.002	4.33 ± 0.005***	4.34 ± 0.003***	4.34 ± 0.007***
Glutamic	16.93 ± 0.005	17.12±0.017***	19.19 ±0.021***	17.51 ± .021***
Proline	4.76 ± 0.031	4.86 ± 0.064	4.88 ± 0.088	4.81 ± 0.081
Glycine	5.06 ± 0.005	5.03 ± 0.005**	5.09 ± 0.002**	4.99 ± 0.008***
Alanine	5.94 ± 0.005	5.88 ± 0.008***	5.91 ± 0.012	5.76 ± 0.005***
Cystine	1.28 ± 0.012	1.25 ± 0.012	1.04 ± 0.012***	1.24 ± 0.012
Valine	5.20 ± 0.013	4.99 ± 0.005***	4.79 ± 0.012***	4.99 ± 0.010***
Methionine	3.13 ± 0.002	3.05 ± 0.009***	2.55 ± 0.012***	2.84 ± 0.012***
Isoleucine	4.94 ± 0.007	4.83 ± 0.010***	4.45 ± 0.002***	4.79 ± 0.016***
Leucine	9.05 ± 0.008	8.81 ± 0.020***	8.77 ± 0.020***	8.73 ± 0.016***
Tyrosine	4.17 ± 0.047	3.85 ± 0.023***	3.67 ± 0.017***	3.79 ± 0.019***
Phenylalanine	4.75 ± 0.078	4.61 ± 0.007	4.33 ± 0.009***	4.40 ± 0.007**
Essential acids amount	50.89	50.37	48.49	50.06
Substitutable acids amount	49.14	49.54	51.42	49.87

It was found that serine content significantly decreased in the femurs of groups II, III and IV by 0.07%, 0.06%, and 0.06%, respectively (P< 0,001) under the action of *Echinacea pallida* extract. Consumption of phytobiotic supplement causes the proline content increasing in red meat of groups II, III and IV by 0.1%, 0.12% and 0.05% respectively. However, a probable difference hasn't been established. The glycine content in the femur Quail muscles was greater by 0.03% (P<0.01) in the group III than in the control sample. However, this indicator was lower by 0.03% (P<0.01) and 0.07% (P<0.001) in the groups II and IV. The level of alanine significantly decreased by 0.06% and 0.18% (P<0.001) in the groups II and IV than the control group. It should be noted that feeding by *Echinacea pallida* extract different doses causes valine content decreasing by 0.21%, 0.41% and 0.21% (P<0.001) in the femurs of the experimental poultry groups.
The lowest amount of cystine and methionine was in the red meat of the group III by 0.24% and 0.58% (P<0.001), respectively, compared to the group I. It should be noted that the lowest levels of isoleucine and leucine were in the poultry muscles from the experimental groups II and IV, respectively by 0.49% and 0.32% (P<0.001) compared to the control.
It was noted that the smallest tyrosine accumulation was observed in the femurs of the poultry of all experimental groups by 0.32%, 0.5% and 0.38% (P<0.001), respectively, compared to the control sample. It was also found that the reduction of phenylalanine content is observed in the Quails of the groups III and IV by 0.42% (P<0.001) and 0.35% (P<0.01), respectively, compared to the control group analogues.
The amount of essential amino acids decreases by 0.52%, 2.4% and 0.83% in Quails of the experimental groups fed by the experimental supplement. However, the amount of substitutable amino acids increased by 0.4%, 2.28% and 0.73% in these groups, respectively, compared to the first poultry control group. Thus, mixed doses of *Echinacea pallida* dry extract have a positive effect on the amount of substitutable and essential amino acids in the Quail meat.
We determined that different doses of *Echinacea pallida* could influence the fatty acid content of the Quail pectoral muscles (Table 4).

Table 4. Fatty acid composition of Quail pectoral muscles (the average value in the sample).

Fatty acid	Groups			
	Control	**II**	**III**	**IV**
Myristic	0.29	0.25	0.30	0.22
Stearic	12.69	11.54	11.33	14.38
Palmitic	18.61	16.91	18.30	16.56
Arachidic	0.14	0.13	0.11	0.05
Margaric	0.12	0.17	0.21	0.15
Pentadecanoic	0.06	0.07	0.03	0.05
Linoleic	23.45	25.38	28.86	26.23
γ-linolenic	0.12	0.14	0.19	0.19
α-linolenic	1.05	1.20	1.20	1.26
Arachidonic	9.04	8.55	8.50	12.26
Oleic	25.92	27.40	24.27	20.11
Gondoinic	0.07	0.15	0.06	0.05
Pentadecileine	0.03	0.03	0.04	0.02
Palmitoleic	5.90	5.83	3.74	4.47
Margarinolein	0.03	0.06	0.05	0.05
Dihomolinoleic	0.12	0.17	0.07	0.15
Dihomo-γ-linolenic	0.13	0.08	0.08	0.31
Docosatetraenoic	0.09	0.08	0.08	0.13
Docosapentaenoic	0.09	0.09	0.08	0.14
Clupanodonic	0.27	0.38	0.20	0.41
Docosahexaenoic	1.79	1.38	2.29	2.78

Table 5. Fatty acid composition of Quail femur muscles (the average value in the sample).

Fatty acid	Groups			
	Control	**II**	**III**	**IV**
Myristic	0.24	0.22	0.20	0.21
Stearic	16.85	14.27	17.11	17.43
Palmitic	15.47	17.30	15.59	14.32
Arachidic	0.06	0.10	0.15	0.10
Margaric	0.14	0.09	0.14	0.17
Pentadecanoic	0.05	0.04	0.02	0.02
Linoleic	23.19	24.94	25.67	25.86
γ- linolenic	0.12	0.18	0.13	0.15
α - linolenic	0.92	0.80	0.73	1.13
Arachidonic	9.54	9.93	11.93	11.32
Oleic	23.27	23.06	19.03	18.74
Gondoinic	0.06	0.12	0.09	0.12
Pentadecileine	0.01	0.02	0.02	0.02
Palmitoleic	5.62	4.47	2.90	3.47
Margarinolein	0.05	0.05	0.04	0.03
Dihomolinoleic	0.15	0.14	0.10	0.23
Dihomo-γ-linolenic	0.08	0.16	0.11	0.26
Docosatetraenoic	0.33	0.46	0.45	0.71
Docosapentaenoic	0.18	0.32	0.24	0.32
Clupanodonic	0.41	0.75	1.25	0.75
Docosahexaenoic	3.24	2.58	4.08	4.64

The supplementary feeding of poultry (group IV) by the maximum dose of the researched feed additive caused the increase of stearic acid content in white poultry meat by 1.69%, margaric acid by 0.03%, linoleic acid by 2.78%, γ- linolenic acid by 0.07% and α - linolenic acid by 0.21% than the control one. However, the poultry of this group has decreased content of myristic, palmitic, arachidic and oleic fatty acids by 0.07%, 2.05%, 0.09% and 5.81%, respectively, compared with indicators of the group I. Minimal and medium doses of *Echinacea pallida* extract cause increased linoleic acid content by 1.93% and 5.41% in the pectoral muscle of the poultry compared to the control group. Poultry of the experimental groups II and III had a decrease of stearic and palmitic fatty acids by 1.15%, 1.36% and 1.7%, 0.31% respectively compared to the control analogues. The content of essential fatty acids such as dihomo-γ-linolenic and arachidonic acids increased by 0.18% and 3.22% in the fourth experimental group compared to the control indicators. The levels of arachidonic acid decreased by 0.49% and 0.54% respectively in the groups II and III, relative to the control data.

We found that the concentration of docosatetraenoic and docosapentaenoic acids in the pectoral muscles exceeded the control by 0.04% and 0.05% in the group IV fed by the maximum dose of the researched supplement. The content of clupanodonic and docosahexaenoic fatty acids increased in the bird of the group IV by 0.14% and 0.99%, respectively, compared with the control sample. Researches have proved that feeding different doses of *Echinacea pallida* extract changed the fatty acid composition of the femur muscles of the Quail (Table 5). Thus, the content of stearic fatty acid increased in the poultry red meat (groups III and IV) by 0.26% and 0.58% respectively.

However, the accumulation of myristic acid in these groups was less by 0.04% and 0.03% compared to the control. We found that linoleic acid content increased by 1.75%, 2.48% and 2.67% in groups I-III compared to the control group. We must note that the level of accumulation of γ-linolenic and α-linolenic fatty acids increased by 0.03% and 0.21% in group IV relative to the control. We also registered an increase in arachidonic fatty acid content by 0.39%, 2.39%, and by 1.78% in groups II-IV compared to the control. While the content of oleic and palmitoleic fatty acids was lower in all the groups, however, the highest rate of accumulation of dihomo-γ-linolenic, docosatetraenoic and docosahexaenoic fatty acids was observed in the femur muscles of Quails from group IV, they were higher by 0.18%, 0.38%, and 1.4%, respectively, compared to the control group. Therefore, the use of different doses of *Echinacea pallida* extract in Quail feeding had a positive effect on the amino acid, fatty acid, and chemical composition of the Quails meat.

Conclusion

The supplementation of the dry extract of *Echinacea pallida* increased the synthesis of essential amino acids in white Quail meat, namely lysine by 0.45%, histidine by 0.11%, arginine by 0.37%, valine by 0.24%, isoleucine by 0.16%, and phenylalanine by 0.08%. It was also increased the amount of essential amino acids by 1.81%. The herbal supplements application in Quail compound feed caused the increase of substitutable amino acids content in red meat, namely serine by 0.06%, proline by 0.12%, glycine by 0.03%. This was also caused the increase of the amount of substitutable amino acids by 2.28%.

The application of *Echinacea pallida* extract in Quails feeding caused the increase of fatty acids in the pectoral and femor muscles, namely linoleic acid by 5.41%, dihomo-γ-linolenic by 0.18%, arachidonic by 3.22% and linoleic by 2.48%, stearic by 0.26%, and arachidonic acid by 2.39%.

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