The effect of a phytogenic additive on nutritional composition of turkey meat

Vplyv fytogénného aditíva na nutričné zloženie mäsa moriek

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Abstract

The aim of the study was to analyze the effect of a blend of phytogenic additive on nutritional and mineral composition of breast, thigh muscles and liver in fattening turkeys. A total 300 female turkeys were monitored in the trial. 1-day old broad-breasted white turkeys hybrid XL were randomly divided into two groups (150 pcs per each). Turkeys in control group were fed by standard diet for fattening and in experimental group from the 1st to the 12th week by complete feed mixture with supplementation of a blend of essential oils from origanum, anise and citrus fruits as well as a prebiotic rich fructooligosaccharides in dosage 1 kg per 1000 kg of feed mixture. Turkeys were housed in group on deep litter. Experiment lasted 18 weeks. Samples of breast and thigh muscles, and liver for nutritional analysis were collected during turkey's dissection (10 samples per each group). After the determination of nutrients, there were found significant ($P < 0.05$) differences between control and experimental samples of breast muscles in content of crude protein and fat. Statistically significant ($P < 0.05$) differences in all analyzed nutrients in thigh muscles were observed. The phytoadditive supplementation markedly ($P < 0.05$) increased content of crude protein in breast (from 91.13 to 93.7% of DM) and thigh muscles (from 79.78 to 85.73% of DM) and ash in thigh muscle (from 4.25 to 4.61% of DM). Tendency of higher ($P > 0.05$) content of DM and fat was recorded in liver. After analysis the macro and microelements, significant ($P < 0.05$) differences in all minerals except potassium and manganese were found. Compare to the control group, in the experimental group were detected significantly ($P < 0.05$) higher amounts of zinc in breast, magnesium and copper in thigh muscle samples. In the

case of liver, there was found higher (P > 0.05) concentrate only in content of manganese in experimental group. Occurrence of manganese was not observed in both muscles.

Keywords: minerals, muscle, nutrients, phytogenic additive, turkeys

Abstrakt

Cieľom štúdie bolo analyzovanie vplyvu zmesi fytogenného aditíva na živinové a minerálne zloženie v prsnom svale, stehennom svale a pečeni výkrmových moriek. V pokuse bolo monitorovaných celkovo 300 jedincov samíc moriek. Morky plemena mäsový medzilíniový úžitkový kríženec morka širokoprsá biela, hybrid XL, vo veku 1 deň boli rozdelené do dvoch skupín (150 kusov v každej skupine). Morkám v kontrolnej skupine bola skrmovaná štandardná kompletná kŕmna zmes pre výkrm a v experimentálnej skupine od 1. do 12. týždňa bola skrmovaná kompletná krmná zmes s prídavkom zmesi esenciálnych olejov z oregana, anízu, citrusových plodov a prebioticky obohatená o fruktooligosacharidy v dávke 1 kg na 1000 kg kŕmnej zmesi. Morky boli ustajnené skupinovo na hlbokej podstielke. Pokus trval 18 týždňov. Vzorky prsného svalu, stehenného svalu a pečene, určené na analýzu živín, boli odobrané počas jatočnej rozrábky (10 vzoriek z každej skupiny). Po stanovení obsahu živín boli zistené signifikantné (P < 0.05) rozdiely medzi kontrolnými a experimentalnými vzorkami prsných svalov a to v obsahu dusikatých látok a tuku. Štatisticky významné (P < 0.05) rozdiely sme spozorovali vo všetkých analyzovaných vzorkách stehenného svalu. Fytoaditívny prídavok výrazne (P < 0.05) zvýšil obsah dusikatých látok v prsnom (z 91.13 na 93.7%) a stehennom svale (z 79.78 na 85.73%) a popolovín v stehennom svale (z 4.25 na 4.61%). Tendencia vyššieho (P > 0.05) obsahu sušiny a tuku bola zaznamenaná v pečeni. Po analýze makro a mikroprvkov sme zistili významné (P < 0.05) rozdiely v obsahu všetkých minerálnych látok okrem draslíka a mangánu. V porovnaní s kontrolnou skupinou, v pokusnej skupine boli zistené významne (P < 0.05) vyššie množstvá zinku vo vzorkách prsných svalov, horčíku a medi vo vzorkách stehenných svalov. V experimentálnej skupine vo vzorkách z pečene bola zistená vyššia (P > 0.05) koncentrácia iba v obsahu mangánu. Výskyt mangánu nebol spozorovaný ani v jednom zo svalov.

Kľúčové slová: fytogénne aditívum, minerálne látky, morky, sval, živiny

Introduction

FAO (2011) still identify increase in poultry meat consumption in recent years and the need for increase production. Consumers have been increasingly interested in products that they perceive as naturally produced or environmentally friendly. Consumers want chickens that provide a high level of nutrient without contaminants, good flavour and rearing techniques that offer good welfare and health for the bird

(Owens et al., 2006). Turkey is one of the leanest types of poultry and a good source of protein and minerals such as sodium, potassium and iron (Ferreira et al., 2000). Feed additives are a group of feed ingredients that can cause a desired animal response in a non-nutrient role such as pH shift, growth or metabolic modifier (Hashemi and Davoodi, 2010). For poultry are widely used supplements with antimicrobial effect, antioxidant effect, pH controlling agents, enzymes, feed acidifiers, probiotics, prebiotics, fytobiotics, synbiotics and other specific active ingredients (Arpášová, 2011). They may have a beneficial effect on gastrointestinal microflora of poultry (Kačániová et al., 2011), production characteristics, meat quality (Haščík et al., 2009; Angelovičová et al., 2010) eggs of poultry (Gálik and Horniaková, 2010; Arpášová, 2011) vitality and health condition (Gerzilov et al., 2015). Phytogenics are a relatively young class of feed additives and in recent years this feed additives have gained considerable attention in the feed industry. Phytogenics are derived from herbs, spices or aromatic plants and have shown antimicrobial, antifungal, antiviral, antioxidant and sedative properties (Hashemi and Davoodi, 2010). The researchers attributed the positive effects of plant extracts on nutrient digestibility to the appetite and digestion-stimulating properties and antimicrobial effects. Therefore they may exert multiple functions in the animal body. Increased feed intake and digestive secretions are also observed in animals offered phytobiotic-supplemented feed (Windisch and Kroismayr, 2006). Vegetable oils, also called essential oils are aromatic, liquids obtained from plant material (flowers, buds, seeds, leaves, twigs, bark, herbs, wood, fruits and roots). It is a complex mixture of different organic molecules – terpenes, alcohols, esters, aldehydes, ketones and phenols (Panda et al., 2009). The two phenols, carvacrol and thymol, the major components of oregano essential oil are mainly responsible for its antimicrobial activity (Juliano et al., 2000). Using phytogenic or herbal plants containing essential oils in poultry farms has developed with successful results (Hashemi and Davoodi, 2010). Anise oil has anethole (85%) as active ingredient and also it has contained eugenol, methylchavicol, anisaldehyde and estragole. As medicinal plant, anise has been used as a stimulating effect of digestion and antiparasitic (Cabuk et al., 2003). Fructooligosaccharides (FOS) reportedly can be substituted for antibiotics to enhance the growth and production effeciency of broilers (Wu et al., 1999). They can be classified as indigestible oligosaccharides because the β-linkages between fructose monomers cannot be hydrolyzed by enzymes of endogenous origin. As a consequence, FOS are quantitatively available as substrates for gastrointestinal microflora (Roberfroid et al., 1998). The FOS have been shown to enhance the growth of Bifidobacterium and Lactobacillus but inhibit Escherichia coli and Salmonella in the large intestine (Xu et al., 2002).

The subject of this work was to determine the effect of a blend of phytogenic additive on nutritional and mineral composition of breast, thigh muscles and liver in fattening turkeys.

Material and methods

Animals and housing

The experiment was realized in cooperation with private turkey farm (Morky Petránek, s.r.o., Čremošné, Slovak Republic). At 1-day old broad-breasted female white turkey hybrid XL were used in trial. Experiment lasted 18 weeks. A total 300 turkeys were randomly divided into two groups, control and experimental (150 pcs per each group). Turkeys were housed in group on deep litter.

Feeding

Turkeys in the control group were fed standard fattening complete feed mixture and in the experimental group from the 1st to the 12th week of turkeys age feed mixture was enriched with blend of essential oils from origanum, anise and citrus fruits as well as prebiotic rich fructooligosaccharides in dose 1kg per 1000 kg of feed mixture. After 12th week, turkeys in the experimental group were fed standard fattening complete feed mixture. Nutrient composition of feed mixture is presented in Table 1. Turkeys in both groups received drinking water and feed mixture *ad libitum*.

Table 1. Nutrient composition of complete feed mixture

Tabuľka 1. Živinové zloženie kompletnej kŕmnej zmesi

	DM	CP	F	CF	NFE	Starch	T.s.	ME_N
	$g*kg^{-1}$			$g*kg^{-1}$ of dry matter				$MJ*kg^{-1}$
				Control group				
KR1	906.3	297.7	56.9	37.4	541.8	343.5	54.1	11.79
KR2	903.9	271.9	51.8	40.5	557.7	362.8	46.7	11.4
KR3	895.9	252.3	70.1	40.7	564.8	357.7	46.1	11.55
				Experimental group				
KR1	902.9	294.1	49.6	41	549.1	346.6	52.1	11.49
KR2	907.5	260.6	63.4	35.9	578.6	400.4	47.6	11.6
KR3	903.5	245.2	59.7	31.9	601	434.1	47.8	12.39
				Both groups				
KR4	915	211.4	82.5	42.1	601.9	417.5	42	12.47
KR5	905.4	193.8	70.5	41.7	630.9	471.6	39.2	12.5
KR6	908.3	183.4	93.6	42.3	631.2	464.3	37	12.98
Wheat	896.3	146.5	15.2	26.9	792.9	667.5	33.2	12.88

DM: dry matter, CP: crude protein, F: crude fat, CF: crude fibre, NFE: nitrogen free extract, T.s.: total sugars, ME_N: metabolisable energy, KR1-KR6: complete feed mixtures for turkeys fattening

Sampling and laboratory analysis

Samples of meat were obtained manually from breast, thigh muscles and liver after slaughter of turkeys, (in 18th week of age) during dissection (10 samples per each group). Nutrients composition of diets and meat were determined by standard laboratory methods and procedures (AOAC, 2000). Content of dry matter was determined by drying of the sample by gravimetric method, crude protein by Kjeldahl method (mineralization, distillation, titration), fat by extraction and gravimetric method according Soxhlet principle and ash by complete combustion of the sample in a muffle furnace at 550°C (4-6 hours). The contents of mineral nutrients were determined by High Resolution Continuum Source Atomic Absorption Spectrometer ANALYTIK JENA contrAA 700 (Ca, Mg, Na, K, Zn, Cu, Fe, Mn) and 6400 Spectrophotometer (P). The determination of individual elements' content was based on the absorptions measured at the following wavelengths: Ca content was detected at 422.7 nm, P at 666 nm, Mg at 285.2 nm, Na at 589.0 nm, K at 766.5 nm, Zn at 213.9 nm, Cu at 324.7 nm, Fe at 248.3 nm and Mn at 279.5 nm. Laboratory analysis of nutritional composition of turkeys meat was carried out in the Laboratory of quality and nutritional value of feeds at the Department of Animal Nutrition in Slovak University of Agriculture in Nitra, Slovakia.

Statistic analysis

The data used for statistical analyses represents means of values obtained from 10 animals from each group. Differences between groups were analyzed with one-way analysis of variance (ANOVA) by using the statistical programme IBM SPSS 20.0. Results were evaluated using Tukey test.

Results and discussion

Nutritional composition

Scientific literature on the nutrient content and food composition tables of offal is relatively scarce. However the nutritive value of all food products including meat and meat products is important, in view of the consumer interest and demand for their nutrition (Pearson and Gillett, 1996). Therefore, there is great need for more detailed information about adequate nutritive value, especially protein (Mittal and Lawrie, 1984).

Results of nutrients composition of turkey meat are shown in Table 2. There were found statstically significant ($P < 0.05$) differences between control and experimental group of breast muscles in content of crude protein and fat. After addition of phytogenic additive, significant ($P < 0.05$) differences in all analyzed nutrients in thigh muscles were found. Higher amounts were detected in content of crude protein and ash in experimental samples of thigh muscles. In samples of liver were found significant ($P < 0.05$) differences only in content of ash. Berri et al. (2001) reported content of dry matter 25.25% and protein 94.1% of DM in breasts. Content of fat was 1.76% of DM in pectoral muscles (Kurt and Kilincceker, 2011). Similar values were observed in present experiment. Laudadio et al. (2014) found 27.97% DM, 88.34%

protein, 7.47% fat, 4.18% ash of DM in breast and 26.69% DM, 85.61% protein, 10.30% fat and 4.08% ash of DM in thigh after soybean meal diet. Turkeys fed soybean oil and blended fat had statistically greater protein and fat content (20.2% and 5.9%, respectively) in drum/thigh meat than those fed soybean oil (King and Fitzpatrick, 1989). Ding and Lilburn (1996) reported content of dry matter 27% and lipid 35.68% of DM in liver of turkey.

In this current study was found lower content of fat (10.98-17.19% of DM) compared with previous experiment. Mohammed (2012) observed insignificant ($P>0.01$) differences among all groups of broilers in contents of DM, crude protein and ash after addition packed fat, sunflower and rapeseed oils in liver. The values for total lipid ($g*100g^{-1}$) in legs and breast were 1.1 and 0.5 (Baggio et al., 2002). In comparison with current results, Karakök et al. (2010) presented higher contents of DM, protein, ash and lower content of fat in thigh muscles. Jankowski et al. (2012) reported no significant differences in chemical composition of raw breast meat between control group and experimental groups (addition of soybean, rapeseed, linseed oil in feed mixture). Dry matter ranged from 26.2 to 26.7%, fat from 2.67 to 3.03% of DM, protein from 90.08 to 90.11% of DM and ash from 4.5 to 4.52% of DM in experimental group (Jankowski et al., 2012). In study by Ebeid et al. (2011), no differences were also found in the content of dry matter, total protein, and crude ash in the breast muscles. Crespo and Esteve-Garcia (2001) found that different dietary fats had a significant effect on the ash content of thigh and breast muscle. Lopez-Ferrer et al. (1999), Crespo and Esteve-Garcia (2002), Rahimi et al. (2011) showed that the dietary PUFA levels does not influence on intramuscular lipid content of breast. Ajuyah et al. (1993) found a higher fat content in breast with increasing levels of PUFA in the diet. In contrast, Cortinas et al. (2004) and Sanz et al. (2000) found lower lipid content of breast muscle of chickens fed diets enriched with polyunsaturated oils. The concentrations of the above components in the whole carcass of chickens fed diets supplemented with different vegetable oils did not differ significantly (Kavouridou et al., 2008). Eleroğlu et al. (2013) reported lower content of protein and ash, higher content of fat in chickens breast muscle with 31.93% of DM after supplementation of *Origanum vulgare* leaves. Similar findings were reported by Grashorn and Serini (2006) and Küçükyilmaz et al. (2012). Katogianni et al. (2008) found 28.3% DM and 87.63% protein in breast muscle. Sarica et al. (2011) reported content of DM 27.67%, protein 71.56% of DM, fat 20.82% of DM and ash 3.87% of DM in thigh muscle of 17 weeks old female turkeys.

In present study lower contents of dry mater and fat but higher contents of crude protein and ash in comparison with previous results were found. Several authors indicated that there is not significant effect of added herbs on the composition of meat products (Koreleski and Swiatkiewcz, 2007; Marcinčáková et al., 2011; Marcinčák et al., 2011; Narimani-Rad et al., 2011) in conventional confined systems. Serdaroglu and Turp (2005) reported 25.6% DM, 78.51% protein of DM, 18.75% fat of DM and 2.56% ash of DM in whole turkey carcasses. Significant Pearson correlation coefficient was found between dry matter with crude protein at the 0.01 level and fat at the 0.05 level.

Table 2. The content of nutrients in samples

Tabuľka 2. Obsah živín vo vzorkách

Sample	Statistical parameter	Dry matter	Crude protein	Fat	Ash
		(%)	(% of DM)		
Pectoral muscle C	Mean	26.73	91.13[a]	3.62[a]	4.25
	S.D.	1.01	1.11	0.90	0.25
Pectoral muscle E	Mean	25.85	93.7[b]	1.65[b]	4.51
	S.D.	0.09	0.02	0.01	0.05
Thigh muscle C	Mean	25.87[a]	79.78[a]	14.12[a]	4.25[a]
	S.D.	0.41	1.62	1.93	0.10
Thigh muscle E	Mean	24.42[b]	85.73[b]	8.62[b]	4.61[b]
	S.D.	0.5	0.48	0.72	0.06
Liver C	Mean	26.81	73.87	10.98	4.98[a]
	S.D.	0.64	7.03	2.37	0.26
Liver E	Mean	29.21	64.93	17.19	4.29[b]
	S.D.	1.94	0.32	10.23	0.18

S.D.: standard deviation, C: control group, E:experimental group. Values with different superscripts in a column (for same kind of sample) are significant at the 0.05 level.

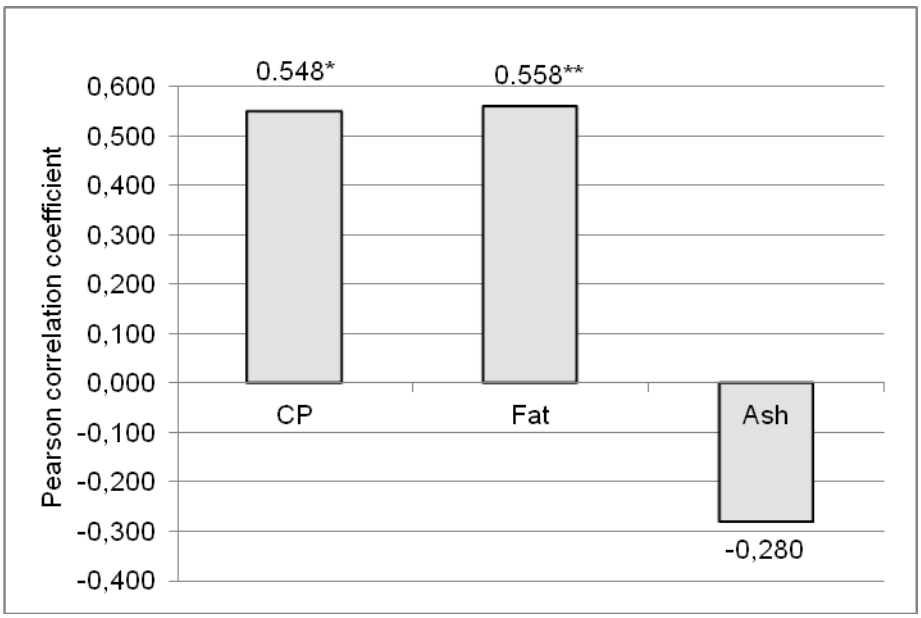

Figure 1. The correlation between dry matter and individual nutrients

Obrázok 1. Korelačný vzťah medzi sušinou a jednotlivými živinami

** Correlation is significant at the 0.01 level, * Correlation is significant at the 0.05 level.

CP: crude protein.

Mineral composition

The main role of minerals is their structural function. They are very important as regulators of physical-chemical processes in the organism, are involved in the maintenance of acid-base balance, perform an important function in the regulation of the osmotic pressure and in formation of buffer system of biological fluid (Pajtáš et al., 2009).
Results of minerals composition of turkey meat are shown in Table 3. Significant ($P < 0.05$) differences in all minerals except potassium and manganese were found. In the case of breast muscle significant ($P < 0.05$) differences were observed only in content of zinc but higher amounts of minerals were found in all experimental groups. Compare to the control group, in the experimental group have been observed significantly ($P < 0.05$) higher concentration of phoshorus, magnesium, sodium and copper in thigh muscle samples. There was found negative affect of treatment on contents of minerals in liver. Higher ($P > 0.05$) content was recorded only in content of manganese. Statistically significant ($P < 0.05$) differences were found in content of calcium, phosphorus, magnesium, sodium, iron and zinc. In study Karakök et al. (2010) was found lower content of calcium than magnesium in thigh muscle compared to present experiment. There was detected incidence of manganese and more amount of iron than zinc from analysis of microelements (Karakök et al., 2010). Higher content of zinc than iron was found and manganese was not found in thigh muscles samples. Content of iron was 12.99 $mg*kg^{-1}$ DM in breast (Berri et al., 2001). Higher content of iron (13.81-14.30 $mg*kg^{-1}$ DM) was found. Barroeta (2007) reported higher content of Fe than Zn in breast muscle of poultry compared to current finding. Serdaroglu and Turp (2005) reported contents of Ca 67.19 $mg*kg^{-1}$ DM and Fe 52 $mg*kg^{-1}$ DM in whole turkey carcasses. The highest Pearson correlation coefficient ($P < 0.01$) was recorded between ash and phosphorus. Statistically significant ($P < 0.01$) correlations were found also between ash and sodium, copper and iron.

Table 3. The content of minerals in samples

Tabuľka 3. Obsah minerálnych látok vo vzorkách

Mineral	Statistical parameter	Pectoral muscle C	Pectoral muscle E	Thigh muscle C	Thigh muscle E	Liver C	Liver E
Ca	Mean	66.01	78.79	1362.25	1431.50	106.98^{a}	76.05^{b}
mg*kg^{-1} DM	S.D.	4.79	14.96	434.52	847.50	19.07	9.75
P	Mean	10.06	10.44	9.65^{a}	10.36^{b}	12.34^{a}	10.87^{b}
g*kg^{-1} DM	S.D.	0.66	0.28	0.34	0.22	0.77	0.14
Mg	Mean	628.70	639.27	517.06^{a}	598.5^{b}	581.65^{a}	494.7^{b}
mg*kg^{-1} DM	S.D.	85.29	22.10	17.73	1.50	52.50	11.40
Na	Mean	2.21	2.22	2.75^{a}	2.97^{b}	3.49^{a}	2.94^{b}
g*kg^{-1} DM	S.D.	0.24	0.20	0.12	0.03	0.22	0.08
K	Mean	13.01	13.63	11.90	12.78	10.75	9.67
g*kg^{-1} DM	S.D.	1.89	0.43	0.31	0.48	0.38	0.79
Cu	Mean	2.26	2.36	3.66^{a}	5.07^{b}	16.57	14.03
mg*kg^{-1} DM	S.D.	0.20	0.08	0.34	0.60	1.97	0.57
Fe	Mean	13.81	14.30	30.38	30.13	240.48^{a}	167.04^{b}
mg*kg^{-1} DM	S.D.	1.45	0.07	2.97	2.34	38.76	28.06
Mn	Mean	N.D.	N.D.	N.D.	N.D.	2.02	2.29
mg*kg^{-1} DM	S.D.					0.59	0.71
Zn	Mean	34.87^{a}	44.91^{b}	132.93	120.94	88.2^{a}	69.55^{b}
mg*kg^{-1} DM	S.D.	1.54	6.15	21.43	15.91	7.24	3.24

S.D.: standard deviation, DM: dry mater, C: control group, E:experimental group. Values with different superscripts in a row (for same kind of sample) are significant at the 0.05 level.

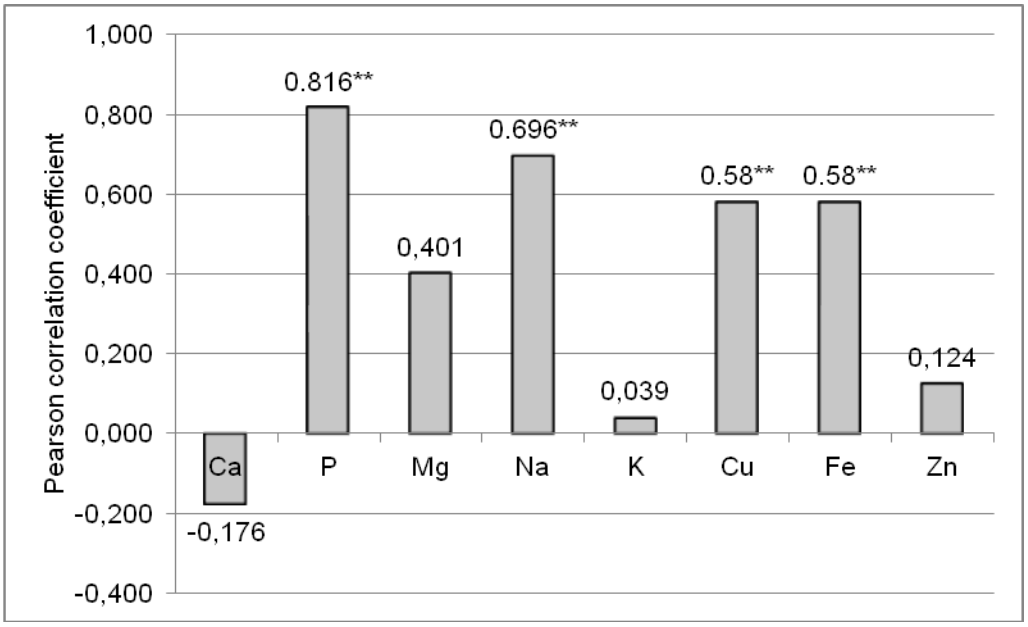

Figure 2. The correlation between ash and individual minerals

Obrázok 2. Korelačný vzťah medzi popolom a jednotlivými minerálnymi látkami

** Correlation is significant at the 0.01 level

Conclusions

The goal of this study was to find the impact of phytogenic additive on nutritional and mineral composition of breast, thigh muscles and liver of turkeys. Supplementation of phytogenic in feed mixtures for turkeys lead to an increase dry matter and fat in liver, crude protein and ash in muscles. Significant ($P < 0.05$) differences were found in content of crude protein and fat in pectoral muscle, content of all nutrients in thigh muscle and content of ash in liver between control and experimental groups. There were found significant ($P < 0.05$) differences in content of zinc in pectoral muscle, content of phosphorus, magnesium, sodium and copper in thigh muscle and content of calcium, phosphorus, magnesium, sodium, iron, and zinc in liver.

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