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EFFECT OF CURING AND THERMAL TREATMENT OF THE QUALITY OF MEAT PRODUCTS FROM TURKEYS FED DIETS ENRICHED PROTEIN-XANTHOPHYLL EXTRACT OF ALFALFA

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Key words: alfalfa, feed supplementation, turkey, meat product, yield of product, chemical composition, sensory evaluation.

Abstract

The aim of the study was to evaluate the effect of the method of curing and thermal processing on yield of product, chemical composition and sensory quality of meat products from turkeys fed diets enriched in protein-xanthophyll extract of alfalfa (PX). The experiment involved 120 turkeys allotted to groups: 1 – control without any supplementation; 2 and 3 with 1.5% and 3% supplementation of PX, respectively. After slaughter and carcasses division breast and thigh muscles of each group were divided into two parts. One part of the mixture were cured and dried and after that smoked and cooked. To the other sample salt was added then roasted. Water and salt content, pH, the sensory evaluation, instrumental color were determined after production. The result showed that the feedstuff supplementation with 1.5% use of PX in turkeys diet does not significantly (P<0.05) affect on tested quality factors of the meat products. Feedstuff with addition the 3% PX caused a significant deterioration in products flavor.

WPŁYW SPOSOBU PEKLOWANIA I OBRÓBKI TERMICZNEJ NA JAKOŚĆ PRODUKTÓW Z MIĘSA INDYKÓW ŻYWIONYCH PASZĄ WZBOGACONĄ W EKSTRAKT Z LUCERNY

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Słowa kluczowe: lucerna, suplementacja paszy, indyki, wyrób mięsny, wydajność produktu, skład chemiczny, ocena sensoryczna.

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Abstrakt

Celem pracy była ocena wpływu sposobu peklowania i obróbki termicznej na wydajność technologiczną, skład chemiczny i jakość sensoryczną pieczonych i wędzonych wyrobów z mięsa indyków żywionych paszą wzbogaconą w ekstrakt białkowo-ksantofilowy preparatu z lucerny (PX). W doświadczeniu zwierzęta podzielono na 3 grupy: grupę 1 – kontrolną – żywiono niesuplementowaną paszą, grupie 2 dodawano do paszy 1,5% PX, zaś grupie 3 – 3% PX. Po uboju i dysekcji tuszki mięśnie piersi i ud każdej z grup dzielono na dwie części. Jedną część peklowano, wędzono i parzono, drugą solono i pieczono. W otrzymanych wyrobach oznaczano zawartość wody i soli, kwasowość, barwę (L*,a*,b*) oraz przeprowadzono ocenę sensoryczną. Stwierdzono, że 1,5-procentowy dodatek PX do paszy indyków nie wpływa istotnie (P<0,05) na badane wyróżniki jakości wędzonych i pieczonych wyrobów z mięsa tych zwierząt. Dwukrotne zwiększenie suplementacji tego preparatu w paszy spowodowało znaczne pogorszenie smaku wyrobów.

Introduction

Sensory quality is one of the most important features in food, including meat products, too. There are many knowing factors affecting the meat quality and thus the consumers desire and its acceptance. Among all factors: feeding habits, feedstuff type and its composition can be mentioned. Feed components influence the nutritional and physico-chemical properties of meat and its sensory characteristics, which in turn are reflected in the quality of meat products.

In the recent years there a lot of plant ingredients (fitobiotics) as potential feed ingredients for poultry have been researched. One of such ingredient is an alfalfa (Medicago sativa L.) and various alfalfa extracts and preparations. Alfalfa is a valuable source of nutrients including essential amino acids, vitamins (A, B, C, D, E, K), and minerals (Ca, Cu, Fe, Mg, Mn, P, Zn, Si) (BEN AZIZ et al. 2006, GAWEŁ 2012) and it contains many biologically active substances. Many alfalfa products contain toxic alkaloid canavanine and coumestrol. Extraction process removes canavanine and coumestrol from alfalfa lives providing potent form of saponins that has been shown to have antiatherosclerotic activity (KHALEEL et al. 2005), antibacterial activity (AVATO et al. 2006) and antifungal activity (POLACHECK et al. 1991). Plant sterols (β-sitosterol, campesterol, cycloartenol, α-spinasterol and stigmasterol) and polyphenols having estrogenic activity and isoflavones (biochanin A, daidzein, genistein and formonoetyna) are also the source of phytoestrogens (*e.g.* coumestrol) which reduce neurovegetative symptoms during menopause, the incidence of ischemic heart disease and hormone-dependent breast and prostate cancer with bone osteoporosis process (LAMSAL et al. 2007). Animal studies by MEHRENJANI et al. (2007) have also shown alfalfa antidiabetic effect and studies by DONG et al. (2007) the immunostimulatory effect.

Alfalfa has long been used in animal nutrition (CARRILHO et al. 2009, RIPOLL et al. 2012). It was found that preparations of alfalfa added to feed, improve feed efficiency increasing the body weight gain and reducing feed consumption as well as increased the fatty acid content in muscle and improve its profile (JIANG et al. 2012). The quality of feed components has an impact on animal health and meat quality (PETTIGREW and ESNAOLA 2001). Several nutrients and additives are transferred from feed to muscles and adipose tissue when fed to monogastric animals. The extract of alfalfa is free from mycotoxins and pesticide contamination (GAWEŁ 2012). Many authors suggest that the addition of alfalfa concentrate to turkey diets did not cause the loss of meat quality (KARWOWSKA et al. 2007, KARWOWSKA 2008, BLANCO et al. 2010, DEL CAMPO et al. 2010, KARWOWSKA et al. 2010, RESCONI et al. 2010, HUTCHISON et al. 2012, PORDOMINGO et al. 2012). However, not much is known about the effects of alfalfa feeding or feed containing preparations of alfalfa on sensory characteristics of products produced from meat of these animals.

The objective was to evaluate the effects of dietary protein-xanthophylls concentrate (PX) of alfalfa to turkey diets (at 1.5 and 3.0%) on the yield of product, chemical composition and sensory quality of smoked and roasted breast and thigh muscles.

Material and Methods

Animals and diet. One hundred and twenty 42-day turkey poults (Big-6 type) were selected at random and divided into three groups of 40. A control group (group 1) was fed according to the Poultry Feeding Standards (NRC 1994). The other groups were fed with 1.5% (group 2) and 3.0% (group 3) protein-xanthophylls (PX) concentrate of alfalfa, instead of extracted soybean extracted meal. The ingredients of the diets are presented in Table 1. Alfalfa concentrate was prepared by condensing the juice of alfalfa leaves. The method of obtaining a protein concentrate from the leaves of alfalfa was developed as a result of thermocoagulation of protein at the temperature of 85–90°C prior to conventional dehydration. (CAILLOT 2008, Commission Decision 2009/826/EC). Feed and water was provided *ad libitum*. After 11 weeks, the turkeys with an average live weight of 16.9 ± 0.5 kg were slaughtered under commercial conditions (Council Regulation (EC) No 1099/2009). The breast and thigh muscles were stored at 4°C for 24 h.

Manufacturing of products. Breast (without bones and skin) and thigh (with a bone and skin) of each group were divided into two parts. The cured dry mixture (99.4–99.5% sodium chloride, 0.5–0.6% sodium nitrite) at a ratio 2.5% of the meat was added to the first part. The same rate of salt was added to

Table 1

Composition of basal diets (%)

Item	Feeding period (weeks)		
	7–9	10–12	13–18
Maize	10.0	10.0	10.0
Wheat	46.63	51.32	57.69
Soybean extracted meal (47% CP)	36.00	31.00	24.50
Soya oil	2.50	3.00	3.60
Calcium phosphate	1.85	1.75	1.60
Ronozyme P 5000	0.015	0.015	0.0
Ronozyme WX	0.02	0.02	0.0
Limestone	1.30	1.27	1.10
NaCl	0.23	0.23	0.22
Sour sodium carbonate ($NaHCO_3$)	0.11	0.10	0.11
Betafin S1 (Betaine)	0.10	0.10	0.0
Choline chloride (60%)	0.10	0.10	0.0
Lysine (98%)	0.35	0.325	0.0
Methionine DL (99%)	0.25	0.25	0.0
Threonine L (98%)	0.02	–	0.03
Vitamin-mineral premix	0.53	0.52	1.15

another sample. Then the meat was stored at 4°C for 48 h. Next, the cured samples were smoked (thick smoke, 50°C, 30 min.) and cooked (75°C, until a final temperature of 70°C was reached in center of product) in the laboratory smoking-cooking chamber (Jugema, Poland). The salted samples were roasted in the roaster (XF135, Unox S.p.A., Italy) at 180°C until the final temperature of 70°C was reached in center of product. Subsequently, the samples were cooled to 20–25°C for 1 h and stored in a refrigerator (4°C) for 24 h. The experimental variants of turkey meat products showed are in Table 2.

Table 2

The experimental variants of turkey meat products

Part of turkey carcasses	Type of processing	Group of turkeys		
		Control (group 1) (n=40)	1.5% PX (group 2) (n=40)	3.0% PX (group 3) (n=40)
Thigh	Smoked and cooked (n=3) Roasted (n=3)	TS1 TR1	TS2 TR2	TS3 TR3
Breast	Smoked and cooked (n=3) Roasted (n=3)	BS1 BR1	BS2 BR2	BS3 BR3

Yield of the final product. The yield of the final product was calculated from the weight of the product (after heat treatment and 24 h cooling) as a percentage of the weight of the raw meat (uncured, unsalted) (U.S. Department of Agriculture, 2012).

Measurement of pH (ISO 2917:2001). Ten grams of minced meat product was homogenized with 100 ml of potassium chloride solution (0,1 mol/L) for 1 min using the homogenizer (IKA ULTRA-TURRAX T25 Basic, Germany). The homogenate was filtered through filter paper and the pH of the filtrate was measured with the digital pH-meter CPC-501 (Elmetron, Poland) equipped with the pH electrode (ERH-111, Elmetron, Poland).

The moisture and total chlorides were quantified according to the ISO recommended standards (ISO 1442:1997) and to the argentometric Volhard method (ISO 1841-1:1996), respectively. The total chloride calculated on salt.

Instrumental color measurements were taken after production (day 1). Color parameters (CIE L*a*b*) were measured on the freshly cut surface of a product in 10 measuring points using 8200 Series reflection spectrocolorimeter (X-Rite Inc., USA) with a D65 illuminant and a 10^{o} standard observer. Color coordinates were determined using the CIE Lab system. The results were expressed as lightness (L*, 100 = white and 0 = black), redness /greenness (a*, positive = red) and yellowness /blueness (b*, positive = yellow). Prior to use, the spectrocolorimeter was calibrated against white and black standard tiles.

Sensory evaluation. To determine the sensory quality, 5-point hedonic scale was used where 1 indicated extremely undesirable property, and 5 – very desirable (ISO 4121: 2003, ISO 5492: 2008). Sensory attributes of products from turkey breast: color and structure of section, consistency, odor and overall flavor were measured. The assessment was made by the 8-person panel consisting of employees of the Department of Meat Technology and Food Quality, University of Life Sciences in Lublin. The panel had years of experience in sensory evaluation practice (ISO 8586: 2014). They were trained theoretically and practically for the methods applied. Meat product samples were sliced into approximately equal size and weight (around 10 g) and placed in plastic odorless, disposable, covered with lids boxes (volume, 125 mL). All samples were separately coded with three digits and were randomly served to avoid carry-over effects. The test samples were kept in boxes at room temperature (22 ± 1^{o}C) for 30 min before analysis. They were presented to panelists in plastic boxes with covers on a white background with assessments cards. Water and unsalted crackers were provided to cleanse the palate between samples.

Statistical analysis

The experiment was repeated three times. Physicochemical analyses were performed in six replicates in each experiment. Analysis of variance (ANOVA) was performed on all variables using the General Linear Model process of the SAS statistical software. The significance of the differences between mean values was calculated at a significance level of *P<0.05* using the *T-Tukey's* range test.

Results and Discussion

A weight loss, primarily water during thermal treatment is an important feature affecting the sensory evaluation of meat products. Their size determines the degree of tenderness, juiciness and other sensory attributes experienced during the test. The earlier study revealed that the chemical composition of raw breast and thigh muscle of turkeys fed with diets supplemented with protein-xanthophylls concentrate of alfalfa was not affected by the diet (KARWOWSKA *et al.* 2010). However, in current study chemical composition was influenced by dietary treatment showing significantly higher yield of smoked and cooked breast (BS) and thighs (TS) in comparison to roasted breast (BR) and thighs (TR) (Table 3). The BS is characterized by an increase of about 10 to 17 percentage points productivity compared to BR. This is mainly due to the method of heat treatment of the samples roasted i.e. using higher temperatures and forced air. The yield of control sample of smoked (TS1) were statistically significantly ($P<0.05$) higher than yield of the thighs of turkeys fed diet with alfalfa preparation (TS2 and TS3). Yield of roasted breast (BR) was at the level 66.30% of the sample BR2 to 70.87% in the control sample (BR1). Difference in the yield of these samples was statistically significant and will certainly have an impact on their chemical composition.

Table 3

Yield of product, moisture and salt content, pH values of meat products stored 24 h at 4°C

Sample	Yield of product [%]	Moisture [%]	NaCl [%]	pH
TR1	66.16 ± 1.45	60.95 ± 0.01	3.81 ± 0.03^{ab}	5.87 ± 0.03
TR2	64.90 ± 2.23	62.27 ± 0.03	1.46 ± 0.05^{b}	5.69 ± 0.01
TR3	64.71 ± 2.86	62.06 ± 0.00	1.75 ± 0.02^{a}	5.81 ± 0.02
TS1	92.05 ± 4.68^{ab}	61.10 ± 0.00^{ab}	1.75 ± 0.04	5.81 ± 0.02
TS2	86.81 ± 4.63^{b}	70.18 ± 0.00^{b}	2.07 ± 0.03	5.79 ± 0.01
TS3	86.14 ± 3.58^{a}	68.67 ± 0.18^{a}	1.90 ± 0.02	5.8 ± 0.01
BR1	70.87 ± 1.56^{a}	45.69 ± 0.06^{ab}	2.63 ± 0.08^{a}	5.89 ± 0.02
BR2	66.30 ± 3.45^{a}	35.59 ± 0.05^{b}	2.97 ± 0.06	5.83 ± 0.03
BR3	69.03 ± 2.12	33.28 ± 0.02^{a}	3.07 ± 0.10^{a}	5.88 ± 0.01
BS1	83.98 ± 5.69	60.92 ± 0.08^{a}	3.22 ± 0.12^{ab}	5.76 ± 0.02
BS2	83.30 ± 4.87	37.29 ± 0.04^{a}	2.34 ± 0.03^{b}	5.61 ± 0.02
BS3	79.91 ± 3.25	56.27 ± 0.18^{a}	2.66 ± 0.08^{a}	5.75 ± 0.04

Values are given as mean ± SD (standard deviation), n = 18

Values, in columns within the same groups (part of turkey carcasses, treatment, parameter), marked with the same characters are significantly different ($P<0.05$)

The salt content in meat products influences the degree of hydration of the proteins and changes color after heat treatment. Furthermore, it forms their durability by lowering water activity. Moreover, from sensory evaluation of meat products point of view, the flavor is primarily determined by salt. In the production process, the same percentage of salt addition or cured dry mixture (2.5%) is used in the samples. However, due to different heat treatment with different yield of finished product, salt content in the finished products differ significantly (Table 3). Salt content was lower in the roasted or smoked thigh samples than in the breast samples ($P<0.05$).

The pH of a meat product is important because it affects many quality factors, including color, texture and flavor (LEE et al. 2010). In the earlier study by KARWOWSKA et al. (2010), the chemical characterization of the raw meat of turkeys fed with protein-xanthophylls concentrate of alfalfa supplemented diets showed that the supplementation had no significant effect on pH of the samples during 120 h of storage ($P<0.05$). The pH values of breast muscles were lower than those of the thigh muscles. Storage time did not affect the pH values. Similar relationships were observed in this study. The pH values between samples did not differ significantly ($P<0.05$).

In consumers opinion color appears to be very important quality characteristic of meat products. The results obtained in this experiment and statistical analysis of color parameters showed no significant effect of the addition of the preparation of the alfalfa fed to turkeys in the value of the parameter L*, a* and b* of meat products (Table 4). Similar relationship was observed in the raw lamb meat (RIPOLL et al. 2012), rabbit meat (CARRILHO et al. 2009) and pork meat, as well as smoked and cooked ham from pigs fed diets supplemented with the alfalfa extract (KARWOWSKA et al. 2007, KARWOWSKA 2008).

Table 4

Color values in CIE L* a* b* of turkey meat products stored 24 h at 4°C

Sample	L*	a*	b*
TR1	62.23 ± 4.20	3.72 ± 0.81	14.36 ± 1.84
TR2	68.19 ± 2.36	3.71 ± 0.13	14.64 ± 0.64
TR3	65.45 ± 1.41	3.82 ± 0.35	15.19 ± 0.45
TS1	66.14 ± 1.09	9.62 ± 1.41	9.98 ± 1.86
TS2	66.44 ± 4.39	10.22 ± 0.95	11.11 ± 1.13
TS3	62.96 ± 4.15	11.63 ± 1.13	11.25 ± 1.55
BR1	77.92 ± 3.68	2.25 ± 1.89	12.65 ± 1.54
BR2	76.04 ± 1.74	1.41 ± 0.34	13.80 ± 0.82
BR3	79.12 ± 1.73	1.46 ± 0.43	13.81 ± 1.18
BS1	74.12 ± 5.51	5.80 ± 1.09	8.36 ± 1.20
BS2	80.78 ± 0.60	5.15 ± 0.18	9.50 ± 0.14
BS3	77.48 ± 3.86	5.38 ± 0.38	9.65 ± 0.70

Values are given as mean ± SD (standard deviation), $n = 30$

Statistical analysis showed a significant effect of dietary addition of alfalfa extract on color, texture and overall flavor of tested meat products (Table 5). The lowest color score was observed in cross-roast breast from turkeys fed with the 3% protein-xanthophylls (PX) concentrate of alfalfa. Moreover, the flavor of sample from this experimental group was rated as the lowest, regardless of the heat treatment. The evaluator's team has sensed it as non-specific, off-taste and off-odors. This result does not agree with earlier study by KARWOWSKA et al. (2007) where sensory of smoked and cured ham from pigs fed with the same preparation with protein-alfalfa xanthophylls was evaluated.

Table 5

Results of sensory evaluation [points] of products from turkey breast stored 24 h at 4°C

Sample	Structure of section	Color of section	Consistency	Odor	Overall flavor
BR1	4.3 ± 0.21	3.6 ± 0.08^{a}	4.4 ± 0.09^{a}	4.6 ± 0.12	4.6 ± 0.21^{a}
BR2	4.1 ± 0.19^{a}	4.0 ± 0.21^{ab}	3.8 ± 0.14^{ab}	4.6 ± 0.11	4.3 ± 0.22^{b}
BR3	4.7 ± 0.11^{a}	3.4 ± 0.12^{b}	4.4 ± 0.23^{b}	4.8 ± 0.09	3.9 ± 0.14^{ab}
BS1	4.3 ± 0.12	3.9 ± 0.13^{ab}	3.9 ± 0.24^{a}	4.6 ± 0.13	4.5 ± 0.31^{a}
BS2	4.5 ± 0.43	4.6 ± 0.22^{b}	4.3 ± 0.38^{a}	4.7 ± 0.10	4.4 ± 0.19^{b}
BS3	4.4 ± 0.33	4.8 ± 0.29^{a}	4.8 ± 0.31^{a}	4.6 ± 0.12	4.0 ± 0.08^{ab}

Values are given as mean ± SD (standard deviation), n = 24
Values, in columns within the same groups (part of turkey carcasses, treatment, parameter), marked with the same characters are significantly different $P<0.05$)

Conclusions

Meat products from turkeys fed diet supplemented with protein-xanthophyll concentrate of alfalfa yield significantly lower and were lower in water content in comparison to the products from birds fed diet without the supplement. The content of protein-xanthophyll concentrate of alfalfa in turkey's diet did not affect the color parameters of tested products. Protein-xanthophyll extract of alfalfa included at 3% of the diets has caused a significant deterioration in flavor of meat products.

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