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# EFFECT OF DIETARY SUPPLEMENTATION WITH EXTRACTED ALFALFA MEAL ON OXIDATION STABILITY OF COOKED HAM

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The effect of dietary supplementation with extracted alfalfa meal (2 g per 1 kg diet) on colour and oxidative stability was studied. The results did not indicate the influence of dietary supplementation with extracted alfalfa meal on the colour changes of smoked ham or on lipid oxidation. Although the addition of extracted alfalfa meal to the diet of pigs decreased pH values it did not alter colour (CIE L*a*b*) parameters of ham samples. During the storage period (14 days) of control and experimental ham slight changes of colour parameters and TBARs values were noted. Potential redox values (ORP) depended on the time of storage; ORP values decreased for control and experimental ham during the storage.

## INTRODUCTION

Oxidation processes are one of the primary mechanisms of quality deterioration in meat and meat products because they lead to the degradation of lipids and proteins (including haem pigments) and they cause the loss of flavour, colour and nutritive value and limit the shelf-life of meat and meat products [Kanner, 1994]. Skeletal muscle is an excellent example of a biological tissue that contains a multicomponent antioxidant system that is biphasic, and is found in both aqueous and lipid environments. Muscle tissue has endogenous antioxidant mechanism to control lipid oxidation *in vivo*. The multicomponent antioxidant system in skeletal muscle includes components that scavenge free radicals, inactivate peroxides and other reactive oxygen species, chelate prooxidative metals (myoglobin) and quench lipid and protein oxidative products [Decker *et al.,* 2000]. Nowadays there is a strong tendency towards isolating organic antioxidants from natural sources as alternative methods to retard oxidative processes in meat and meat products [Wenk, 2003].

The addition of antioxidants to meat products is known to be effective in colour stability and lipid oxidation. In the literature, there are many reports on the benefits of supplementing the diet with vitamin E [Buckley *et al*., 1995; Faustman *et al*., 1998; Haak *et al*., 2006; Houben & Gerris, 1998], tea catechins and rosemary extract [O'Grady *et al*., 2003] on the quality of meat.

The aim of the current study was to investigate the effects of dietary extracted alfalfa meal supplementation of pig diets on the oxidative stability of smoked ham.

## MATERIALS AND METHODS

**Animals and diets.** Studies were performed using 40 hybrid fatteners [(Polish Large White x Polish Landrace) x Duroc] of about 14 kg of their initial body weight. Two feedings groups, 10 gilts and 10 boars each, were formed in the experiment. Four animals were kept in each pen. Fatteners were fed according to NRC [1998] standards. The control diets did not contain any growth of promoters supplement. The mixture of experimental group contained 2 g extracted alfalfa meal per 1 kg feed. Alfalfa extract was prepared by compacting and drying the juice of alfalfa leaves (the method is patented). Eight animals from each group were chosen for study. The animals used in the study ranged in body weight at slaughter about 125 kg.

**Ham manufacture.** From each feeding group (control and experimental) 4 hams were obtained (from half-carcasses kept at 7°C for 48 h after slaughter). Each cut was deskinned, deboned and cleaned of external fat. Brine was injected into the muscles to increase weight by 20%. The muscles were massaged at 4°C for 4 h (30 min massage, 10 min pause). Then, the samples were smoked at 55-60°C (40 min) and cooked in water at 80°C until a core temperature of 68°C was reached. Cooked hams were cooled to a temperature of about 20°C and stored at 8°C for about 24 h.

**Measurement of pH.** The pH of the samples was measured using pH-meter CPC-501 (Elmetron) equipped with a pH electrode ERH-111. Each sample was analysed in triplicate.

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**Oxidation-reduction potential (ORP).** Oxidation-reduction potential was measured according to Nam & Ahn method [2003]. ORP values were determined using pH-meter CPC-501 CPC-501 (Elmetron) set to the milivolt scale and equipped with redox electrode (ERPt-13). Each sample was analysed in triplicate.

**Colour measurements.** Hunter colour lightness (L*), redness (a*) and yellowness (b*) values were measured on freshly cut surfaces of each sample using 8200 Series reflection spectro-colorimeter (X-Rite), using illuminant D65 and 10° observer angle. Before each measuring session the instrument was calibrated against a standard white plate. Readings were obtained from three locations of each product randomly selected to obtain a representative reading of the colour of the products.

**Lipid oxidation determinations.** Lipid oxidation was assessed by the 2-thiobarbituric acid method. The determination of thiobarbituric acid reactive substances (TBARs) contained in the samples was performed according to Pikul *et al*. [1989]. The rose-pink colour obtained through the reaction between malondialdehyde and 2-thiobarbituric acid was measured at 532 nm using a Nicole Evolution 300 spectrophotometer (Thermo Elektron Corporation). The TBA content was expressed as mg of malondialdehyde per kg of the samples. Each sample was analysed in triplicate.

**Sensory analysis.** Sensory quality evaluation of ham was performed by properly practiced group consisting of 7 persons with qualified sensory sensitivity. Scaling method of 9-point hedonic grade was applied in assessment, in which 1 point stands for an extremely undesirable trait and 9 points – highly desirable one. Sensory quality evaluation was prepared according to the guidelines in respective standards [PN-ISO 4121:1998; PN-ISO 5492:1997]. The assessment was conducted at an ambient temperature in 24 hrs after the production of ham. The following qualitative traits were determined: consistence, juiciness, colour of cross-section, flavour and odour.

**Statistical analysis.** Results were subjected to statistical analysis. T-Tukey's test ($p>0.05$) was applied to verify the difference significance.

## RESULTS AND DISCUSSION

The pigs used in the study ranged in body weight at slaughter from 124.6 kg to 124.7 kg (Table 1). There was an effect of dietary supplementation with extracted alfalfa meal on fattening time of pigs. After 143 days of feeding the control group of pigs characterised 124.6 kg of body weight while the experimental group of animal gained almost the same body weight (124.7 kg) during 131 days of feeding. It was indicated moreover, that better meatiness and lower backfat thickness were obtained by animals from the experimental group.

The changes in meat products colour (L*a*b* values) measured during the chilling storage are given in Table 2. There was no significant difference in colour parameters between control and experimental groups of ham. Ham manufactured from supplemented alfalfa meal muscle did not differ significantly in colour during the storage than hams manufactured from basal muscle. During the chilling storage of experimental samples slight changes in CIE L*a*b* parameters were noted. Studies performed by Hopkins & Nicholson [1999] also revealed that diet had no significant effect on colour parameters (L*a*b*) values. In their studies the meat of lambs fed on Atriplex and either supplemented with lucerne hay or oat grain was compared to those grazed on lucerne. Houben & Gerris [1998], on examining the effect of dietary vitamin E on the colour stability of pasteurised ham, reported that supplementation with vitamin E conferred only slightly beneficial effects on ham quality.

The examination of the acidity of ham samples (Table 3) indicated that dietary extracted alfalfa meal supplementation of pig diets did affect the pH values ($\alpha \geq 0.05$). By 2 and 6 days of storage, all the samples had similar pH values. The highest differences were observed after 10 and 14 days since the production. The ham samples with dietary supplementation with extracted alfalfa meal characterized lower pH values compared to the control but the difference were not significant.

Dietary supplementation with extracted alfalfa meal had neither a significant effect on potential redox of ham samples nor on lipid oxidation – TBARs values (Table 3). Potential redox of the meat products samples from control and experimental groups increased during the whole storage period. The examination taken 14 days since the production indicated that ORP values of two variants of ham samples were similar. Low potential redox value helped to maintain the haem pigments in a reduced form. TBA values did not alter significantly during 14 days of storage.

TABLE 1. Performance and some carcass traits.

| Item | Groups | | P value |
|---|---|---|---|
| | Control | Experimental | |
| Body weight at slaughter (kg) | 124.6 | 124.7 | 0.78 |
| Fattening time (day) | 143 | 131 | 0.01 |
| Average daily gains (g) | 771 | 846 | 0.00 |
| Meatiness (%) | 52.4 | 56.9 | 0.04 |
| Average backfat thickness (mm) | 24.8 | 17.8 | 0.01 |

TABLE 2. Hunter colorimetry of meat products stored at 4°C.

| Sample | Parameter | Storage time (day) | | | |
|---|---|---|---|---|---|
| | | 2 | 6 | 10 | 14 |
| Control | L* | 66.97$^{a}$ | 67.66$^{a}$ | 67.36$^{a}$ | 66.80$^{a}$ |
| | a* | 9.45$^{a}$ | 8.91$^{a}$ | 9.06$^{a}$ | 9.46$^{a}$ |
| | b* | 9.75$^{a}$ | 9.38$^{a}$ | 9.36$^{a}$ | 9.88$^{a}$ |
| Experimental | L* | 68.41$^{a}$ | 67.27$^{ab}$ | 67.62$^{ab}$ | 66.92$^{b}$ |
| | a* | 9.30$^{a}$ | 9.54$^{a}$ | 9.66$^{a}$ | 9.52$^{a}$ |
| | b* | 9.59$^{a}$ | 9.63$^{a}$ | 9.85$^{a}$ | 10.19$^{a}$ |

Averages marked with the same letters are not significantly different ($p>0.05$).

TABLE 3. Physicochemical properties of meat products stored at 4°C.

| Sample | Parameter | Storage time (day) | | | |
|---|---|---|---|---|---|
| | | 2 | 6 | 10 | 14 |
| Control | pH value | 5.76[a] | 5.73[a] | 5.97[b] | 6.06[b] |
| | ORP (mV) | 289.74[a] | 262.45[b] | 265.80[b] | 216.97[c] |
| | TBARs (mg/kg) | 1.10[a] | 1.04[a] | 1.00[a] | 1.00[a] |
| Experimental | pH value | 5.67[a] | 5.73[a] | 5.90[b] | 5.86[b] |
| | ORP (mV) | 295.81[a] | 261.50[b] | 255.89[b] | 219.90[c] |
| | TBARs (mg/kg) | 1.06[a] | 1.00[a] | 1.00[a] | 0.94[a] |

Averages marked with the same letters are not significantly different ($p>0.05$).

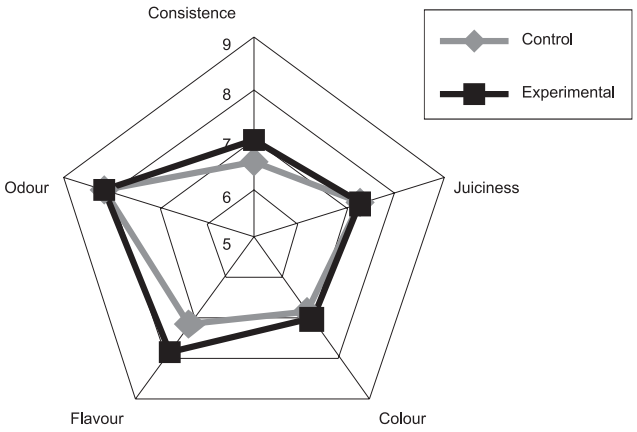


FIGURE 1. Results of sensory evaluation of meat products.

The results of sensory evaluation of experimental ham indicated an increase of scores for flavour as well as consistence compared to control product. Odour, juiciness and colour of control and experimental products gained similar score (Figure 1).

## CONCLUSIONS

Dietary supplementation with extracted alfalfa meal affected the reduction of fattening time and increase of meatiness of pig. It has been observed however, that diet had no significant effect on meat colour, TBA values of ham during 14 days of storage. There was a small difference in colour parameters and TBA values between control and experimental groups of ham. The sensory analysis indicated that the experimental ham characterized similar or higher score of sensory properties compared to control product.

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# WPŁYW WZBOGACENIA DIETY ŚWIŃ EKSTRAKTEM LUCERNY NA STABILNOŚĆ OKSYDACYJNĄ SZYNKI

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Procesy oksydacyjne są przyczyną niekorzystnych zmian jakości mięsa i wyrobów mięsnych, prowadzą do degradacji tłuszczów oraz białek (m.in. barwników hemowych), powodują pogorszenie smakowitości, barwy, wartości odżywczej oraz ograniczają trwałość mięsa i wyrobów mięsnych. Obecnie istnieje tendencja do izolowania przeciwutleniaczy naturalnie występujących w surowcach roślinnych i ich stosowania w celu opóźniania procesów oksydacyjnych w mięsie i wyrobach mięsnych. Podejmowane są próby zwiększania ilości przeciwutleniaczy w żywieniu zwierząt rzeźnych, głównie świń. Celem badań była ocena wpływu dodatku ekstraktu lucerny w żywieniu świń na stabilność oksydacyjną szynek wędzonych parzonych podczas ich 14-dniowego przechowywania. Stosowano wzbogacenie diety świń w ilości 2 g ekstraktu lucerny na 1 kg diety.

Uzyskane wyniki badań wykazały, że dodatek ekstraktu lucerny wpłynął na skrócenie procesu żywienia, wzrost masy mięśniowej u świń. Wyniki badań jakościowych szynki nie wykazały istotnego wpływu wzbogacenia diety świń ekstraktem lucerny na wartości parametrów barwy oraz wskaźnika utlenienia tłuszczu szynek wędzonych podczas ich 14-dniowego przechowywania. Wartości parametrów barwy L*a*b* oraz wskaźnika TBA szynek kontrolnych oraz eksperymentalnych były bardzo zbliżone. Wartości potencjału oksydoredukcyjnego wyrobów zależały od czasu przechowywania; wartości tego wyróżnika istotnie malały dla wszystkich wariantów doświadczalnych podczas ich przechowywania.