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COMPREHENSIVE EVALUATION OF RAPESEED CAKE UTILIZATION IN THE NUTRITION OF MONOGASTRIC ANIMALS

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1. RESEARCH BACKGROUNDS AND OBJECTIVES

Meeting the growing global demand for food requires the use of alternative protein sources as an indispensable component of sustainable feeding practices for farm animals. As a by-product of the oil industry, cold-pressed rapeseed cake offers a viable opportunity to promote environmental sustainability. It is a locally produced, cost-effective, and nutritionally valuable feed material that can reduce dependence on unsustainable soybean meal. The quality of rapeseed cake is fundamentally influenced by the presence of antinutritional compounds (e.g., glucosinolates) and the method of processing. Given the considerable variability in the antinutritional factors across different rapeseed varieties and hybrids, effective treatment is essential to ensure safe utilization.

The aim of the dissertation is to apply a specific chemical treatment method that, through its mechanism of action, reduces the reduction of potential antinutritional effects in rapeseed by-products. The PhD research takes a comprehensive approach, examining multiple applications (broiler chicken, finishing pig, and laying hen), in order to accurately assess the applicability of both untreated and chemically treated rapeseed cake ("Peelko" supplement, a trademarked product under ID M1101164, produced by ROP Ltd., Hungary) —in the feeding of monogastric animals.

The doctoral study aimed to answer the following research questions:

- Can the effectiveness of the treatment be verified through physiological assessments?
- Does the inclusion of untreated or treated cold-pressed rapeseed cake in the diet affect the thyroid function of broiler chickens, pigs, and laying hens?

- What are the effects of untreated or treated cold-pressed rapeseed cake on animal performance parameters and the quality of animal products (chicken meat, pork, eggs)—in terms of nutrient content, fatty acid composition, shelf life (malondialdehyde concentration as an indicator of lipid peroxidation), and sensory (organoleptic) characteristics?

The results of this research may provide practical guidance regarding the optimal inclusion rate of rapeseed cake in monogastric animal diets. These findings can contribute to the safe and efficient use of both untreated and treated rapeseed cake in the feeding of broiler chickens, pigs, and laying hens.

2. MATERIALS AND METHODS

2.1. FEEDING TRIAL WITH BROILER CHICKENS

2.1.1. ANIMALS AND HOUSING

The rapeseed feeding trial with broiler chickens was conducted at the experimental animal facility of the Albert Kázmér Faculty, Széchenyi István University, Mosonmagyaróvár, Hungary. A total of 600 Ross-308 broiler cockerels were placed in 24 floor pens at one day of age (25 birds per pen, 12.5 birds/m² stocking density; n = 8 pens per treatment group).

2.1.2. DIETS AND TREATMENTS

The feeding period was divided into three phases: starter (day 1–21), grower (day 22–32), and finisher (day 33–42). During the starter phase, all pens received the same basal diet. Thereafter, three treatment groups were established: control (C): diet containing extracted soybean meal; untreated rapeseed cake (R): diet containing 10% and 15% cold-pressed rapeseed cake during the grower and finisher phases, respectively; treated rapeseed cake (R+): diet containing 9.62% and 14.62% cold-pressed rapeseed cake plus 0.38% “Peelko” supplement in grower and finisher phases, respectively.

The cold-pressed rapeseed cake was produced by mechanical pressing without steam using a horizontal screw press (V+V Cooperative, Héreg, Hungary). The glucosinolate content of the rapeseed cake was 1.85 μmol/g, determined by high-performance liquid chromatography (HPLC) (Bonafarm-Bábolna Feed Ltd., Nagyigmánd, Hungary). The “Peelko” feed supplement (trademark registration number HU 16100063) was applied according to the manufacturer's instructions (ROP Ltd., Érd, Hungary).

Diets were formulated using Bestmix® software (Adifo, Industrielaan 11B, 9990 Maldegem, Belgium) to be isoenergetic (ME, MJ/kg) and to contain equal levels of standardized ileal digestible (SID) amino acids.

2.1.3. MEASUREMENTS AND ANALYSES

Individual body weights were recorded for each bird on days 1, 21, 32, and 43 using a BAT 1 scale (Veit Electronics, Moravany, Czech Republic). Weight recordings coincided with diet transitions. Production performance was evaluated based on body weight, feed intake, and mortality data collected during these periods.

At the end of the trial (day 43), blood samples were collected from the wing vein (*vena cutanea ulnaris*) of 10 birds per group to measure serum levels of triiodothyronine (T3) and thyroxine (T4). Hormone levels were determined using an I-RIA method originally developed for humans but modified and validated for avian species (T3: I-T3 RIA kit; T4: I-T4 RIA kit).

Following blood sampling, the birds were euthanized, and the thyroid glands (glandula thyreoidea) were excised and weighed using a calibrated NB-600 laboratory balance (Demandy, Budapest, Hungary). Samples were then collected for histological analysis, which was carried out by Autopsy Path Ltd. (Budapest, Hungary).

To determine the chemical composition (dry matter, crude protein, and fat content) of muscle tissues (thigh and breast), 10 samples per treatment were collected and analyzed in accordance with Hungarian Standard MSZ 6920-4:1987. Fatty acid profiles were analyzed via gas chromatography following the MSZ ISO 5508:1992 standard, using an Agilent Technologies gas chromatograph (Santa Clara, CA, USA) equipped with

a Supelco SPTM 2560 capillary column (Merck KGaA, Darmstadt, Germany; 100 m × 0.25 mm × 0.2 μm).

The oxidative stability of muscle tissue was assessed by measuring malondialdehyde (MDA) concentrations according to Ramanathan and Das (1992). MDA levels were determined from samples taken within one hour post-slaughter (fresh), and after one month (MDA 1) and two months (MDA 2) of frozen storage at −16 °C.

Muscle color (thigh and breast) was measured at the laboratory of the Department of Physics and Chemistry, Faculty of Mechanical, Computer and Electrical Engineering, Széchenyi István University, using a MiniScan XE Plus colorimeter (HunterLab, Virginia, USA) equipped with EasyMatch software. Illumination was provided by a CIE D65 xenon light source, and color coordinates (L*, a*, b*) were recorded according to CIE standards.

The sensory evaluation of broiler meat was conducted by Campden BRI Hungary (Budapest, Hungary) in an accredited laboratory (NAT-1-1152/2007), following the MSZ ISO 6685:2007, section 5.4.3. Five trained experts assessed the samples in duplicate using coded identifiers, and results were scored on a Williams Latin Square intensity scale ranging from 0 to 9.

Statistical analyses were performed using IBM SPSS Statistics 23.0 (IBM Corp., Armonk, NY, USA) for Windows. For parametric data, a univariate general linear model (GLM) was applied with Tukey's post hoc test to assess significant differences among groups. For non-parametric data, the Kruskal–Wallis test was used, followed by Bonferroni-adjusted pairwise comparisons to determine statistical significance. A P-value < 0.05 was considered indicative of significant differences.

2.2. FEEDING TRIAL WITH GROWING-FINISHING PIGS

2.2.1. ANIMALS AND HOUSING

The trial was carried out at the pig research farm of the Institute for Animal Breeding, Nutrition and Meat Science (Herceghalom, Hungary), using 27 F1 gilts (Hungarian Large White × Hungarian Landrace; n = 9 pigs per treatment). Animals were housed individually in open-topped pens with 1 m² floor area and concrete slatted flooring. Feed and water were provided ad libitum using automated systems (Schauer Agrotronic GmbH, Prambachkirchen, Austria). The pigs entered the trial at 94 days of age, and the experiment lasted for 67 days.

2.2.2. DIETS AND TREATMENTS

Throughout the experimental period, a single-phase growing-finishing diet was fed, starting at 94 days of age (average initial body weight: 39 kg) and continuing until 161 days (~90 kg final body weight). Three dietary treatments were formulated: control (C): diet based on extracted soybean meal, untreated rapeseed cake (R): partial replacement of soybean meal with 8% cold-pressed rapeseed cake, treated rapeseed cake (R+): 7.62% cold-pressed rapeseed cake plus 0.38% “Peelko” supplement.

The processing method of the rapeseed and the composition of the treatment were identical to those described in *Section 2.1.2.* The glucosinolate content of the rapeseed cake was 3.1 µmol/g, as determined by high-performance liquid chromatography (HPLC; Bonafarm-Bábolna Feed Ltd., Nagyigmánd, Hungary). Diet formulation was performed using Bestmix® software, as described in *Section 2.1.2*.

2.2.3. MEASUREMENTS AND ANALYSES

Individual body weights were recorded at the beginning of the trial (94 days of age), as well as at 124 and 161 days. Daily feed intake was continuously monitored, and production parameters (average daily gain, feed intake, and feed conversion ratio) were calculated.

At the end of the trial (day 67), blood samples were collected from the anterior vena cava (*vena cava cranialis*) of all pigs (9 pigs per treatment, total n = 27) for thyroid hormone analysis (T3 and T4). Hormone levels were determined as described in *Section 2.1.3*.

After slaughter, the thyroid gland (*glandula thyreoidea*) was excised and weighed for each animal. Carcass evaluation was carried out according to the SEUROP grading system, based on Hungarian regulation No. 136/2011 (XII.22) VM on the post-mortem classification and commercial grading of slaughter pigs.

For fatty acid analysis, muscle samples were collected from the *m. semimembranosus* (ham muscle) after carcass classification. The fatty acid profile was determined using gas chromatography, following the same protocol described in *Section 2.1.3*.

Statistical analysis was performed using IBM SPSS Statistics 23.0 (IBM Corp., Armonk, NY, USA). Where data met the assumptions of normality and homogeneity of variance, one-way ANOVA was used to evaluate treatment effects. In cases of normally distributed data with unequal variances, Welch's ANOVA was applied. Pairwise comparisons between treatment groups were conducted using Bonferroni’s post hoc test (for equal variances) or Dunnett’s C test (for unequal variances). Normality was assessed using the Kolmogorov–Smirnov test, and homogeneity of variances was evaluated using Levene’s test.

2.3. FEEDING TRIAL WITH LAYING HENS

2.3.1. ANIMALS AND HOUSING

The trial involved 96 Lohmann Brown laying hens, which were housed at 21 weeks of age at the Experimental Farm of the Albert Kázmér Faculty, Széchenyi István University, Mosonmagyaróvár, Hungary. Birds were kept in a three-tier Big Dutchman Eurovent 1250/a-EU cage system. Each tier contained 8 pens, with 4 hens per pen. The size of each pen was 60 cm × 63 cm × 50 cm. A 16-hour daily lighting program was provided throughout the experimental period.

2.3.2. DIETS AND TREATMENTS

From weeks 21 to 24, the hens were fed a pre-laying diet. From week 24 until week 56, they received one of three different laying hen diets: control (C): 25% extracted soybean meal; untreated rapeseed cake (R): 15% cold-pressed rapeseed cake; treated rapeseed cake (R+): 14.62% cold-pressed rapeseed cake plus 0.38% “Peelko” supplement.

The glucosinolate content of the rapeseed-containing diets ranged between 2.5 and 3.1 μmol/g.

From weeks 24 to 33, all hens received a daily feed allowance of 120 g per bird (480 g per pen), which was increased to 130 g (520 g per pen) from weeks 34 to 56. Each treatment group was fed across 8 pens, totaling 32 birds (n = 96 hens per trial; n = 32 hens per treatment; n = 4 hens per pen; n = 8 pens per treatment).

2.3.3. MEASUREMENTS AND ANALYSES

At the end of the experiment (56 weeks of age), blood samples were collected from the wing vein of 10 hens per treatment. Triiodothyronine

(T3) and thyroxine (T4) levels were analyzed using the same method as described in *Section 2.1.3*.

Egg production was recorded daily, and egg weights were measured three times weekly using a BluMagix BM-KSC615 digital scale.

The chemical composition of eggs (dry matter, protein, fat, and ash) was determined according to the Hungarian Feed Codex (2004). Based on the chemical composition, energy content was calculated in accordance with the Hungarian Food Regulation 1-1-90/496 (Annex 1 of Decree 152/2009. (XI.12.) FVM).

Fatty acid profiles of the eggs were determined using gas chromatography equipped with a flame ionization detector (FID, Agilent Technologies 689N Network, USA), following sample preparation procedures (fat extraction, saponification, methylation, and dilution in hexane). Separation was performed using a Supelco SP™ 2560 Fused Silica capillary column (100 m × 0.25 mm × 0.2 µm) and a Supelco™ 37 Component FAME Mix standard.

Yolk color was determined following the method described in *Section 2.3.1*.

Sensory evaluation of eggs was conducted as outlined in *Section 2.3.1*.

Sensory traits were statistically evaluated by one-way ANOVA (significance level: 5%), and mean values were compared using the Newman–Keuls test (5%). Egg production data (egg number, egg weight, and total egg mass), along with chemical and fatty acid composition results, were analyzed by one-way ANOVA using IBM SPSS Statistics 23.0 (IBM Corp., Armonk, NY, USA) at a significance level of $P<0.05$.

All animal experiments involving broiler chickens, fattening pigs, and laying hens were conducted in accordance with Directive 86/609/EEC of the European Commission and Article 32 of Act XXVIII on the protection of animals used for research purposes.

3. RESULTS

3.1. RESULTS FROM THE BROILER CHICKEN TRIAL

Compared to the control, both treatments significantly reduced the average body weight of broiler chickens on day 43. Although birds in the untreated rapeseed cake (R) and treated rapeseed cake (R+) groups had lower final weights, no significant differences in daily weight gain were observed at any time point. During the grower and finisher phases—and when these phases were evaluated together—the R+ treatment improved the feed conversion ratio (FCR) significantly ($P<0.05$), and mortality was also lowest in this group.

Goiter (thyroid enlargement) was observed as a result of cold-pressed rapeseed cake feeding (R and R+ groups). The highest thyroid weight was found in the R group. However, the chemical treatment (R+ group) significantly reduced the extent of goiter compared to the R group, although the gland weight still remained significantly higher than that in the control group ($P<0.05$).

The mean T3 concentrations across groups mirrored the thyroid weight trends. In the R+ group, T3 levels were significantly lower than in the R group (3.92 nmol/L), yet still significantly higher than in the control. The highest T4 concentration was detected in the R group, while the control and R+ birds had nearly identical T4 levels. These findings (thyroid weight, T3 and T4 hormone levels) suggest that the chemical treatment

(R+) was able to counteract the thyrostatic effect of rapeseed cake ($P< 0.05$).

Histological sections from the R group revealed altered acinar architecture in the thyroid glands, whereas the acini in the R+ group showed no deviation in diameter compared to the control ($P<0.05$).

Neither treatment (R, R+) affected the dry matter content of breast and thigh meat samples. However, the R treatment significantly ($P<0.05$) reduced the crude protein content in breast muscle and increased the fat content in thigh muscle compared to both the control and R+ treatments.

There were no significant differences in the fatty acid profiles between R and R+ groups in either breast or thigh samples. This suggests that the fatty acid composition of the cold-pressed rapeseed oil (residual in the cake) was the determining factor in observed changes. A reduction in saturated fatty acids (SFA) was mainly due to a decrease in palmitic acid (C16:0). Among the polyunsaturated fatty acids (PUFA), levels of linoleic (C18:2n-6) and linolenic acid (C18:3n-3) increased markedly in the rapeseed-fed groups (R, R+). The proportion of monounsaturated fatty acids (MUFA) remained unchanged. From a human nutrition and health perspective, a key result was that while the total amounts of n-3 and n-6 PUFAs increased in the R and R+ groups, the n-6 to n-3 PUFA ratio narrowed compared to the control ($P<0.05$).

Malondialdehyde (MDA) concentrations—used as indicators of lipid peroxidation—were highest in the R group across all time points. The chemical treatment tested in this study (R+) effectively prevented lipid peroxidation in meat samples. In the R+ group, MDA values were statistically indistinguishable from those of the control, indicating that the

minerals in the supplement were capable of mitigating oxidation even in the presence of highly reactive unsaturated fatty acids.

The R treatment influenced the color parameters of breast meat. In the R group, both lightness (L*) and red–green index (a*) differed from those in the control and R+ groups. The b* index (yellow–blue) in the R+ group was significantly lower than in the control.

When rapeseed cake was included in the diet (R and R+), some sensory properties—specifically fatty aftertaste and fibrousness—were rated significantly worse in the R group compared to the other treatments (C and R+).

3.2. Results from the growing-finishing pig trial

Feeding rapeseed cake significantly reduced the average daily weight gain of pigs, resulting in lower body weights at both 124 and 161 days of age ($P<0.05$). Accordingly, pigs in the R+ and control (C) groups achieved more favorable final body weights compared to those in the R group. No significant differences were observed in feed intake across the groups. However, feed conversion ratio (FCR) across the entire fattening period was most efficient in the R+ group ($P<0.05$).

Feeding untreated cold-pressed rapeseed cake (R group) significantly increased thyroid gland weight ($P<0.05$). The extent of goiter was mitigated by the R+ treatment. No significant difference in thyroid weight was observed between the R+ and control groups. Despite the presence of goiter in the R group, no measurable differences were detected in serum thyroid hormone concentrations (T3 and T4) among the groups.

Slaughterhouse carcass classification revealed no significant differences between groups for any evaluated parameters; results were comparable across treatments (C, R, R+).

In ham muscle samples, the proportion of saturated fatty acids (SFA) was highest in the control group (42.76%), and this value was significantly reduced by the chemical treatment (R+: 40.69%). The total percentage of polyunsaturated fatty acids (PUFA) was significantly increased in the R+ group compared to the R group. The highest proportions of both n-6 and n-3 fatty acids were observed in the R+ group. Notably, the R+ treatment resulted in the narrowest n-6/n-3 PUFA ratio (22.96), which was significantly lower than in both the R and control groups ($P<0.05$).

3.3. Results from the laying hen trial

Egg production was not affected by dietary treatments; the laying rate remained consistent across all groups. According to commercial classification (European Commission Regulation, 2008), eggs from all treatments (C, R, and R+) were categorized as size "L."

Serum triiodothyronine (T3) concentrations were similar among the treatment groups, and no significant differences were observed in thyroxine (T4) levels. However, based on mean values, T4 concentrations were slightly elevated in the rapeseed-fed groups (R and R+) compared to the control, regardless of the chemical treatment (R+).

No significant differences were observed in any chemical parameters of the eggs; all three groups yielded comparable values in terms of dry matter, protein, fat, and ash content.

The proportion of saturated fatty acids (SFA) in egg yolk significantly decreased in the experimental groups (R and R+) compared to the control.

Conversely, oleic acid, vaccenic acid, and the total monounsaturated fatty acids (MUFA) were significantly higher in the R and R+ groups. The proportion of polyunsaturated fatty acids (PUFA) in the yolk was significantly higher in the control group compared to the rapeseed-fed groups. The proportion of n-6 fatty acids was significantly lower in the R and R+ groups, while the highest n-3 fatty acid content was observed in the R+ group, which differed significantly from the control ($P<0.05$).

The lightness index (L*) showed only slight variation among groups. Overall, the results of the colorimetric assessment indicate that the eggshell color from the R+ group was the most vivid.

Summarizing the results of the organoleptic evaluations, it can be stated that feeding untreated and treated rapeseed cake caused only minor changes in the sensory attributes of hard-boiled eggs and scrambled eggs. These differences were not statistically or practically significant.

3.4. COMBINED RESULTS OF THE ANIMAL FEEDING TRIALS

The chemically treatment (R+) aimed at reducing the antinutritional content of rapeseed cake, had no significant effect on live weight in broilers but showed a beneficial impact in pigs compared to the R treatment ($P<0.05$). No differences were observed in egg production. Regardless of species, the R+ treatment improved feed conversion efficiency. This favorable outcome was evident not only in comparison with the R group but also relative to the control.

In both broiler and pig trials, feeding cold-pressed rapeseed cake (R and R+ groups) increased thyroid gland weight compared to the control, regardless of treatment. The chemical treatment reduced goiter size (with significantly lower gland weight than in the R group), although thyroid

weight did not return to control values. However, the histological analysis of thyroid tissues revealed that in the R+ group, acinar diameters did not differ from those in the control group. In contrast, significantly enlarged acini were found in histological sections from the R group.

The n-6/n-3 fatty acid ratio improved across all tested animal products as a result of rapeseed cake inclusion. The narrowest n-6/n-3 PUFA ratios were found in the ham muscle of pigs and the egg yolk of laying hens fed the R+ diet.

Due to the elevated MDA concentrations, the shelf life of broiler meat was negatively affected by cold-pressed, untreated rapeseed cake (R group). This reduction in oxidative stability is closely associated with the higher proportion of polyunsaturated fatty acids present in these samples.

4. CONCLUSIONS AND RECOMMENDATIONS

Overall, the results indicate that the R+ treatment effectively counteracted the adverse effects of untreated rapeseed cake on the production performance of the tested monogastric species. Based on the observed production traits, the applied chemical treatment is recommended to mitigate performance loss when using cold-pressed rapeseed cake in diets for intensively reared monogastric animals.

Findings from the thyroid gland investigations suggest that, despite the relatively low glucosinolate content (1.85 μmol/g) in the rapeseed used for broiler diets, a thyrostatic effect was still observed in chickens fed both R and R+ diets. However, the treatment was able to attenuate this effect, as supported by the serum T3 and T4 hormone levels in broilers. The highest glucosinolate content (3.1 μmol/g) was measured in the rapeseed fed to pigs, which significantly increased thyroid weight ($P<0.05$). In this case, a

clear association was observed between feeding duration and the beneficial, size-reducing effect of the treatment on the thyroid gland. Unlike in broilers, the longer duration of the pig trial (67 days) allowed the positive effects of the supplement to manifest. In pigs, thyroid weights did not differ significantly between the R+ and control groups.

Given the considerable variability in glucosinolate content across rapeseed varieties in practice, our results suggest that the applied treatment may serve as an effective and appropriate tool to mitigate the thyrostatic effects of rapeseed in monogastric nutrition.

In the evaluation of product quality, the previously observed link between higher PUFA levels and increased MDA concentrations (indicative of lipid peroxidation) in broiler meat could not be confirmed in the R+ group. Despite the elevated PUFA content in these samples, MDA levels did not increase when the treatment was used. For color parameters and most sensory traits in meat and eggs, the experimental R+ treatment demonstrated a favorable effect compared to the untreated rapeseed cake (R) group. These findings suggest that the R+ treatment contributes to the production of animal-derived foods with improved dietary properties, and therefore, its application may offer a promising approach for enhancing the nutritional value of products derived from cold-pressed rapeseed cake.

5. NOVEL SCIENTIFIC RESULTS

1. Both untreated and chemically treated rapeseed cake increased thyroid gland weight and serum T3 hormone concentration in broiler chickens compared to the control. However, the applied chemical treatment counteracted the thyrostatic effect of untreated rapeseed cake by reducing the extent of goiter formation and mitigating the severity of histopathological alterations.

2. The chemical treatment eliminated the negative effects of cold-pressed rapeseed cake on meat quality, specifically the reduction in breast muscle protein content and the increase in thigh fat content. In broilers fed chemically treated rapeseed cake, the chemical composition of meat samples did not differ from that of the control group.

3. Feeding both untreated and chemically treated rapeseed cake reduced the n-6/n-3 polyunsaturated fatty acid (PUFA) ratio in meat samples (broiler breast and thigh, pig ham) and in egg yolks. The chemical treatment further narrowed this ratio, with the most favorable values observed in pig ham and egg yolk samples.

4. Despite the higher PUFA content in breast and thigh meat samples, the chemical treatment of rapeseed cake prevented lipid peroxidation. This was evidenced by malondialdehyde concentrations in broiler meat samples being nearly identical to those of the control group.

5. The chemical treatment of rapeseed cake positively influenced egg yolk color, as indicated by significantly higher a* and b* color values.

6. LIST OF PUBLICATIONS RELATED TO THE DISSERTATION

Scientific article published in international, peer-reviewed journal in a foreign language

Tóth, T., **Horváth, R. É.**, Dóka, O., Kovács, M., Fébel, H. (2024): The effects of mineral supplementation in rapeseed cake diet on thyroid function and meat quality in broiler chickens. Agriculture, 14:12, 2333. doi: 10.3390/agriculture14122333.

Scientific articles published in a peer-reviewed professional journal in Hungary

Horváth, É. R., Tóth, T., Fébel, H. (2014): A repcedara- és pogácsa felhasználási lehetőségei a monogasztrikus állatok takarmányozásában. Utilization possibilities of rapeseed meal and rapeseed cake in feeding of monogastric animals. Review. Állattenyésztés és Takarmányozás, 63:2, 165-183.

Horváth, R. (2017): Az extrahált repcedara és repcepogácsa felhasználása hízósertések takarmányozásában. Állattenyésztés és Takarmányozás, 63:1, 44-58.

Scientific article accepted for publication in a peer-reviewed professional journal in Hungary

Horváth, É. R., Tóth, T., Fébel, H. (2025): A natúr és kezelt repce melléktermékek takarmányozási potenciálja: lehetőségek és kihívások (Irodalmi áttekintés). Acta Agronomica Óváriensis, 66:1.

Foreign-language conference proceedings published in a journal or conference volume

Horváth, R., Zsédely, E., Fébel, H., Tóth, T. (2013): The effect of treated rapeseed cake on productive performance of broiler chickens and sensory profile of meat. ASD, Padova, Italy. 09-18-20-2013, 20.

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Horváth, É. R., Tóth, T., Fébel, H. (2012): Speciális adalékanyaggal kezelt repcepogácsa etetésének hatása a brojlercsirkék fontosabb termelési mutatóira és a hús érzékszervi tulajdonságaira. XVIII. Ifjúsági Tudományos Fórum, Keszthely. 2012-04-12.

Horváth, R., Tóth, T., Fébel, H. (2012): Kezelt repcepogácsa hatása a tojótyúk termelési mutatóira és a tojás fontosabb tulajdonságaira. Óvári Tudományos Napok, Mosonmagyaróvár 2012-10-05.

Horváth, É. R., Fébel, H., Tóth, T. (2013): Kezelt repcepogácsa etetésének hatása a brojlercsirkék egyes termelési mutatóira és a hús érzékszervi tulajdonságaira. 16. Nemzetközi Takarmányozási Szimpózium: A klímaváltozás hatása a takarmányozásra, Kaposvár 2013-08-30, 97-104.

Horváth, É. R., Tóth, T., Hermán I., Fébel H. (2014): Kezelt és kezeletlen repcepogácsa etetésének hatása a hízósertések fontosabb termelési mutatóira. XXXV. Óvári Tudományos Nap. A magyar és nemzetközi

agrár- és élelmiszer-gazdaság lehetőségei, Mosonmagyaróvár 2014-11-13, 486-491.

Horváth, R., Zsédely, E., Lelovics, Zs., Fébel, H., Tóth, T. (2016): A tojás, mint funkcionális élelmiszer – Az egészséges táplálkozás költséghatékony fejlesztései és marketingüzenetei. Marketing, public relations és reklám az egészségügyben. 19. országos konferencia, Budapest 2016-02-18, 8-9.

Article published in a popular science journal

Tóth, T., **Horváth, É. R.**, Fébel, H. (2014): A repcetermékek takarmányozási célú felhasználása a sertések és baromfifajok takarmányozásában. AgroNapló 2014/4, 153-154.