INFLUENCE OF DIETARY REPLACEMENT OF SUNFLOWER OIL WITH MILK THISTLE (SILYBUM MARIANUM) OIL ON FATTENING CHARACTERISTICS AND MARKET VALUE OF BROILER CARCASSES

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Influence of dietary replacement of sunflower oil with milk thistle (*Silybum marianum*) oil on fattening characteristics and market value of broiler carcasses

Utjecaj zamjene suncokretovog ulja uljem sikavice (*Silybum marianum)* na tovna svojstva, kvalitetu i tržišnu vrijednost trupova brojlera

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SUMMARY

The paper investigates the influence of dietary replacement of 3% sunflower oil (SO group) with 3% milk thistle oil (MTO group) in broiler diets on fattening characteristics and carcass quality. During 42 days of fattening, MTO group achieved insignificantly higher live weight (2.21 kg : 2.19 kg; P>0.05), significantly better feed conversion (1.80 kg : 1.83 kg; P = 0.034) and production number (292.33: 285.33; P = 0.013) compared to the SO broiler group. Carcass weight and portion of main parts did not statistically significantly differ between the groups (P>0.05). Market value of carcass cuts and breast fillets was higher in MTO group than in SO group. Lipids of breast and thigh muscles in the SO group contained significantly higher concentration of total n-3 PUFA (2.48% : 1.91%, P = 0.049, i.e. 2.29% : 1.57%; P<0.001) than MTO group.

Key-words: milk thistle oil, sunflower oil, carcass quality, FA profile, market value

INTRODUCTION

Feeding mixtures used for broilers fattening are often supplemented with various types of oil, in order to provide energy value of diets and to use the benefits of fat-soluble vitamins. In the presented research, milk thistle *(Silybum marianum)* oil was used as a dietary substitute for sunflower oil in broiler feed. Milk thistle is a plant used for production of silymarin - an ingredient, which has antioxidant effects, absorbs free radicals and has anti-inflammatory activity (Fiebrich and Koch, 1979; Bosisio et. al., 1992; De La Puerta et al., 1996). Cold pressed oil of milk thistle is an excellent source of linoleic acid (C18: 2, n-6) being important in synthesis of biologically active substances such as prostaglandin, prostacyclin, tromboselicines and other substances that regulate metabolism. Suchy et al. (2008) reported that supplementation of *Silybum marianum* seed cakes to chicken broiler diets resulted in non-significant reduce of weight gain and feed conversion, if compared to the control.

The research of Shivanone et al. (2007) showed that silymarin in broiler diets did not affect broiler growth whereas Blevins et al. (2010) and Mojahedtalab et al. (2013) pointed out that such dietary supplementation reduced feed consumption and conversion, but did not affect weight gain. Mekala et al. (2006), Gawel et al. (2003), as well as Wojcik et al. (2002) investigated the effects of silymarin in feed on performances of chicken and turkey broilers. However, the results obtained were contradictory. On the contrary, Kalantar et al. (2014) reported that 0.5% of *Silybum marianum* extract supplemented to broiler diets did improve broiler performances.

The aim of the presented research was to determine influence of dietary replacement of sunflower oil with milk thistle oil on performances of broilers and carcass quality.

MATERIAL AND METHODS

The research was carried out on 60 Cobb 500 broilers, 30 of which (3 x 10) belonged to the group

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fed sunflower oil (SO), and 30 broilers (3 x 10) fed milk thistle oil (MTO). During the first three weeks of fattening broilers consumed powdered starter diets of the same composition.

At the beginning of the 4th fattening week (since 22nd day), broilers were randomly divided into two groups and fed pelleted finisher diets of modified composition. Feeding and watering of broilers was *ad libitum* and automatically regulated. Composition and nutritive value of starter and finisher diets was presented in the Table 1.

Table 1. Composition of broiler diets

Tablica 1. Sastav smjesa za brojlere

Ingredient, % *Sastojak, %*	Starter diet 1st – 21st day *Starter smjesa 1.-21. dan*	Finisher diet 22nd – 42nd day *Finišer smjesa 22. – 42. dan*	
		SO group *SO skupina*	MTO group *MTO skupina*
Corn	51.50	61.10	61.20
Alfalfa	2.50	3.00	3.00
Protein gold	2.00	-	-
Soybean roasted	9.00	-	-
Soybean meal (46%)	29.50	27.80	27.80
Sunflower oil	0.50	3.00	-
Silybum marianum oil	-	-	3.00
Premix*	5.00	5.00	5.00
Total	100.00	100.00	100.00
**Chemical analysis of diets – *Kemijska analiza smjesa*			
Water, g/kg	96	100	102
Ash, g/kg	60	56	61
Crude protein, g/kg	243.9	200.7	200.8
Fat, g/kg	47	57	55
Crude fibres, g/kg	44	43	43
Calcium, g/kg	11.1	10.6	11.3
Phosphor, g/kg	4.8	4.3	4.5
Sodium, g/kg	1.9	1.8	1.9
Sugar, g/kg	50.6	47.6	45.0
Starch, g/kg	329.8	388.9	371.9

SO 3% sunflower oil; MTO 3% milk thistle oil; *Premix (1 kg) contains: vitamin A 300,000.00 I.J; vitamin D3 40,000.00 I.J; vitamin E 600.00 mg; vitamin K3 40.00 mg; vitamin B1 20.00 mg; vitamin B2 120.00 mg; vitamin B6 40.00 mg; vitamin B12 300.00 mg; vitamin C 300.00 mg; niacin 800.00 mg; pantothenic acid 240.00 mg; folic acid 10.00 mg; biotin 2.00 mg; choline chloride 10,000.00 mg; iodine 12.0 mg; iron 500.00 mg; copper 75.00 mg; manganese 1,600.00 mg; zinc 1,000.00 mg; cobalt 3.00 mg; selenium 3.00 mg; antioxidant 2,000.00 mg; calcium min. 38.00 g; sodium min. 23.00 g; methionine 55,000.00 mg; lysine 24,000.00 mg; **Chemical food analysis was performed according to reference methods: M-2 (HRN ISO 6496:2001), M-3 (HRN ISO 5984:2004), M-4 (HRN EN ISO 5983-2:2010), M-5 (HRN ISO 6492:2001), M-6 (HRN EN ISO 6865:2001), M-12 (HRN ISO 6491:2001), M-13 (HRN ISO 7485:2001), M-14 (AA/AMG; AOAC-996.11

Feed conversion was calculated as a ratio of consumed feed and weight gain. After 42 days, broilers were weighed, slaughtered and defeathered. Carcasses were processed according to the EC regulations 543/2008 and cut into the main parts: breasts, drumsticks with thighs, backs and wings. Dressing percentage was presented in % as a ratio of carcass weight and broiler live weight.

Production number (PN) was calculated as follows: (percentage of fattened broilers x average live weight) / (duration of fattening period x feed conversion) x 100.

Content of fatty acids in diets and meat was determined by the Chrompack CP-9000 chromatograph equipped with flame ionization detector. Quantitative evaluation was obtained on the basis of percentage relations of chromatographic peaks of pure methyl ester towards the height of chromatographic peaks of samples. Percentage portion of fatty acids in a sample was calculated as a function of comparative weight percentage of fatty acid methyl ester (Csapó et al., 1986). Fatty acids were presented as % of total fatty acids.

Prices valid on the Croatian market (carcass 20 HRK/kg, breast and drumsticks with thighs 25 HRK/kg, wings 21 HRK/kg and backs 15 HRK/kg, breast fillet 45 HRK/kg) were taken as a basis for calculation of broiler carcass market value Average market value of broilers in SO and MTO group was determined according to the portion of main parts in carcass and their market value.

Analysis of variance (ANOVA) was performed by using the GLM procedure for two treatments (SO and MTO). Obtained differences between groups were tested by the Fisher's LSD test. Significant differences between experimental groups were assigned with different subscripts ($^{a,b}P<0.05$, $^{A,B}P<0.001$).

RESULTS AND DISCUSSION

Concentrations of fatty acids in sunflower and milk thistle oils, as well as in starter and finisher (SO and MTO) diets are presented in the Table 2. In comparison with milk thistle oil, sunflower oil contains more ΣSFA (18.50% : 12.43%), and less Σn-6 PUFA (58.85% : 63.11%). Sunflower oil contains more Σn-3 PUFA than milk thistle oil (0.41% : 0.30%) having narrower n-6/n-3 ratio. Rusníková et al. (2012) conducted chemical analysis to prove that milk thistle oil contained 6.13-6.29% palmitic acid (C 16:0), 3.70-3.81% stearic acid (C 18:0), 19.56-20.36% oleic acid (C 18:1), 58.42-60.83% linoleic acid (C18:2) and 0.24-0.26% α-linolenic acid (C 18:3). Due to the high content of linoleic acid, milk thistle oil is similar to sunflower oil. The analysis of finisher diets determined equal concentrations of n-6 PUFA in both mixtures (58.05% : 58.06%). Due to higher concentration of n-3 PUFA in finisher diets of SO group than of MTO group, the n-6/n-3 PUFA ratio was narrower (24.91 : 51.38) in SO than in MTO group. If compared to SO group, higher production number in MTO broiler group resulted from their better performances.

Table 2. Concentrations of fatty acids in plant oils and chickens' diet

Tablica 2. Koncentracije masnih kiselina u biljnim uljima i hrani za piliće

Fatty acid *Masna kiselina*	Sunflower oil *Suncokretovo ulje*	Milk thistle oil *Ulje sikavice*	Starter diet *Starter smjese*	Finisher diets *Finišer smjese*	
				SO group *SO skupina*	MTO group MTO skupina
∑ SFA	18.50	12.43	18.94	13.73	16.92
∑ MUFA	22.24	24.16	24.74	25.89	23.89
∑n-6 PUFA	58.85	63.11	53.23	58.05	58.06
∑n-3 PUFA	0.41	0.30	3.09	2.33	1.13

SO 3% sunflower oil; MTO 3% *milk thistle* oil
∑ SFA = C12:0 + C14:0 + C15:0 + C16:0 + C17:0 + C18:0 + C20:0 + C22:0
∑ MUFA = C14:1 + C16:1 + C16:1n-7 + C 18:1n9t + C18:1 n9c + C18:1 isomers + C20:1n9
∑ n-6 PUFA = C 18:2n6 + C20:2n6 + C20:3n6 + C18:4n6 + C18:2 isomers
∑ n-3 PUFA = C 18:3n3 + C20:3n3

The Table 3 overviews fattening characteristics (live weight, feed conversion and production number) for both SO and MTO groups. Average live weight of broilers differed between groups by only 20 g, thus, being not statistically significant (P>0.05). When compared to SO group, MTO group achieved better feed conversion (for 30 g; P = 0.034) and higher production number (for 7 points, P = 0.013), the differences of which were statistically significant.

Table 3. Indicators of broilers' fattening characteristics

Tablica 3. Pokazatelji tovnih svojstava brojlera

Indicator - *Pokazatelj*	SO group – *SO skupina*	MTO group – MTO *skupina*	P value – *P vrijednost*
Live weight, kg	2.19 ± 0.23	2.21 ± 0.31	0.911
Feed conversion, kg	1.83^{a} ± 0.015	1.80^{b} ± 0.010	***0.034***
Production number	285.33^{b} ± 0.58	292.33^{a} ± 2.52	***0.013***

SO 3% sunflower oil; MTO 3% *milk thistle* oil; ^{a,b} P<0.05

Comparison of results referring to fattening characteristics of both SO and MTO groups was partially in accordance with the research results of Blevins et al. (2010), Suchy et al. (2008), Shiavone et al. (2007), as well as Mojahedtalab et al. (2013), and completely in accordance with the result published by Kalantar et al. (2014). Quality indicators of Cobb 500 broiler carcasses are presented in the Table 4. The research was focused on carcass weight (g), dressing percentage (%), absolute (g) and relative (%) portions of main parts in carcass. Statistical data analysis indicated that differences in the mentioned indicators between SO and MTO groups were not statistically significant (P>0.05). Within this research, portions of breasts in broiler carcasses were higher than those stated by Kralik et al. (2010) for Ross broilers. Kralik G. et al. (2011) determined that Cobb 500 broilers gained 2022 g of live weight during 42 days of fattening, the dressing percentage was 70.35%, and portions of breasts and drumsticks with thighs in carcass were 37.39% and 29.45%, respectively, being in accordance with the present research.

Table 4. Carcass quality traits (n=30)

Tablica 4. Pokazatelji kvalitete trupova (n=30)

Indicator *Pokazatelj*	SO group ($\bar{x}$ ± s) *SO skupina ($\bar{x}$ ± s)*	MTO group ($\bar{x}$ ± s) *MTO skupina ($\bar{x}$ ± s)*	P value *P vrijednost*
Carcass weight, g	1568.53 ± 167,27	1583.87 ± 245,33	0.778
Dressing percentage, %	71.34 ± 0.72	71.63 ± 1.73	0.310
Breast weight, g	587.07 ± 66.80	592.80 ± 106.45	0.804
Portion of breast in carcass, %	37.43 ± 1.62	37.29 ± 2.43	0.794
Thighs with drumsticks weight, g	461.47 ±51.34	461.07 ±66.30	0.979
Portion of thighs with drumsticks in carcass, %	29.43 ± 1.11	29.26 ± 2.03	0.683
Back weight, g	347.47 ± 48.54	361.60 ± 65.64	0.347
Portion of back in carcass, %	22.11 ± 1.54	22.74 ± 1.39	0.100
Wings weight, g	172.53 ± 16.58	168.40 ± 20.95	0.400
Portion of wings in carcass, %	11.03 ± 0.18	10.71 ± 0.76	0.093

SO 3% sunflower oil, MTO 3% *milk thistle* oil; $\bar{x}$ = arithmetic means; s = standard deviation

The Table 5 shows the content of fatty acids in broiler breast and thigh muscles. Breast muscles of MTO group contained higher concentrations of ΣSFA and ΣMUFA, and lower concentrations of Σn-6 PUFA. Differences between groups were not statistically significant (P>0.05). Total n-3 PUFA was statistically significantly higher in SO than in MTO group for both types of muscles (P<0.05). The n-6/n-3 PUFA ratio was more favorable in breast muscle lipids of SO group than of MTO group. Kralik et al. (2012) reported on the importance of Σn-3 PUFA and the n-6/n-3 ratio in broiler breasts for human nutrition. In comparison with SO group, the chemical analysis of thigh muscle of MTO group proved statistically significantly higher concentration of ΣSFA (P<0.05) and lower concentration of Σn-3 PUFA (P<0.001).

Market value of carcass cuts was determined on the basis of summarized market values of carcass main parts (Table 6). The value was higher if compared to price of whole carcass (SO group 31.13 HRK/kg; MTO group 31.66 HRK/kg). Market value of breast fillets (Table 7) was higher in MTO group than in SO group. The most favourable market value of broiler carcass is achieved by its cutting into main parts and by deboning of breast muscles, i.e. by selling of breast fillets. In their previous research, Kralik I. et al. (2011) stated that, in Croatian conditions, it was more profitable to sell broiler meat cuts rather than whole carcasses.

Table 5. Content of fatty acids in lipids of broiler breast and thigh muscles (% of total fatty acids, n = 5)

Tablica 5. Sadržaj masnih kiselina u lipidima mišića prsa i zabataka brojlera (% u ukupnim masnim kiselinama, n = 5)

Fatty acid – *Masna kiselina*	SO group ($\bar{x} \pm s$) *SO skupina* ($\bar{x} \pm s$)	MTO group ($\bar{x} \pm s$) MTO *skupina* ($\bar{x} \pm s$)	P value *P vrijednost*
Breast muscles – *Mišići prsa*			
∑ SFA	25.99 ± 2,22	27.61 ± 1,58	0.222
∑ MUFA	33.75 ± 3.16	37.05 ± 2.83	0.119
∑n-6 PUFA	37.78 ± 3.72	33.43 ± 3.28	0.085
∑n-3 PUFA	2.48^{a} ± 0.46	1.91^{b} ± 0.32	***0.049***
Thigh muscles – *Mišići zabataka*			
∑ SFA	23.30^{b} ± 1,43	$26,08^{a}$ ± 1,59	***0.019***
∑ MUFA	34.52 ± 0.02	37.30 ± 2.43	0.127
∑n-6 PUFA	39.89 ± 3.88	35.05 ± 3.74	0.079
∑n-3 PUFA	2.29^{A} ± 0.25	1.57^{B} ± 0.15	***<0.001***

SO 3% sunflower oil, MTO 3% *milk thistle* oil; $\bar{x}$ = arithmetic means; **s** = standard deviation; $^{a,b}P<0.05$, $^{A,B}P<0.001$

∑ SFA = C12:0 + C14:0 + C 15:0, 16:0 + C 17:0 + C 18:0 + C22:0

∑ MUFA = C14:1 + C16:1 + C16:1n-7 + C18:1 + C 18:1n9t + C18:1 n9c + C18:1 isomer + C20:1n9

∑ n-6 PUFA = C 18:2 isomers + C12:2n6 + C18:3n6 + C20:2n6 + C20:3n6 + C20:4n6 + C22:4n6

∑ n-3 PUFA = C 18:3n3 + C20:3n3 + C20:5n3 + C22:6n3

Table 6. The market value of main parts and carcasses of broilers (HRK)

Tablica 6. Tržišna vrijednost osnovnih dijelova i trupova brojlera (kn)

Group *Skupina*	Breast *Prsa*	Thighs with drumsticks *Batak+zabatak*	Back *Leđa*	Wings *Krila*	Carcass value *Vrijednost trupova*	
					In parts *U dijelovima*	Whole carcass *Cijeli trup*
SO	14.67	11.52	5.20	3.61	35.00	31.13
MTO	14.85	11.52	4.41	3.53	35.31	31.66

SO 3% sunflower oil, MTO 3% *milk thistle* oil

Table 7. Weight and market value of broiler breast muscles

Tablica 7. Masa i tržišna vrijednost filea u trupovima brojlera

Skupina *Group*	Breast muscles *(g)* *Prsni file (g)*		Market value of breast muscles (HRK) *Tržišna vrijednost prsnog filea (kn)*	Market value (parts + breast muscles), HRK *Tržišna vrijednost (dijelovi + prsni file), kn*
	Weight *Masa*	%		
SO	449.05	76.50	20.22	40.55
MTO	464.37	78.31	20.89	41.35

SO 3% sunflower oil, MTO 3% *milk thistle* oil

CONCLUSION

The presented research proved that it was possible to replace sunflower oil with milk thistle oil in broilers feeding. The MTO broiler group achieved better feed conversion and higher production number than SO group. There were no statistically significant differences determined for quality of carcasses between SO and MTO groups (P>0.05). Fatty acid profile was more favorable in breast and thigh muscle lipids of SO than of MTO broiler groups. Market value of carcass cuts and breast fillets was higher in MTO group than in SO group of broilers.

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UTJECAJ ZAMJENE SUNCOKRETOVOG ULJA ULJEM SIKAVICE (*Silybum marianum*) NA TOVNA SVOJSTVA, KVALITETU I TRŽIŠNU VRIJEDNOST TRUPOVA BROJLERA

SAŽETAK

U radu se istražuje utjecaj zamjene 3% suncokretovog ulja (SO skupina) s 3% ulja sikavice (MTO skupina) u hrani pilića na tovna svojstva i kvalitetu trupova. MTO skupina pilića postigla je nesignifikantno veću živu masu (2,21 kg : 2,19 kg; P>0,05) za 42 dana tova, signifikantno bolju konverziju hrane (1,80 kg : 1,83 kg; P = 0,034) i proizvodni broj (292,33: 285,33; P = 0,013) od SO skupine pilića. Masa trupa i udjeli osnovnih dijelova nisu se statistički značajno razlikovali između skupina (P>0,05). Tržišna vrijednost konfekcioniranih trupova i prsnoga filea bila je veća kod MTO skupine u odnosu na SO skupinu brojlera. Lipidi mišića prsa i zabataka sadržavali su značajno veće koncentracije suma n-3 PUFA (2,48% : 1,91%, P = 0,049, odnosno 2,29% : 1,57%; P<0,001) kod SO u odnosu na MTO skupinu pilića.

Ključne riječi: ulje sikavice, suncokretovo ulje, kvaliteta trupova, FA profil, tržišna vrijednost

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