

EFFECTS OF BLENDING AND INCLUSION LEVEL OF SOY OIL AND ITS ACIDULATED SOAPSTOCK ON BROILER PERFORMANCE

DJELOVANJE MIJEŠANJA I RAZINE UKLJUČIVANJA SOJINOG ULJA I NJEGOVE ZAKISELJENE SAPUNASTE SMJESE NA REZULTATE BROJLERA

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SUMMARY

This study was conducted to investigate the effect of diets containing blends of soy oil and its acidulated soapstock on broiler performance. Six hundred 7-day-old Ross broiler chicks were assigned to factorial arrangement (2×5) with 2 levels of oil (3, 6%) and 5 blends of soy oil and its soapstock (100:0, 75:25, 50:50, 25:75 and 0:100) with 4 replicates in a completely randomized design. The levels of inclusion of fat in diets had a significant effect on feed intake and feed conversion ratio (FCR), and birds fed diets containing 3% of fat had higher weight gain and better FCR ($P < 0.05$). Weight gain and feed conversion ratio were significantly ($P < 0.05$) affected by the blending ratio of soy oil and its acidulated soapstock. The soy oil: soapstock ratio of 0:100, in diet resulted in significantly lower weight gain, but there were not any significant differences between other blending ratios on weight gain and FCR. The interaction effects of fat levels × blending ratio of soy oil and its acidulated soapstock were significant on weight gain and FCR in the whole rearing period. The weight gain of birds receiving diets containing 6% of fat with the 0:100 (soy oil: soapstock) were significantly lower ($P < 0.05$) than those in the other treatments. It was concluded that the acidulated soy oil soapstock could be used as an energy source in broiler diets, and the soy oil replaced with its soapstock by 75% in the whole rearing period.

Key words: broiler, acidulated soapstock, fat, soybean oil

INTRODUCTION

Lipids have been used in poultry production for many years to formulate high energy diets. Soy oil acidulated soapstock is a by-product of oil extraction industry and it is not suitable for human consumption (El-Rahim, 2006). It contains high level of fatty acids

and active biological compounds such as colin, tocopherol and carotenoids and could be used as source of fat in broiler ration. The inclusion rate of

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acidulated soapstock in poultry diets is limited by its unsaponifiable compounds and high level of free fatty acid content. Broilers fed diets supplemented with a blend of soy oil and its acidulated soapstock have shown better performance than birds fed diets containing acidulated soapstock as a source of fat (Lara et al. 2006). The aim of this study was to investigate the effect of feeding diets containing blends of soy oil and its acidulated soapstock on broiler performance.

MATERIALS AND METHODS

Six hundred 7-day-old Ross broiler chicks were assigned to factorial arrangement (2×5) with 2 levels of oil (3 , 6%) and 5 blends of soy oil and its soapstock (100:0, 75:25, 50:50, 25:75 and 0:100) with 4 replicates in a completely randomized design. Chemical composition of soy oil and its acidulated soapstock is shown in table 1. All diets were isonitrogenous and isocaloric and formulated to meet the nutrient requirements according to NRC 1994 (Table 2). Chickens were fed starter diet (7 to 21 d) and grower diet (21 to 42 d). Feed and water were provided ad-libitum and a 24h lighting program was applied throughout the 42-day experiment. Feed intake and weight gain were recorded weekly and feed conversion ratio (FCR) was calculated. Results

were statistically analyzed by ANOVA with the general linear models procedure of SAS (SAS Institute, 1994) and means were compared using Duncan's multiple-range test.

RESULTS

Data presented in Table 3 showed that the level of inclusion of fat in diets had a significant effect on feed intake and feed conversion ratio (FCR) at start and the whole rearing period. Diets containing 3% of fat resulted in lower weight gain and better FCR (P<0.05). Also, birds receiving 3% of fat in their diets showed high weight gain, numerically. Weight gain and FCR were significantly (P<0.05) affected by the blending ratio of soy oil and its acidulated soapstock. The soy oil: soapstock ratio of 0:100, in diet resulted in lowest weight gain. Also, significantly higher FCR as found in birds fed diets containing fat with blending ratio of 0:100 (soy oil: soapstock), but there were no significant differences between other blending ratios on weight gain and FCR. The interaction effects of fat levels × blending ratio of soy oil : soapstock were significant on weight gain and FCR at start in the whole rearing period. The weight gain of birds receiving diets containing 6% of fat with the 0:100 soy oil: soapstock ratio was significantly lower (P < 0.05) than in other treatments.

Table1. Fatty acid composition of soy oil and its acidulated soapstock

Tablica 1. Sastav masnih kiselina sojinog ulja i njegove zakiseljene sapunaste smjese

Fatty acid - Masna kiselina (%)	Fat sources - Izvori masnoće	
	Soy oil - Sojino ulje	Acidulated soapstock Zakiselj sap.smjesa
Total free fatty acids - Ukupne slobodne masne kiseline	0.05	51.4
Palmitic acid - Palmitinska kiselina (C16:0)	11.67	9.25
Oleic acid - Oleinska kiselina (C18: 1)	27.43	22.35
Linoleic acid - Linolna kiselina (C18: 2)	54.53	43.9
Linolenic acid - Linolenska kiselina (C18: 3)	6.34	4.35
Others - Ostalo	0.03	20.15

Table 2. Ingredient and chemical composition of experimental diets (g/kg)

Tablica 2. Sastojci i kemijski sastav pokusnih obroka (g/kg)

Ingredients - Sastojci	Starter - Početni (7-21 d)									
	1	2	3	4	5	6	7	8	9	10
Corn - Kukuruz	502	507	512	517	522	430	436	446	460	470
Soybean meal - Sojino brašno	407	406	405	404	403	430	432.2	430	430	430
Fatty acids - Masne kiseline	0	7.5	15	22.5	30	0	15	30	45	60
Soy oil - Sojino ulje	30	22.5	15	7.5	0	60	45	30	15	0
Oyster shell - Školjka kamenice	18.5	18.5	18.5	18.5	19	19.8	19.8	18.9	19	19
Dicalcium phosphate - Dikalcijev fosfat	14.1	14	14	14	14	15	14.6	14.6	15	15
NaCl	4.3	4.3	4.3	4.3	4.3	5	4.5	4.4	4	4.1
Vit.& Min. Permixon ¹ - Vit. i min. premiks	5	5	5	5	5	5	5	5	5	5
DL-Methionin	1.2	1.2	1.2	1.2	1.2	1	1.3	1.3	1	1
Inert - Tromost	0	0	0	0	0	35	26.9	18.5	10	2
Calculated nutrients - Uračunate hranjive tvari										
ME(kcal/kg)	2.93	2.93	2.93	2.93	2.93	2.93	2.93	2.93	2.93	2.93
Crude protein - Sirova bjelančevina (%)	21.06	21.06	21.06	21.06	21.06	21.06	21.06	21.06	21.06	21.06
Calcium - Kalcij (%)	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Ava. phosphorus - Iskoristivi fosfor (%)	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39

Ingredients - Sastojci	Grower - Porast (22-42 d)									
	1	2	3	4	5	6	7	8	9	10
Corn - Kukuruz	570	575	580.4	585	590.7	497	508	518	528	538
Soybean meal - Sojino brašno	342	340.8	339	339	338	367	366	364	362	360
Fatty acids - Masne kiseline	0	7.5	15	22.5	30	0	15	30	45	60
Soy oil - Sojino ulje	30	22.5	15	7.5	0	60	45	30	15	0
Oyster shell - Školjka kamenice	19.8	19.8	19.8	19.8	19.8	20.2	20.3	20.3	20.3	20.3
Dicalcium phosphate - Dikalcijev fosfat	10.8	10.8	10.8	10.8	10.8	11.3	11.3	11.3	11.3	11.3
NaCl	3.2	3.2	3.2	3.2	3.2	3.2	3.4	3.4	3.3	3.3
Vit.& Min. Permixon ¹ - Vit. i min. premiks	5	5	5	5	5	5	5	5	5	5
DL-Methionin	1	1	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6
Inert - Tromost	0	0	0	0	0	0	34	25.6	17.2	8.8
Calculated nutrients - Uračunate hranjive tvari										
ME(kcal/kg)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Crude protein - Sirova bjelančevina (%)	18.75	18.75	18.75	18.75	18.75	18.75	18.75	18.75	18.75	18.75
Calcium - Kalcij (%)	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84
Ava. phosphorus - Iskoristivi fosfor (%)	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32

¹. Premix contained per kg: Mn, 64.5mg; Zn, 33.8mg; Fe, 100mg; Cu, 8mg; I, 640mg; Co, 190mg; Se, 8mg, vitamin A 4400000IU; Vitamin D 72000 IU; vitamin E 14400 IU; Vitamin K 2000 IU; Cobalamin 640 mg; thiamine, 612 mg; riboflavin, 3000 IU; calcium pantothenate, 4896 mg; niacin, 12160; pyridoxine, 612 mg; folic acid, 1.5 mg; choline chloride, 260 g.

Table 3. Effects of levels and blending of soy oil and its acidulated soapstock on broiler performance

Tablica 3. Djelovanje količina i miješanja sojinog ulja i njegove sapunaste smjese na rezultate brojlera

Variable - Varijabla		Starter - Početni (7-21 d)			Grower - Porast (22-42 d)			Total - Ukupno (7-42)		
Main effects Glavno djelovanje		FI(g)	WG(g)	FCR	FI(g)	WG(g)	FCR	FI(g)	WG(g)	FCR
Soy oil - Sojino ulje (%)										
	3	819.6 ^b	562.4	1.46 ^b	3275.2	1539.2	2.13 ^b	4094.8 ^b	2101.6	1.95 ^b
	6	882.3 ^a	562	1.57 ^a	3336.9	1500.0	2.23 ^a	4219.2 ^a	2062.0	2.05 ^a
SEM		19.44	13.46	0.05	63.28	39.63	0.06	69.27	40.7	0.04
Blending ratio ¹ Omjer miješanja										
	100:0	801.2 ^b	564.1	1.43 ^b	3261.3	1536.3 ^a	2.13 ^b	4062.5	2100.4 ^a	1.93 ^b
	75:25	866.3 ^a	558.5	1.56 ^a	3315.6	1543.5 ^a	2.15 ^b	4181.9	2102.1 ^a	1.99 ^{ab}
	50:50	849.0 ^a	560.7	1.52 ^{ab}	3349.5	1545.6 ^a	2.17 ^{ab}	4198.5	2106.2 ^a	1.99 ^{ab}
	25:75	876.2 ^a	578.1	1.52 ^{ab}	3280.5	1518.8 ^a	2.17 ^{ab}	4156.7	2096.9 ^a	1.98 ^a
	0:100	862.1 ^a	549.6	1.56 ^b	3323.3	1453.8 ^b	2.29 ^a	4185.5	2003.5 ^b	2.09 ^a
SEM		27.49	19.03	0.07	89.49	51.8	0.085	97.97	51.61	0.06
Interaction Effects Djelovanje interakcije										
		**	NS	**	NS	NS	NS	NS	*	*
3 (%) ×	100:0	735.6 ^d	569.8	1.29 ^d	3286.4	1572.3	2.09	4021.9	2142.1 ^a	1.88 ^c
	75:25	836.1 ^{bc}	566.1	1.48 ^{ab}	3321.1	1564.9	2.12	4157.1	2131.0 ^a	1.95 ^c
	50:50	796.0 ^c	556.7	1.43 ^d	3290.0	1559.0	2.11	4086.0	2115.7 ^{ab}	1.93 ^c
	25:75	889.9 ^{ab}	567.4	1.57 ^a	3184.3	1535.5	2.07	4074.2	2102.9 ^{ab}	1.94 ^{bc}
	0:100	840.5 ^{abc}	552.0	1.52 ^{abc}	3294.4	1464.4	2.25	4134.9	2016.5 ^{ab}	2.05 ^{ab}
6 (%) ×	100:0	866.8 ^{ab}	558.3	1.55 ^{abc}	3236.3	1500.4	2.16	4103.1	2058.7 ^{ab}	1.99 ^{abc}
	75:25	896.5 ^{ab}	551.0	1.63 ^a	3310.2	1522.2	2.17	4206.7	2073.2 ^{ab}	2.03 ^{ab}
	50:50	902.1 ^a	564.6	1.60 ^{ab}	3408.9	1532.2	2.22	4311.0	2096.8 ^{ab}	2.06 ^{ab}
	25:75	862.5 ^{ab}	588.8	1.46 ^{bc}	3376.7	1502.1	2.25	4239.2	2090.8 ^{ab}	2.03 ^{ab}
	0:100	883.8 ^a	547.3	1.62 ^{ab}	3352.3	1443.3	2.33	4236.1	1990.5 ^b	2.13 ^a
SEM		38.88	26.91	0.09	126.56	73.26	0.12	138.56	81.48	0.089

^{a-c} Means in each column with different superscript are significantly different (P<0.05), NS: Not significant.

¹ Soybean oil: Acidulated soapstock ratio, FI: Feed intake (g), WG: Weight gain (g) and FCR: Feed conversion ratio

DISCUSSION

In our study, birds fed diets containing 3% of fat had better performance than those fed 6 % of fat in their diets. Fats are included in poultry diets primarily as high-energy ingredients. However, the chemical structures of fats and oils are extremely variable. In addition, the age of birds has a marked influence on

the utilization of dietary fats. The digestibility of fats in young chickens follows the concentration of bile acids and lipase activity (Krogdahl, 1985), which shows temporal fluctuations with age. Thus, inclusion of high rate fat in diets decreases fat digestibility due to restriction in bile acids concentration and lipase activity. These findings are also supported by Rodrigues et al. (2005).

In this study, the soy oil: soapstock ratio of 0:100 reduced broiler performance. Absorption of fats is influenced by many factors such as chemical characteristic of fat. Lipid absorption will be influenced by whether the fatty acids are free fatty acids (FFA) or triglycerides (Garrett and Young, 1975). Lipase enzyme hydrolyzes triglycerides to fatty acids and monoglyceride molecules. Monoglycerides and unsaturated fatty acid (such as oleic and linoleic acids) readily form mixed micelles with bile salts which are essential for efficient fat absorption, particularly for saturated fatty acids. Soybean oil contains high levels of unsaturated fatty acids and is more completely digested by fowl. But, its acidulated soapstock completely consists of free fatty acids (Leeson and Atteh, 1995). Thus, the soapstock digestibility is restricted by absence of monoglycerides in intestinal fluid decreasing growth performance.

The results obtained in this experiment show a growth-depression attributed to rate of substitution of acidulated soapstock for soy oil in diets. The growth decreased significantly when soapstock was substituted completely by 6% soy oil in diets. It may be due to restriction in digestion and absorption of high level of free fatty acid as fat source in diets. In agreement with these findings, Waldrop, et al. (1995) reported a decrease in broiler performance when fed

diets containing more than 30g/kg of acidulated soapstock.

It was concluded that the acidulated soy oil soapstock could be used as an energy source in broiler diets and the soy oil can be replaced with its soapstock by 75% in the whole rearing periods.

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SAŽETAK

Ovaj je rad proveden radi istraživanja djelovanja obroka sa sojinim uljem i njegovom zakiseljenom sapunastom smjesom na rezultate brojerskih pilića. Šest 7 dana starih brojerskih pilića linije Ross svrstano je u faktorijalni red (2x5) s dvije količine ulja (3%,6%) i 5 mješavina sojinog ulja i njegove sapunaste smjese (100:0, 75:25, 50:50, 25:75 i 0:100) s 4 ponavljanja u potpuno slučajnom planu. Razine uključivanja masnoće u obroke imale su značajan učinak na uzimanje hrane i omjer konverzije hrane (FCR), te su pilići hranjeni obrocima s 3% masnoće imali veći prirast tjelesne mase i bolji FCR (P<0.05). Na prirast tjelesne mase i omjer konverzije hrane značajno je djelovao omjer miješanja sojinog ulja i njegove zakiseljene sapunaste smjese (P<0.05). Omjer sojino ulje: sapunasta smjesa od 0:100 u obrocima rezultirao je značajno nižim prirastom tjelesne mase ali nije bilo nikakve druge značajne razlike između drugih omjera miješanja na prirast tjelesne mase i na FCR. Djelovanje interakcije razine masti x omjer miješanja sojinog ulja i zakiseljene sapunaste smjese bilo je značajno na prirast tjelesne mase i FCR u čitavom razdoblju uzgoja. Prirast tjelesne mase pilića koji su dobivali obroke sa 6% masti s 0:100 (sojino ulje : sapunasta smjesa) bio je značajno niži (P<0,05) od prirasta pilića u drugim tretiranjima. Zaključuje se da bi se zakiseljena sapunasta smjesa sojinog ulja mogla upotrijebiti kao izvor energije u obrocima brojlera a sojino ulje nadomjestiti sa 75% sapunaste smjese u čitavom uzgojnom razdoblju.

Ključne riječi: brojler, zakiseljena sapunasta smjesa, masti, sojino ulje