

Influence of Feeding Diets Containing Dried Vegetable Fat Blend on the Performance of Broilers

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Abstract – Addition of fat became a common practice to increase energy density of poultry diets. Blending of unsaturated with saturated fatty acids is the best way to use fat in poultry feeding. Influence of feeding broilers on diets contained dried high saturates vegetable oil blend was evaluated in the present work by designing the experiment as five groups of one day old broilers. The first group fed on starter, grower and finisher diets during 0-2, 3-4, and 5-6 weeks of age, respectively without dried fat and it was considered as control group. Other four groups fed on diets contained normal (NRC, 1994) or extra (75 Kcal/Kg diet) ME content from dried fat along the experimental periods (0-42 days old) and on diets contained normal or extra ME content from dried fat only after two weeks of age (14-42 days old) to evaluate the effects of dried fat supplementation on growth performance, blood parameters, and carcass traits. Our results data revealed a negative effect of feeding broilers on diets contained dried high saturates vegetable oil blend with normal ME content or extra ME content on the relative growth rates, body weights, feed intakes and feed conversion ratios either along the experimental periods (0-42 days of age) or only after the starting period (14-42 days of age) compared to the control group. Dressing percentages of birds` groups fed on diets contained dried fat were lower than that of control group. However, dressing percentages of birds fed on diets contained dried fat along the experimental periods were lower than those fed on diets contained dried fat only after the starting periods. Addition of dried fat to the diets of broilers didn't influence the liver and breast weights but increased thigh weight compared to the control group. Abdominal fat weights decreased by supplementation of diets with dried fat either along the experimental periods or only after the starting period. Plasma triglycerides and cholesterol levels decreased by supplementation of diets with dried fat, whereas plasma LDL levels of groups fed on diets contained extra ME and plasma VLDL levels of groups fed diets contained dried fat along the experimental periods decreased compared with those of control group. On the other hand, plasma HDL levels increased by dried fat supplementation. Glutathione reductase concentrations of plasma decreased in birds of groups fed on diets contained extra ME either along the experimental periods or only after the starting period compared with that of control group. Plasma malondialdehyde levels decreased in all groups fed on diets contained dried fat either along the experimental periods or only after the starting period. It was concluded that feeding broilers on diets rich in saturated fatty acids decreased the growth performance, dressing percentages, abdominal fat, plasma triglycerides, LDL, VLDL, glutathione reductase, malondialdehyde and increased thigh weight, plasma HDL. These effects were more pronounced when birds fed these diets from one day to 42 days old.

Keywords – Dry-Fat, Broilers, Growth Performance.

I. INTRODUCTION

Poultry diet formulation is based on the concept that birds eat primarily to meet their energy needs [34]. The addition of fat to diets, besides supplying energy [35]-[39], it has other benefits, that include: improved absorption of fat-soluble vitamins, increased growth rates, increased feed efficiency, decreased feed intake, decreased dustiness of feeds and reduced dust losses, lubricant for equipment in feed mills, increased palatability of feeds [13]-[11], increased rate of body gain can decrease age at market and increased through output of housing systems, lower heat increment during heat stress keeps caloric intake up [47]-[28] and may slow gut transit of other feeds [30]-[31]-[32]-[33] resulting in increased digestibility [1]-[16]-[17]. Day-old broiler chicks had increased apparent fat digestibility when fed on diets contained soy oil [60]. It became common practice to add more fat to commercial broiler`s diets to increase energy density [51]. Chicken fed diets containing high fat content (5-10%) deposit 10-15% more energy in their body compared with similar diets low in fat. When fats or oils are added to poultry rations as extra energy, the resultant increase in metabolizable energy of the total ration is greater than the gross energy supplied by the fat. This extra energy comes from increased utilization of other components of the diet and not from the fat itself [49]-[9]. The main factor affecting the metabolizable energy value of fats is their digestibility, which is dependent on the length of carbon chain and the degree of saturation of the constituent fatty acids [37]-[23]-[54]-[24]. Interactions between the degrees of saturation, relative to fat absorption have been suggested by several authors [54]-[23]. It has been proven that the best way to use fats with more saturated fatty acids in poultry diets, such as animal and palm fats, is by blending them with unsaturated fatty acids [37]-[38]. Fats of vegetable origin have high unsaturated fatty acid content with high degrees of metabolizable energy, which are well absorbed and utilized as a source of energy by the bird [60]. A synergistic effect occurs when these vegetable fats are mixed with fats high in saturated fatty acids (animal fats, palm fats or restaurant greases), providing a higher metabolizable energy level to the blend. The aim of this work was to study the effect of feeding broilers on diets contained normal or extra ME from blend, consists of calcium salts of 70% palm oil fatty acids, 25% sunflower+corn oils and 5% soybean oil on the growth performance and carcass traits of broilers.

II. MATERIALS AND METHODS

Birds and treatments

The experiment was carried out under the protocol approved by the faculty of veterinary medicine Sadat city University, Egypt. A total of 150 one day old chicken "cobb₅₀₀" were raised to 42 days old and allotted randomly to 5 floor pens with 30 birds each. The first was the control group, which fed on starter, grower, and finisher diets without dried fat during 0-2Wks, 2-4 Wks, and 4-6Wks of age, respectively. Four treatment groups {T1, T2, T3, and T4} were designed to feed on diets contained dried fat as normal [34] ME for T1 and T3 groups and extra ME (75 Kcal/Kg) for T2 and T4 groups either along the experimental periods {T1 and T2} or only after the starting periods (T3 and T4) as shown in Table 1. The used dried fat is a modern modified dry-fat product which consists of calcium salts of 70% palm oil fatty acids, 25% sunflower+corn oils and 5% soybean oil and provided by Norel-Misir, Egypt [6]. It supplies 7160 Kcal ME/Kg as evaluated by Selim et al., [45] using model of Wiseman et al. [55]. Metabolizable energy value of dried fat was calculated using the model of Wiseman et al. [55] based on fatty acids analysis of dried fat and the ratio between unsaturated and saturated fatty acids.

Management and housing

Top-dressed litter with 2 inch of fresh pine wood shavings was used as bedding. The temperature was set at 30 to 33°C during the first week and was reduced by 2 °C per week until 20 °C was reached. Relative humidity was about 60 to 80%. The lighting program was 23L:1D. The chicks were vaccinated according strain's vaccination program. Access to feed and water was provided on an *ad libitum* basis.

Birds` performance measurements

Body weight and feed intake were monitored on a pen basis weekly, whereas weight gain, relative growth rate [8] and feed conversion ratio [50] values were calculated at the end of starting and finishing periods. Mortality was also recorded on a daily basis in each pen. Chickens were killed by cervical dislocation at the end of the trial. Six birds per treatment group were randomly selected for determining carcass traits. They were defeathered, eviscerated and dressed. Liver, gizzard, proventriculus, thigh and breast were collected, weighed and calculated as percentage of live weight.

Sampling and Methods of analysis

Representative samples of mixed rations and dried fat were taken for chemical analysis [5]. Fatty acids profile was determined using official method of analysis No. 969.33. At the end of 5th week of age, blood samples were obtained from wing vein and directly aliquoted into 2-mL sterile vials, and allowed to clot for 4 h after centrifugation (20 min, 1500 rpm). The serum samples were used for determination of triglycerides [18], cholesterol [2], malondialdehyde, glutathione reductase, high density lipoprotein HDL [29], low density lipoprotein LDL, and very low density lipoprotein VLDL [22] using Spectrophotometer and commercially available kits

(Biosystem S.A, Costa Brava, 30, Barcelona, Spain) according to manufacturer's instructions.

Statistical analysis

Experimental data were analyzed as a randomized block design. All data were subjected to one-way ANOVA by the GLM procedure using the SPSS 18.00 statistical package (SPSS Ltd., Surrey, UK). Duncan's test was carried out to assess any significant differences at the probability level of $P > 0.05$ among the experimental treatments.

III. RESULTS AND DISCUSSION

The effects of different types of fat on feed efficiency of poultry could be related to their degree of unsaturation and age of the birds because some authors have reported that the digestibility of fat increases as the degree of unsaturation increases [15] and high levels of free saturates are not well utilized by young birds [55]. Our data in table (3) revealed a significant negative effect of feeding broilers on diets contained dried fat with normal ME {T1 and T3} content [34] or extra ME content {T2 and T4} on the relative growth rates, body weights, feed intakes and feed conversion ratios either along the experimental periods {T1 and T2} or after the starting period {T3 and T4} till marketing compared to the control group. These results of feeding broiler high saturated fatty acids blend were agreed with the finding of Vila and Esteve-Garcia [56] who compared feeding broilers on diets contained high and low saturated fatty acids and didn't agreed with that of Waldroup, et al. [54] who find no difference between broilers fed on diets contained high or low free fatty acids content and Stahly [52] who find improved growth performance of broilers fed on diets contained ratio of USFA:SFA more than 4

The lowest growth performance were for the birds fed on diets contained dried fat along the experimental periods {T1 and T2} compared to the other groups {control, T3, and T4}. These reduced growth performance might be due to increased saturated fatty acids (56.2%) and lowest ratio of unsaturated to saturated fatty acids (0.78) in the dried fat blend. Wiseman et al., [55] proved less fat digestibility of young birds as saturated fatty acids increased. Also, Ketels and De Groote [21] stated that the ratio of USFA: SFA must be more than 2.5 or more than 4 in the study of Stahly, [52]. The high saturates decreased the fat digestibility and efficiency of ME utilization [55] where the young birds have less efficient fatty acids binding proteins, can't recycle bile salt as the adult birds and the maximum absorption of saturated fatty acids in young birds is 59.5% during the first two weeks of age [10].

As shown in table (4), dressing percentages of birds fed on diets contained dried fat {T1, T2, T3, and T4} are significantly lower than control group as a result of reduced body weights of these groups compared to the control group. However, dressing percentages of birds fed on diets contained dried fat along the experimental periods were significantly lowered than those fed on diets contained dried fat only after the starting periods. Addition of dried fat to the diets didn't influence the liver and breast

weights but increased significantly thigh weight compared to the control group. These findings were in agreement with that of Shahryar et al. [46] who showed no effects on liver and breast weights for high dietary fat intake of broilers. Extra energy from dried fat supplementation for broilers along the experimental periods {T2} or only after the starting period {T4} increased thigh weight. This increased thigh weight was in agreement with the finding of Lesson and Summers [25] but wasn't in agreement with the finding of Shahryar et al. [46]. This increased thigh weight might be due to increased ME from increased utilization of other components of diets and not from fat itself [49]-[9]. Gizzard and Preventriculus weights weren't affected by addition of dried fat to diets of birds along the experimental periods {T1 and T2} but increased when dried fat added to the diets after starting periods {T3 and T4}. This might be due to decreasing the passage rate of food and gradually increasing gizzard function and finally gizzards muscular mass, that is the cause of gizzard muscular hypertrophy. These finding were in agreement with that of Tabiedian et al. [53]. Abdominal fat was reduced by supplementation of diets by dried fat either along the experimental periods (T1 and T2) or only after the starting period (T3 and T4). This reduced abdominal fat might be as a result of inhibition for lipogenesis, which involved the flux rate of fatty acyl coenzyme-A or availability of lipid precursors in the form of dietary carbohydrate [40]. This finding was in accordance with Sanz [43] and Zolitsch *et al.* [61] but not in agreement with Ghazalah *et al.* [19] who find increased abdominal fat percentage by increased dietary fatty acids.

Table (5) showing that plasma triglycerides, Cholesterol, LDL, and VLDL levels were reduced numerically by feeding broilers on diets contained dried fat as normal or extra ME content either along the experimental periods or only after starting periods

compared to control group. The lowest values were for birds fed on diets contained dried fat along the experimental periods {T1 and T2} followed by those fed on diets contained dried fat only after the starting period {T3 and T4}. These differences were significant only for plasma triglycerides and cholesterol of all treatments groups {T1, T2, T3, and T4}, for plasma LDL of groups fed extra ME from blend {T2 and T4} and for VLDL levels of groups fed diets contained dried fat along the experimental periods {T1 and T2} when compared with the control group. The reduction in plasma cholesterol, LDL, and VLDL of group fed on extra ME from dried fat along the experimental periods {T2} was significant compared with group fed on normal ME along the experimental periods {T1}. Plasma HDL levels of broilers groups fed on diets contained dried fat {T1, T2, T3, and T4} increased significantly when compared with control group. The increased plasma HDL levels were a consequence for increased free fatty acids intake. The reduced plasma triglycerides, Cholesterol, LDL, and VLDL leads to reduced fat deposition [44] and is effective for decrease of fat accretion in tissues and carcass [56]. These finding were in accordance with Shimomura, et al. [48] and Rahimi *et al.* [36] who fed broilers on diets enriched with vegetable free fatty acids. A higher rate of dietary fatty acids absorption resulted in greater substrate availability, leading to faster β -oxidation of free fatty acids, eventually lowering the postprandial plasma triglyceride concentration [27]. Thus, lipogenesis was negatively affected, indicating reducing fat storage, by favoring unsaturated over saturated fatty acids in the diet [26]-[14]. This has been confirmed by further individual studies in which broiler chickens fed diets enriched with poly-unsaturated fatty acids compared to diets high in saturated fatty acids had low fat deposition as abdominal fat [43] or total body fat [44].

Table 1: Composition of different used diets and their calculated nutrients content

Ingredients	Vegetable oil (NRC Energy)			Polyfat (NRC Energy)			Polyfat (Extra Energy)		
	Starter	Grower	Finisher	Starter	Grower	Finisher	Starter	Grower	Finisher
Yellow corn	55.4	60.25	63.49	55.5	59.35	62.50	53.45	57.55	60.09
Soybean meal50-	33	28.5	24.5	33.0	29.0	24.89	33	28.7	25.4
Corn gluten 60	6.0	5.5	6.0	6.0	5.5	6.0	6.0	5.5	6.0
Vegetable oil	1.5	2.0	2.5	-	-	-	-	-	-
Dry-Fat ¹	-	-	-	1.5	2.5	3.0	3.5	4.5	5.0
Dicalcium-P. ²	1.70	1.5	1.4	1.70	1.50	1.4	1.70	1.5	1.4
Lime stone	1.5	1.4	1.3	1.40	1.30	1.2	1.50	1.4	1.3
Common salt	0.30	0.30	0.3	0.30	0.30	0.3	0.30	0.30	0.3
Premix ³	0.30	0.30	0.3	0.30	0.30	0.3	0.30	0.30	0.3
DL-methionine ⁴	0.15	0.12	0.11	0.15	0.12	0.11	0.15	0.12	0.11
L-lysine ⁵	0.15	0.13	0.10	0.15	0.13	0.10	0.10	0.13	0.10
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Calculated analysis									
ME Kca/kg	2925	3015	3090	2925	3015	3095	3000	3090	3170
CP%	22	20.2	19.1	22	20.15	10.1	22.1	20.1	19.1
EE%	4.01	4.65	5.25	3.24	4.98	5.27	5.4	6.35	7.28



Calcium%	1.11	1.0	0.95	1.11	1.00	0.95	1.11	1.0	0.95
Total phos.%	0.75	0.68	0.60	0.75	0.67	0.60	0.75	0.66	0.61
DL.methionine%	0.56	0.53	0.51	0.57	0.54	0.51	0.56	0.53	0.51
L.lysine%	1.18	1.11	1.0	1.15	1.10	1.10	1.16	1.10	1.0

¹Polyfat®: is a calcium salt of fatty acids of palm oil (75%), sunflower + corn oil (20%) and soy oil (5%) of Norel Egypt company.

²Dicalcium phosphate, 18% granular phosphate and 23 % calcium..

³Premix of Altoba company: 1.5 kg vitamins mixture contains: vitamin A 12000000 IU, vitamin D3 3000000 IU, vitamin E 40000 mg, vitamin K3 3000 mg, vitamin B1 2000 mg, vitamin B2 6000 mg, vitamin B6 5000 mg, vitamin B12 20 mg, niacin 45000 mg, biotin 75 mg, folic acid 2000 mg, pantothenic acid 12000 mg. In addition to 1.5 Kg of minerals mixture contains: manganese 100000 mg, zinc 600000 mg, iron 30000 mg, copper 10000 mg, iodine 1000 mg, selenium 200 mg and cobalt 100 mg. ⁵DL-Methionine, Met AMINO® (DL-2-amino-4-(methyl-thio)-butane acid,

⁴DL-methionine, α-amino-γ-methyl-oily acid) by Feed Grade 99% (EU).

⁵L-Lysine HCL 99% (Feed Grade) L-Lysine: 78.0% Min (Indonesia).

Table 2: Chemical analysis and calculated ME values of Polyfat

Items	Value
Gross Energy (KCal/Kg)	7688 ± 92
Peroxide No. (mmol O ₂ /Kg)	3.00
Acid No. (%)	0.35
Fatty acid Profile (% of total fatty acids):	
Capric (C 10:0)	0.2
Lauric (C 12:0)	3.3
Myristic (C 14:0)	2.2
Palmitic (C 16:0)	46.4
Palmitoleic (C 16:1 w7)	0.2
Stearic (C 18:0)	4.1
Vaccinic (C 18:1 w7)	0.7
Oleic (C 18:1n9)	33.4
Linoleic (C 18:2)	9.0
Linolenic (C 18:3)	0.2
Octadecatetraenoic (C 18:4 w3)	0.3
SFA	56.2
UFA	43.8
UFA:SFA	0.78
Oleic: Palmitic (O:P)	0.72
Linoleic: Palmitic (L:P)	0.19
(L+O)/P	0.91
ME of PF (kcal/kg; Based on UFA:SFA) ¹	7160
ME of PF (kcal/kg; Based on% C 18:2) ²	7188

¹: Model reported by Wiseman *et al.* (1991)

²: Model reported by Halloran and Sibbald (1979)

Table 3: Effect of feeding diets containing Polyfat on the growth performance of broilers

	Control	T1	T2	T3	T4
0 – 14 day old					
BW	607.4±7.4 ^a	355.8±10.9 ^c	362.7±9.3 ^c	493.3±28.2 ^b	522.7±22.1 ^b
RGR	171.4±0.01 ^a	151.4±0.02 ^d	152.3±0.01 ^d	164.0±0.02 ^c	166.5±0.01 ^{bc}
FCR	1.89±0.03 ^b	2.463±0.09 ^a	2.38±0.07 ^a	2.46±0.16 ^a	2.23±0.11 ^a
FI g/bird	1053.9	745.0	740.0	1048.6	1034.6
14 – 42 day old					
BW	1984.5±21.4 ^a	1360.4±32.5 ^c	1335±30.3 ^c	1583.8±66.1 ^b	1698.5±34.7 ^b
RGR	106 ± 0.01 ^{bc}	117 ± 0.02 ^a	114 ± 0.03 ^{ab}	106 ± 0.05 ^c	106 ± 0.03 ^{bc}
FCR	1.89±0.04 ^b	1.85±0.06 ^a	1.87±0.07 ^a	2.3±0.17 ^a	2.04±0.07 ^a
FI g/bird	2584.0	1841.0	1795.0	2380.0	2370.0
Mortality %	6.6	10.0	16.0	6.6	3.3

Total RGR and CR

RGR	191 ± 0.002 ^a	186 ± 0.004 ^d	186 ± 0.004 ^d	188 ± 0.005 ^c	189 ± 0.002 ^b
FCR	1.88 ± 0.02 ^a	1.98 ± 0.05 ^{bc}	1.98 ± 0.05 ^{bc}	2.28 ± 0.10 ^a	2.07 ± 0.04 ^b
Total FI g/bird	3637.9	2586.0	2535.0	3428.6	3404.6

^{abcd}Values in the same row with a different superscript differ significantly at P < 0.05

Table 4: Effect of feeding of diets containing Polyfat on the carcass traits of broilers

	Control	T1	T2	T3	T4
Dressing %	79.6 ± 0.01 ^a	65.3 ± 0.01 ^b	64.2 ± 0.03 ^b	68.8 ± 0.01 ^c	71.4 ± 0.01 ^c
Eviscerated%	84.9 ± 0.01 ^a	70.1 ± 0.01 ^b	69.5 ± 0.02 ^b	74.8 ± 0.0 ^c	76.2 ± 0.0 ^c
Thigh % NS	8.9 ± 0.01 ^c	10.2 ± 0.00 ^b	11.9 ± 0.01 ^a	10.5 ± 0.00 ^b	12.3 ± 0.00 ^a
Breast%	13.19 ± 0.01	13.3 ± 0.02	13.7 ± 0.01	12.8 ± 0.00	14.7 ± 0.00
Liver %	2.0 ± 0.00	2.1 ± 0.0	2.0 ± 0.0	2.2 ± 0.0	2.1 ± 0.0
Gizzard %	2.0 ± 0.0 ^b	2.0 ± 0.0 ^b	2.1 ± 0.0 ^b	2.6 ± 0.0 ^a	2.7 ± 0.0 ^a
Preventriculus %	0.4 ± 0.0 ^b	0.4 ± 0.0 ^b	0.4 ± 0.0 ^b	0.6 ± 0.0 ^a	0.6 ± 0.0 ^a
Abdomonal fat%	2.8 ± 0.0 ^a	2.3 ± 0.0 ^b	2.3 ± 0.0 ^b	2.5 ± 0.0 ^b	2.4 ± 0.0 ^b

^{abcd}Values in the same row with a different superscript differ significantly at P < 0.05

Table 5. Effect of feeding diets containing Polyfat on the blood parameters of broilers

Items mg/dl	Control	T1	T2	T3	T4
Triglycerides	180.1 ± 11 ^a	158 ± 5.8 ^c	155 ± 2.6 ^c	165 ± 4.4 ^b	164 ± 2.3 ^b
Cholesterol	240 ± 8.6 ^a	215 ± 13.3 ^b	201 ± 6.0 ^c	220 ± 7.5 ^b	224 ± 9.3 ^b
HDL	43.5 ± 2.0 ^d	63.5 ± 3.0 ^{ab}	64.8 ± 2.6 ^{ab}	56.6 ± 3.4 ^{bc}	66.2 ± 2.6 ^a
LDL	154 ± 10 ^a	137 ± 14.8 ^a	105 ± 9.2 ^b	131 ± 10 ^a	115 ± 11 ^b
VLDL	37 ± 0.6 ^a	34 ± 1.2 ^b	31 ± 0.5 ^c	35 ± 0.9 ^{ab}	35 ± 0.6 ^{ab}
Malondialdehyde	11.1 ± 0.5 ^a	8.1 ± 2.1 ^b	8.5 ± 0.7 ^b	8.8 ± 0.2 ^b	8.9 ± 0.0 ^b
Glutathione	7.7 ± 0.2 ^a	7.4 ± 0.2 ^{ab}	6.9 ± 0.1 ^b	7.2 ± 0.3 ^{ab}	6.7 ± 0.1 ^b

^{abcd}Values in the same row with a different superscript differ significantly at P < 0.05

Glutathione reductase plays a vital role in protecting cells from harmful effects of reactive oxygen species of lipid peroxidation [3]. In the present study, plasma glutathione reductase levels reduced numerically in all groups fed on diets contained dried fat {T1, T2, T3, and T4} and this reduction was significant in birds of groups fed on diets contained extra ME from dried fat either along the experimental periods {T2} or only after the starting period {T4} compared with control group. The Glutathione reductase activity was assayed by following the reduction of glutathione [7]. Dried fat contains more saturated fatty acids than that recommended for poultry and glutathione reductase activity increased as unsaturated and polyunsaturated fatty acids increased compared to saturated fatty acids, however, the decrease in activity of glutathione reductase in red blood cells is a positive feedback mechanism in response to reduced lipid peroxidation [39]. The reduced levels of plasma glutathione reductase might be due to less accumulation of lipid peroxidation products in liver [42]-[58]. Malondialdehyde as well as other carbonyl compounds are naturally occurring byproducts of polyunsaturated fatty acids peroxidation [12]. Furthermore, plasma malondialdehyde level reflects lipid peroxidation endogenously, which is the sequela of diminished anti-

oxidant protection as reactive oxidative species levels increase [42]. Our data revealed significant reduced plasma malondialdehyde levels in all groups fed on diets contained dried fat either along the experimental periods {T1 and T2} or only after the starting period {T3 and T4}. The low plasma malondialdehyde levels were a direct reflection of glutathione reductase activity in the birds fed on diets contained dried fat.

CONCLUSION

It was concluded that feeding broilers on diets rich in saturated fatty acids decreased the body weight, relative growth rate, body weight gain, feed intake, feed conversion ratio, dressing percentages, abdominal fat, plasma triglycerides, LDL, VLDL, glutathione reductase, malondialdehyde and increased thigh weight, plasma HDL. These effects were more pronounced when birds fed these diets from one day to 42 days old.

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