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## Inclusion of Sunflower Meal, With or Without Enzyme Supplementation, in Broiler Diets

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Alternative feedstuffs, broiler production, enzyme complex.

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### ABSTRACT

Two experiments were carried out to evaluate the effects of the dietary inclusion of different dietary sunflower meal (SFM) levels (0% and 20%), with or without the supplementation of an enzyme complex (EC) (cellulase,  $\beta$ -glucanase, xylanase, and phytase) on broiler performance, carcass and cuts yields, economics, and dietary AMEn values. A randomized block experimental design, with a 2x2 factorial arrangement of eight replicates of 20 birds each, was used to test performance. A completely randomized experimental design with a 2x2 factorial arrangement of eight replicates of four birds each was used to test metabolism. No interaction effects between SFM and EC were observed on performance. Although SFM significantly reduced feed intake in the starter phase and total period, weight gain was not different in these phases. Feed: gain ratio improved with the use of SFM in all phases, probably due to the dietary inclusion of oil, which may have improved digestibility. There was a significant increase in weight gain with the use of EC in the starter phase, which is possibly explained by the immature digestive system of birds at this age. There were no SFM or EC significant effects on carcass or cuts yields. There was no significant effect of the addition of EC on dietary AMEn values; however, EC significantly improved the apparent metabolizability coefficients of phosphorus and calcium.

### INTRODUCTION

The low metabolizable energy of sunflower meal and its deficient utilization by non-ruminant animals are directly related to its high fiber content, resulting in worse live performance (Furlan *et al.*, 2001).

Waldroup *et al.* (1970) concluded it is possible include up to 20% of sunflower meal broiler diets with no lysine supplementation, which was later confirmed by Valdivie *et al.* (1982) and Zatari & Sell (1990). However, Furlan *et al.* (2001) asserted that up to 15% of sunflower meal can be included in broiler feeds with no effect on performance, provided lysine is supplemented; however, lower feed cost per kilogram of body weight gain ratio, better economic efficiency index, and feed cost were observed with 0% of inclusion of sunflower meal. Pinheiro *et al.* (2002) found better economic performance when broilers were fed 0% sunflower meal from three to 35 days of age, and 4% sunflower meal from 36 to 42 days of age.

Monogastric animals do not have endogenous capacity to digest fiber, and therefore, the use of exogenous enzymes is important as they hydrolyze non-starch polysaccharides that can potentially be used by the animals, improving, for instance, energy use.

Senkoylu & Dale (1999), in a review on sunflower meal, proposed that the addition of exogenous enzymes is required when this raw



material is used due to its high non-starch polysaccharide content.

Oliveira *et al.* (2007) evaluated two sunflower meal inclusion levels (0 and 15%), with or without an enzyme complex (cellulase, protease, and amylase) in the diet of 21 to 42-day-old broilers, and did not find any significant interactions between sunflower meal and the enzyme complex. Those authors concluded that the dietary inclusion of 15% sunflower meal improves live performance, but does not affect carcass yield.

The objective of the present experiments was to evaluate live performance, carcass yield and cuts, economic feasibility, and metabolizable energy content of diets containing 0% or 20% sunflower meal, and supplemented or not with enzymes.

## MATERIAL AND METHODS

Two experiments were carried out at the Poultry Sector of the Department of Animal Science of the Federal University of Viçosa, MG, Brazil.

The first experiment evaluated the performance of 640 one- to 42-day-old male Cobb broilers. Birds were housed in a masonry broiler house, equipped with screens, and with a clay-tiled roof, divided in 1.0 x 1.5 m pens, provided with wood-shavings litter, a nipple drinker, and a tube feeder.

The average environmental temperatures recorded during the experiment were: 25.5°C (20.0 and 31.0°C of minimum and maximum temperatures, respectively) from 1 to 21 days, and 24.5°C (19.0 and 30.0°C of minimum and maximum temperatures, respectively) from 21 to 42 days.

A randomized block experimental design with four treatments in a 2x2 factorial arrangement (two sunflower meal inclusion levels: 0% and 20%; and supplementation or not of an enzyme complex), with eight replicates of 20 birds each.

Diets were formulated according to Rostagno *et al.* (2005) (Tables 1 and 2). Sunflower meal contained 89.95% DM, 28.09 % CP, and 22.37% CF. The used enzyme complex was Rovábio Max (cellulase,  $\beta$ -glucanase, xylanase, and phytase) at 100g/MT of feed.

The experimental diets contained equal levels of calories, of protein, and of the main digestible amino acids. No nutritional value was considered for the enzyme complex.

Birds and diets were weighed at beginning and in the end of each experimental phase (01 to 21 days, and 22 to 42 days) in order to calculate the following parameters: weight gain, feed intake, and feed: gain

ratio at 21 and 42 days of age, and livability and production index at 42 days. Carcass traits, such as carcass yield, breast, thigh and drumstick, and abdominal fat yields, were also assessed.

The economic feasibility of the dietary inclusion of sunflower meal was assessed first by calculating feed cost per kilogram of body weight gain (Yi), as proposed by Bellaver *et al.* (1985).

$$Y_i = (P_i \cdot Q_i) / W_i,$$

where Yi is the feed cost per kilogram of body weight gain in the nth treatment; Pi, price per kilogram of feed used in the nth treatment; Qi, feed intake amount in the nth treatment; and Wi, weight gain of the nth treatment. Then, the Economic Efficiency Index (EEI) and the Cost Index (IC) proposed by Fialho *et al.* (1992) were calculated.

$$EEI = (MCE / CTei) \cdot 100 \text{ and } CI = (CTei / MCE) \cdot 100,$$

where MCE is the lowest feed cost per kilogram of weight gain observed among treatments; and CTei, cost of the i treatment.

**Table 1** - Percentage and chemical composition of the starter diets (on as-fed basis).

Ingredients (%)	Sunflower meal inclusion levels	
	0%	20%
Corn	56.97	43.89
Soybean meal	36.74	26.77
Sunflower meal	0.00	20.00
Soybean oil	2.30	5.30
Dicalcium phosphate	1.85	1.71
Limestone	0.91	0.92
Salt	0.50	0.49
DL-Methionine 99%	0.24	0.21
L-lysine HCl 99%	0.15	0.33
L-Threonine 98%	0.03	0.06
Vitamin premix <sup>1</sup>	0.10	0.10
Mineral premix <sup>2</sup>	0.05	0.05
Choline chloride 60%	0.10	0.10
Anticoccidial (salinomycin 12%)	0.06	0.06
Antioxidant <sup>3</sup>	0.01	0.01
<b>Calculated composition</b>		
Metabolizable energy, kcal/kg	2,975	2,975
Crude protein, %	21.50	21.50
Crude protein, % <sup>4</sup>	21.19	21.31
Crude fiber, %	2.97	6.68
Calcium, %	0.91	0.91
Total phosphorus, %	0.67	0.73
Available phosphorus, %	0.45	0.45
Available lysine, %	1.17	1.17
Available methionine + cystine, %	0.83	0.83
Available methionine, %	0.54	0.54

1 - Vitamin premix (per kg of product): vit. A - 10,000,000 IU; vit. D3 - 2,000,000 IU.; vit. E - 30,000 IU.; vit. B1 - 2.0 g; vit. B2 - 6.0 g; vit. B6 - 4.0 g; vit. B12 - 0.015 g; pantothenic acid- 12.0 g; biotin - 0.1 g; vit. K3 - 3.0 g; folic acid - 1.0 g; nicotinic acid- 50.0 g; Se - 250.0 mg.  
2 - Mineral premix (per kg of product): Fe - 80 g; Cu - 10 g; Co - 2 g; Mn - 80 g; Zn - 50 g; I - 1 g.3 - Antioxidant: BHT (butylated hydroxy toluene). 4 - Determined value.



**Table 2** - Percentage and chemical composition of the grower diets (on as-fed basis).

Ingredients (%)	Sunflower meal inclusion levels	
	0%	20%
Corn	62.56	47.23
Soybean meal	30.57	21.95
Sunflower meal	0.00	20.00
Soybean oil	3.15	7.17
Dicalcium phosphate	1.65	1.49
Limestone	0.85	0.85
Salt	0.47	0.46
DL-Methionine 99%	0.21	0.15
L-lysine HCl 99%	0.18	0.32
L-Threonine 98%	0.04	0.06
Vitamin premix <sup>1</sup>	0.10	0.10
Mineral premix <sup>2</sup>	0.05	0.05
Choline chloride 60%	0.10	0.10
Anticoccidial (salinomycin 12%)	0.06	0.06
Antioxidant <sup>3</sup>	0.01	0.01
<b>Calculated composition</b>		
Metabolizable energy, kcal/kg	3,100	3,100
Crude protein, %	19.15	19.15
Crude protein, % <sup>4</sup>	19.10	19.73
Crude fiber, %	2.74	6.94
Calcium, %	0.82	0.82
Total phosphorus, %	0.62	0.68
Available phosphorus, %	0.41	0.41
Available lysine, %	1.05	1.05
Available methionine + cystine, %	0.76	0.76
Available methionine, %	0.49	0.47

1 - Vitamin premix (per kg of product): vit. A - 10,000,000 IU.; vit. D3 - 2,000,000 IU.; vit. E - 30,000 IU.; vit. B1 - 2.0 g; vit. B2 - 6.0 g; vit. B6 - 4.0 g; vit. B12 - 0.015 g; pantothenic acid- 12.0 g; biotin - 0.1 g; vit. K3 - 3.0 g; folic acid - 1.0 g; nicotinic acid - 50.0 g; Se - 250.0 mg.  
2 - Mineral premix (per kg of product): Fe - 80 g; Cu - 10 g; Co - 2 g; Mn - 80 g; Zn - 50 g; I - 1 g. 3 - Antioxidant: BHT (butylated hydroxy toluene).4 - Determined value.

In the second experiment, a metabolism trial, 160 Cobb broilers, from 15 to 24 days of age and 467g average body weight, were used to estimate the dry matter apparent digestibility (DMAD), apparent metabolizable energy corrected for nitrogen (AMEn), and gross energy metabolizability coefficient (GEMC) of the starter feeds fed in the performance experiment described above, using the total excreta collection method. A completely randomized experimental design with four treatments in a 2x2 factorial arrangement (two sunflower meal inclusion levels: 0% and 20%; and the addition or not of an enzyme complex), with eight replicates of five birds each, was applied.

The average temperatures recorded during the experiment were: 23.0°C (17.0 and 29.0°C minimum and maximum temperatures, respectively).

Chicks were reared in a masonry broiler house from 1 to 14 days of age, and then transferred to metabolic cages. The total experimental period was nine days, with four days for bird adaptation to the experimental diets and cages, and the remaining five days for excreta collection, which was carried out twice daily, at 12-h

intervals. In order to prevent sample contamination and loss, trays lined with plastic sheets were placed under each metabolic cage.

Collected excreta samples were placed in plastic bags, duly identified, weighed, and stored in a freezer. At the end of the collection period, excreta were homogenized, and aliquots were taken and placed in a forced-circulation oven at 55°C for pre-drying. Laboratory analyses were subsequently carried out, according to the techniques described by Silva & Queiroz (2002).

At the end of the experiment, feed intake per experimental unit during the five days of excreta collection was determined. Once the results of laboratory analyses of the feed ingredients, reference feed, test feeds, and excreta were obtained, AME and AMEn were calculated according to the models proposed by Matterson *et al.* (1965). Calcium and phosphorus apparent metabolizability coefficients were calculated using the following formula:

$$AMC = ((M_{ti} - M_{te}) / M_{ti}) * 100,$$

where AMC is the apparent metabolizability coefficient of the evaluated mineral, M<sub>ti</sub> is the total intake of the evaluated mineral, and M<sub>te</sub> is the total excretion of the evaluated mineral.

Data were submitted to analysis of variance. Data normality and homogeneity test did not indicate any need of data transformation. Means were compared by the SNK test, at 5% probability, with aid of SAEG (System of Statistics and Genetic Analysis) statistical software (UFV, 2000).

## RESULTS AND DISCUSSION

The performance results obtained in the starter (1 - 21 days) and grower (22 - 42 days) phases, as well as for the total experimental period (1 - 42 days) are presented in Tables 3, 4, and 5.

No significant interaction between sunflower meal and enzyme complex on feed intake, weight gain and feed:gain ratio was observed in none of the periods.

During the starter phase and total experiment period, feed intake was significantly reduced with the use of sunflower meal, which may be explained by the high crude fiber content of this diet and the high oil level of the experimental feeds. Furlan *et al.* (2001) found no significant difference in feed intake for the starter and grower phases or total experimental period with the dietary addition of sunflower meal.



**Table 3** - Effect of sunflower meal inclusion levels (SFM), with or with no addition of enzyme complex (EC) on feed intake (FI), weight gain, (WG), and feed: gain ratio (F:G) of broiler during the starter phase (1-21 days).

		Sunflower meal		EC	CV
		0%	20%	average	(%)
FI (g/bird)	With EC	1.185	1.141	1.163	2.832
	With no EC	1.211	1.159	1.185	
	SFM average	1.198a	1.150b		
WG (g/bird)	With EC	0.852	0.850	0.851B	2.627
	With no EC	0.874	0.865	0.870A	
	SFM average	0.863	0.857		
F:G (g/g)	With EC	1.392	1.344	1.368	1.675
	With no EC	1.385	1.340	1.363	
	SFM average	1.389b	1.342a		

a,b - Means followed by different letters in the same row are different (P<0,05) by the SNK test. A,B - Means followed by different letters in the same column are different (P<0,05) by the SNK test.

**Table 4** - Effect of sunflower meal inclusion levels (SFM), with or with no addition of enzyme complex (EC), on feed intake (FI), weight gain, (WG), and feed: gain ratio (F:G) of broiler during the grower phase (22-42 days).

		Sunflower meal		EC	CV
		0%	20%	average	(%)
FI (g/bird)	With EC	3.192	3.174	3.183	2.595
	With no EC	3.242	3.189	3.216	
	SFM average	3.217	3.181		
WG (g/bird)	With EC	1.799	1.825	1.812	3.302
	With no EC	1.811	1.846	1.828	
	SFM average	1.805	1.836		
F:G (g/g)	With EC	1.775	1.740	1.757	2.582
	With no EC	1.791	1.728	1.760	
	SFM average	1.783b	1.734a		

a,b - Means followed by different letters in the same row are different (P<0.05) by the SNK test.

**Table 5** - Effect of sunflower meal inclusion levels (SFM), with or with no addition of enzyme complex (EC) on feed intake (FI), weight gain, (WG), and feed: gain ratio (F:G) of broiler during the entire experimental period (1-42 days).

		Sunflower meal		EC	CV
		0%	20%	average	(%)
FI (g/bird)	With EC	4,377	4,315	4,346	2.396
	With no EC	4,453	4,348	4,401	
	SFM average	4,415a	4,332b		
WG (g/bird)	With EC	2,651	2,675	2,663	2.471
	With no EC	2,684	2,711	2,698	
	SFM average	2,668	2,693		
F:G (g/g)	With EC	1.651	1.613	1.632	1.846
	With no EC	1.659	1.604	1.632	
	SFM average	1.655a	1.609b		

a,b - Means followed by different letters in the same row are different (P<0,05) by the SNK test.

Although sunflower meal significantly reduced feed intake in the starter phase and the total experimental period, no effect was observed on weight gain, allowing us to infer that the high oil content improved diet digestibility.

Oliveira *et al.* (2007), testing 0 and 15% sunflower meal inclusion levels, with or with no enzyme

supplementation, in grower broilers, did not find any significant effect of sunflower meal on feed intake; however, there was significant reduction in weight gain. In present study, no significant effect of sunflower meal on feed intake and weight gain during the grower stage was observed.

The enzyme complex had a significant effect on weight gain only during the starter phase possibly due to the immature digestive system of broilers at this age. It is known that after hatching, the broiler digestive system is anatomically complete, but its functional digestion and absorption capacities are still immature, with low secretion of pancreatic enzymes, which will only increase as feed intake and bird age increase (Maiorka *et al.*, 2002).

Sunflower meal promoted significant improvement in feed:gain ratio during the starter and the grower phases, as well as during total experimental period. This is probably due to an interaction between nutrients, as oil inclusion level increased with sunflower meal dietary level in order to supply the birds' energy requirements, possibly improving diet digestibility.

The effects of sunflower meal dietary inclusion, with or with no enzyme supplementation on carcass yield, abdominal fat, thigh and drumstick, breast, and breast fillet yields are shown in Table 6.

**Table 6** - Effect of the addition of an enzyme complex (EC) in diets containing different sunflower meal levels (SFM) on carcass yield, abdominal fat, thigh and drumstick, breast, and breast fillet yields of 42-day-old broilers<sup>1</sup>.

Yield,%		Sunflower meal		EC	CV (%)
		0%	20%	average	
Carcass	With EC	76.47	75.93	76.20	2.104
	With no EC	76.01	75.64	75.83	
	SFM average	76.24	75.79		
Abdominal fat	With EC	1.43	1.47	1.45	16.775
	With no EC	1.38	1.46	1.42	
	SFM average	1.41	1.47		
Thigh and drumstick	With EC	27.71	27.23	27.47	3.077
	With no EC	27.28	27.98	27.63	
	SFM average	27.50	27.61		
Breast	With EC	34.75	34.67	34.71	2.466
	With no EC	35.35	34.82	35.09	
	SFM average	35.05	34.75		
Breast fillet	With EC	27.26	27.19	27.23	3.018
	Without EC	27.83	27.17	27.50	
	SFM average	27.55	27.18		

1 - (P>0.05).

There was no interaction between sunflower meal and the enzyme complex, and no significant effect of



sunflower meal or the enzyme complex on the evaluated parameters. Oliveira *et al.* (2003), evaluating 0, 15, and 30% sunflower meal levels in broiler diets, also did not observe any significant effect on carcass and cuts yields.

Dry matter apparent digestibility coefficient (DMADC), gross energy apparent metabolizability coefficient (GEAMC), and apparent metabolizable energy corrected for nitrogen (AMEn) values are shown in Table 7. No significant interaction between sunflower meal and the enzyme complex were detected for DMADC, GEAMC, or AMEn.

The dietary inclusion of sunflower meal increased AMEn, which may explain the improvement in feed:gain ratio of broilers during the starter phase.

**Table 7** - Effect of the addition of an enzyme complex (EC) in diets containing different sunflower meal levels (SFM) on Dry matter apparent digestibility coefficient of (DMADC) and gross energy apparent metabolizability coefficient (GEAMC), expressed as percentage (%), and apparent metabolizable energy corrected for nitrogen (AMEn) value expressed in kcal / kg (on as-fed basis).

		Sunflower meal		EC average	CV (%)
		0%	20%		
DMADC	With EC	73.34	67.49	70.42	1.572
	With no EC	73.90	68.28	71.09	
	SFM average	73.62A	67.89B		
GEAMC	With EC	72.91	68.49	70.70	1.358
	With no EC	73.25	68.77	71.01	
	SFM average	73.08A	68.63B		
AMEn	With EC	2,979	3,053	3,016	1.370
	With no EC	2,993	3,065	3,029	
	SFM average	2,986B	3,059A		

A, B - Means followed by different letters in the same row are different (P<0.05) by the SNK test.

Although the enzyme complex improved weight gain in the starter phase, no significant effect was observed on AMEn.

Phosphorus (PAMC) and calcium (CaAMC) apparent

metabolizability coefficients are presented in Table 8. There was a significant effect of the interaction between sunflower meal and the enzyme complex on PAMC and CaAMC.

The diets with no inclusion of sunflower meal did not improve PAMC or CaAMC when the enzyme complex was added to the diet. However, the inclusion of 20% of sunflower meal in the diet reduced PAMC and CaAMC. According to Torin (1991), the reduction in mineral availability can be largely attributed to the presence of fiber, and in fact, may be as important as the presence of phytic acid. However, when the enzyme complex, which in addition to fiber-degrading enzymes also contains phytase, was added, phosphorus and calcium retention increased in broilers fed the diet containing 20% sunflower meal.

**Table 8** - Effect of the addition of an enzyme complex (EC) in diets containing different sunflower meal levels (SFM) on phosphorus (PAMC) and calcium (CaAMC) apparent metabolizability coefficients, expressed as percentage (%).

Treatment	PAMC		CaAMC	
	With no EC	With EC	With no EC	With EC
0% SFM	56.78Aa	57.84Aa	58.23Aa	58.27Aa
20% SFM	47.29Bb	52.43Ba	51.94Bb	56.37Ba
CV (%)	2.940		2.923	

A, B - Means followed by different letters in the same column are different (P<0.05) by the SNK test. a, b Means followed by different letters in the same row are different (P<0.05) by the SNK test.

Table 9 shows feed cost per kilogram of body weight gain, economic efficiency index (EEI), and cost index (CI).

The results show that the lowest feed cost per kilogram of body weight gain and the highest economic efficiency and cost rates were obtained when the broilers received feeds containing 0% sunflower meal, which is consistent with the results of Furlan *et al.* (2001).

**Table 9** - Feed cost per kilogram of body weight gain (FC), economic efficiency index (EEI), and cost index (CI) of broilers fed diets containing different levels of sunflower meal (SFM), with or with no addition of an enzyme complex (EC).

	Treatments			
	0% SFM	0% SFM + EC + CE	20% SFM	20% SFM+EC
<b>Starter phase (1 to 21 days)</b>				
FC, R\$/kg BW	1.00	1.01	1.05	1.05
EEI, %	100.00	99.08	95.63	95.86
CI, %	100.00	100.93	104.57	104.32
<b>Grower phase (22 to 42 days)</b>				
FC, R\$/kg BW	1.28	1.31	1.36	1.36
EEI, %	100.00	99.37	98.58	97.45
CI, %	100.00	100.64	101.44	102.62
<b>Total period (1 to 42 days)</b>				
FC, R\$/kg BW	1.19	1.21	1.26	1.26
EEI, %	100.00	98.18	94.47	94.16
CI, %	100.00	101.85	105.86	106.21



## CONCLUSIONS

A level of 20% sunflower can be included in broiler feeds with no harmful effects on performance, provided oil and lysine are supplemented. However, it is not economically feasible, although this feasibility may vary with sunflower meal, oil, and synthetic lysine prices, if used. The addition of the enzyme complex does not change AMEn values; however, it improves phosphorus and calcium retention in diets containing sunflower meal.

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