

Use of Sunflower Cake in the Diet of ISA Brown Pullets

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Abstract: Recently, feed ingredient prices and availability concerns have resulted in the examination of diet formulations using alternative, locally available, high protein feed ingredients. An experiment was carried out to evaluate sunflower cake (SC) dietary effect on the performance of ISA brown pullets. The duration of the experiment was 20 weeks. A total of 48 one-day-old pullets were randomly allocated in three groups (C, SC_{6.25} and SC_{12.5}) with four replications. The pullets of the control group (C) were given proper full rations without sunflower cake for the 1st, 2nd and 3rd rearing ages, whereas in the treatment groups SC_{6.25} sunflower cake was added at 6.25% of rations and in group SC_{12.5} at 12.5% of rations. The pullets were housed in floor pens with litter and were offered feed and water *ad libitum*. According to the results of statistical analysis, the addition of 6.25% sunflower cake in the diet significantly ($P < 0.05$) affected body weight gain and feed conversion ratio. The results of this study showed that sunflower cake can be added to the ration of ISA brown pullets of 0-20 weeks of age up to 12.5% without any adverse effect on their performance.

Key words: ISA brown pullets, sunflower seed cake, feed ingredients, performance.

1. Introduction

The increasing feed ingredient prices remain the greatest single parameter that determines profit margins in poultry production. Corn and soybean meal have been used as basal feed ingredients in poultry feed formulation for decades, but recently their high prices have resulted in examining of diet formulations using alternative, locally available, high protein ingredients, thereby decreasing feed costs [1, 2]. Although the use of such ingredients in poultry rations may be beneficial from a cost standpoint, it could have detrimental effects to poultry performance, because fiber in poultry is considered as something that “dilutes” the composition of other feed ingredients, such as energy and crude protein [3], which can have adverse effects on feed consumption and digestibility of feed components [4]. On the other hand, increased dietary fiber can have positive effects, such as better

satiety, improved behaviour and better overall welfare [2].

Sunflower cake or sunflower meal is an important by-product of the oil extraction from the sunflower seed [5, 6]. Sunflower cake is a good feed ingredient for livestock, containing high amounts of protein (22%-44%) with good amino acid composition and average amounts of energy [5, 7, 8]. The fiber content of sunflower cake can vary within 12%-32%, depending on the degree of hull removal and the method used for the oil extraction. Another important characteristic is that sunflower cake does not contain anti-nutritional factor, in contrast with other common feed ingredients (soybean meal, cottonseed meal, rapeseed meal) [6]. Sunflower cake is usually cheaper than soybean meal and can be produced in countries that do not produce soybeans [5, 6]. In recent years, the dietary use of sunflower cake is under examination in ruminants, pigs and poultry [5, 9-11].

Therefore, the aim of this work was to study the possibility of using sunflower cake as an alternative to

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imported soybean meal in the diets of ISA brown pullets.

2. Materials and Methods

2.1 Sunflower Cake

Ground sunflower cake (screen diameter < 2.0 mm) mixture, a product of New Energy SA (Greece), from cultivated hybrids Dalia CS, Imeria CS, Robia CS, Fabiola CS, Klarika CL, Fushia CL, Codicap, Neomia NK, Sanay MR and Tristan, were used in this study. Table 1 presents the chemical composition of the examined sunflower cake.

2.2 Experimental Rations, Pullets, Housing and Design

For the purposes of the experiment, a total of 48 one-day-old ISA brown pullets were used. The pullets were randomly allocated in three groups (C, SC_{6.25} and SC_{12.5}) with four replications (cage) of four pullets per cage. Hence, the complete experimental setup was three experimental treatments × four replicates × four pullets. Each replication was housed in a floor cage with wheat straw litter, equipped with a semiautomatic feeder and a semi-automatic drinker. Before the transfer of pullets in the experimental cages,

the building was preheated for 12 h, so that the temperature on arrival of the birds was 30 °C. During the first 7 d, 22-23 h of light with intensity 30 lux was provided to encourage intake of water and food and afterwards a normal decreasing lighting program was applied. Especially, hours of light with 15 lux during the 2nd, 3rd, 4th, 5th and 6th week were 18, 16, 15, 13 and 12 h, respectively, and for the rest weeks of experiment 11 h stably. Drinkers were cleaned daily at the first three weeks and then once a week throughout all the period of the experiment. Starter diet was distributed 4-5 h after delivery of pullets. Stocking density was about 0.5 m² per pullet. The initial temperature for the first three weeks was 30 °C at the edge of each brooder (26 °C at 1.5 m from the brooder) and afterwards the temperature was gradually decreased [12]. Relative humidity throughout of experiment ranged from 55% to 60%.

Pullets of the control group (C) consumed proper full rations without sunflower cake for the 1st, 2nd and 3rd ages based on corn and soybean meal, whereas in treatment groups SC_{6.25}, sunflower cake was added at 6.25% of rations and 12.5% for group SC_{12.5} replacing soybean meal. The three diets for each age (0-6 weeks, 7-14 weeks and 15-20 weeks) of

Table 1 Chemical composition of sunflower cake.

Composition	Content (g/kg)
Chemical analysis	
Dry matter	944.0
Crude protein	258.0
Ether extract	22.0
Crude fiber	238.8
Ash	61.9
Calculated analysis*	
Lysine	10.0
Methionine	5.0
Methionine + cystine	10.0
Threonine	10.5
Ca	2.1
P available	1.4
ME (kcal/kg)**	1,711.0

* Estimations were based on National Research Council (NRC) [13].

** ME: metabolizable energy, it was calculated according to NRC [13]: ME = (36.63 × crude protein) + (77.97 × ether extract) + (19.87 × nitrogen-free extract).

Table 2 Ingredients and chemical analysis of experimental pullet rations.

Ingredients (g/kg)	Treatments								
	1st age (0-6 weeks)			2nd age (7-14 weeks)			3rd age (15-20 weeks)		
	C	SC _{6.25}	SC _{12.5}	C	SC _{6.25}	SC _{12.5}	C	SC _{6.25}	SC _{12.5}
Corn seed	503.0	454.0	406.3	598.0	550.4	503.4	500.4	590.5	595.1
Barley	50.0	50.0	50.0	50.0	50.0	50.0	227.1	98.5	50.0
Soybean meal 44%	313.0	280.2	253.4	249.3	219.0	188.4	196.5	172.5	144.3
Herring 72%	20.0	20.0	20.0	20.0	20.0	20.0	-	-	-
Wheat bran	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
Sunflower cake	-	62.5	125.0	-	62.5	125.0	-	62.5	125.0
Sunflower oil	38.0	50.0	50.0	6.7	22.1	37.2	-	-	9.6
Vegetable fat	-	3.8	19.3	-	-	-	-	-	-
CaCO ₃	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00
Monocalcium phosphate (MCP)	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50
Sodium carbonate	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Salt	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
L-lysine HCl	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50
DL-methionine (99%)	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Threonine	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Formic acid	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
Vitamins and trace minerals premix**	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
Probiotic	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Xylanase	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Phytase	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Coccidiostatic	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Total	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00
Chemical analysis (g/kg)									
Dry matter	864.0	852.4	844.5	891.0	880.7	870.6	896.2	899.5	894.5
Crude protein	200.0	200.0	200.0	180.0	180.0	180.0	160.0	160.0	160.0
Ether extract	63.0	76.0	83.0	35.0	31.0	31.0	25.3	27.6	37.6
Crude fiber	41.0	50.0	62.0	36.0	47.0	60.3	40.0	49.0	60.0
Calculated analysis*									
ME (kcal/kg)	2,940.0	2,940.0	2,940.0	2,840	2,840	2,840	2,740	2,740	2,740
Lysine (g/kg)	14.5	14.4	13.8	13.0	12.6	12.2	10.7	10.4	10.0
Methionine + cystine (g/kg)	9.8	9.8	9.8	9.2	9.2	9.3	8.3	8.4	8.4
Ca (g/kg)	9.9	10.0	9.9	9.9	10.0	10.0	9.4	9.4	9.4
Available P (g/kg)	4.5	4.4	4.4	4.4	4.3	4.3	4.4	4.1	4.0

* Calculated analysis based on NRC tables [1].

** Composition of vitamins and trace minerals premix per kg of diet: 12,000 IU vitamin A; 5,000 IU vitamin D₃; 100 mg vitamin E; 4 mg vitamin K₃; 2.60 mg vitamin B₁; 8 mg vitamin B₂; 3 mg vitamin B₆; 0.015 mg vitamin B₁₂; 10 mg vitamin C; 85 mg niacin; 2 mg folic acid; 20 mg panthothenic acid; 0.20 mg biotin; 500 mg choline chloride; 120 mg Mn; 100 mg Zn; 40 mg Fe; 20 mg Cu; 1 mg I; 0.30 mg Se; 0.20 mg Co.

the pullets were isonitrogenous and isonitrogenous (Table 2) and appropriate for the birds rearing stage [12, 13]. The consumption of water and food were *ad libitum*.

2.3 Experimental Measurements

During the experiment, samples were taken of the

experimental diets and sunflower cake, which were analysed according to the Weende methods [14]. In particular, the identification of crude protein (CP) was performed using the Kjeldahl method in semiautomatic equipment Buchi; ether extracts (EE) with a Soxhlet extractor with ether petroleum; crude fiber (CF) using a fibrous automatic Fibertech Tecator

device; the dry matter measuring weight loss after placing the sample in an oven to constant weight. Nitrogen free extract (NFE) was calculated as Eq. (1):

$$\text{NFE} = \text{dry matter\%} - (\text{CP\%} + \text{EE\%} + \text{CF\%} + \text{ash\%}) \quad (1)$$

Metabolizable energy (kcal/kg) was calculated according to National Research Council (NRC) [13], as Eq. (2):

$$\text{ME} = 36.63 \times \text{CP} + 77.97 \times \text{EE} + 19.87 \times \text{NFE} \quad (2)$$

At every day of the experiment, the feed intake was determined by measuring leftover feed, and at every week the bodyweight of each pullet was individually measured. Feed efficiency was calculated as Eq. (3):

$$\text{Feed efficiency} = \frac{\text{weight gain of pullet during the same period}}{\text{feed supplied to pullet}} \quad (3)$$

2.4 Statistical Analysis

In this trial, the replication (cage) was considered as the experimental unit. The statistical processing of the experimental data was performed using the least squares analysis of variance [15]. The differences of averages were evaluated using Duncan's test. Significant differences among treatment means were

tested at the 0.05 probability level. The statistical analysis was made with the help of the SPSS statistical software package [16].

3. Results

Table 3 presents the effect of sunflower cake supplementation on the performance parameters of the pullets. Feed intake was significantly ($P < 0.05$) higher in the control group during the first rearing period (0-6 weeks) compared to the other two groups. But this effect was reversed during the other two rearing periods (7-14 weeks and 15-20 weeks), where the pullets of the control group consumed less feed than the pullets of the other two groups. Growth rate did not differ during the first age period among the group, but was significantly ($P < 0.05$) better for the SC_{6.25} group, compared to the control group during the second and third age of the pullets, as well as overall. In addition, feed efficiency was not different during the first and second age, but was significantly ($P < 0.05$) better for the SC_{6.25} group during the third rearing age, and overall, compared to the control group, but also the SC_{12.5} group.

Table 3 Effect of sunflower cake on pullet performance.

Performance	Treatments			SE	P
	C	SC _{6.25}	SC _{12.5}		
Feed intake (g/day)					
1st age (0-6 weeks)	28.0 ^a	26.0 ^b	26.0 ^b	0.4	*
2nd age (7-14 weeks)	62.0 ^a	63.8 ^b	63.0 ^b	0.5	*
3rd age (15-20 weeks)	81.8 ^a	83.0 ^b	84.2 ^b	0.7	*
Average	56.1	56.4	56.4	0.3	NS
Body weight gain (g/day)					
1st age (0-6 weeks)	10.7	10.9	10.8	0.2	NS
2nd age (7-14 weeks)	13.1 ^a	14.4 ^b	13.8 ^{ab}	0.3	*
3rd age (15-20 weeks)	10.2 ^a	12.1 ^b	10.8 ^a	0.3	*
Average	11.4 ^a	12.5 ^b	11.8 ^{ab}	0.4	*
Feed efficiency (g of weight gain/g of feed)					
1st age (0-6 weeks)	2.6	2.4	2.4	0.1	NS
2nd age (7-14 weeks)	4.7	4.4	4.6	0.2	NS
3rd age (15-20 weeks)	8.1 ^a	6.9 ^b	7.8 ^a	0.3	*
Average	4.9 ^a	4.5 ^b	4.8 ^a	0.2	*

^{a, b} Means in the same row not sharing a common superscript differ significantly at $P \leq 0.05$; * Significant at $P < 0.05$; NS: not significant.

Mortality was very low, as only one pullet in the SC_{12.5} group died at the beginning of the second age period.

4. Discussion

The sunflower cake examined in this experiment is a relatively high protein feed ingredient with moderate amount of crude fiber. When it is used as a soybean meal replacement, it is expected that the overall crude fiber content of the diet will increase. In this experiment, on average, 62.5 g/kg of sunflower cake were used to replace about 30 g/kg of soybean meal in the diets of the second group (SC_{6.25}), and 125 g/kg of sunflower cake were used to replace about 60 g/kg of soybean meal in the diets of the third group (SC_{12.5}). As expected, this replacement increased crude fiber by about 10 g/kg for the diets of the second group and 20 g/kg for those of the third group, respectively. Diets for growing poultry are generally formulated with low fiber, often at levels less than 3%. Nevertheless, recently these generalizations are being reevaluated, because the demand for soybean meal is increasing along with its cost, making other proteinaceous feeds with comparably higher crude fiber contents more appealing, due to their significantly lower cost [2].

The results of this study are in partial agreement with those of Kalmendal et al. [10], who observed that the growth rate of the chickens increased linearly with the increasing participation of sunflower cake in the diet, while the food utilization decreased significantly when the ration included sunflower cake at 30%, but not when add a smaller percentage. It has been suggested that increased consumption of fiber increases the rate of passage of the feed through the digestive tract [2], but its effect is also influenced by feed particle size and solubility [17]. Hetland et al. [18, 19] observed beneficial effects of fiber inclusion in the diet of pullets, which may be due in improvements in nutrient digestibility, growth rate, health and animal welfare [10, 20, 21], although these effects are likely depended on the amount and type of dietary fiber, as

well as on the composition of the basal diet [22]. Pottgüter [1] further observed that higher fiber content in pullet feed also helps to get used to eating a larger volume of feed, forcing the pullets to spend more time eating. Abdallah et al. [23] claimed that the improvement in growth performance may be attributed to the effect of fiber on the length of the small intestine and the weight of gizzard and ceca.

5. Conclusions

Although sunflower cake has a relative moderate content of crude fiber, it is a valuable protein source for pullets and could be included in their diets up to a level of 125 g/kg without any adverse effects on their performance. Therefore, sunflower cake could potentially be a viable cheaper and eco-friendly alternative to imported soybean meal proteins in ISA brown pullets diets.

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