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GROWTH PERFORMANCE, CARCASS TRAITS AND ECONOMICS OF BROILER CHICKENS AS AFFECTED BY DIETARY SUNFLOWER MEAL

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ABSTRACT

An experiment was conducted with 120 unsexed one week old broiler (Hubbard) chicks to evaluate the effect of different levels of sunflower seed meal (SFM) on growth performance, carcass traits and economic feasebility in broiler chickens. The experimental diets consisted of four levels of SFM: 0% (control), 25, 50 and 75% instead of soybean meal (SBM) in a completely randomized design. Each dietary treatment was assigned to five replicate groups and the experiment lasted 5 weeks (1-6 weeks of age). The obtained results can be summarized as follow: live body weight, body weight gain and feed conversion ratio were significantly (P<0.01) improved with increasing SFM up to 50% substitution for SBM in broiler diets throughout the growing period. Carcass traits including, carcass, dressing and giblets percentages were not significantly (P>0.05) affected by feeding on the SFM diets. Economic efficiency during the experiment was improved by 60.31, 74.60 and 44.44% for diets containing 25, 50 and 75% SFM, respectively as compared with control diet. It could be concluded that increasing SFM inclusion level in the diet up to 50% replacing SBM improved the growth performance, feed utilization and economics of broiler chickens.

Key words: Sunflower meal, performance, carcass, economics, broilers.

INTRODUCTION

The poultry industry in many countries, including Egypt, is facing drastic challenges due to high prices of traditional feedstuffs such as maize and soybean meal (SBM), which are mainly used in poultry diets. Therefore, there is an imporatnat need for affordable and nutritious feed. It is well known that feed represents the main cost of animal and poultry production (about 75% of the total cost). Increasing feed ingredients price of poultry nutrition, caused to look closely at agricultural by-products which are less cost than traditional ones (Alagawany and Attia, 2015). Thus, the waste residues of vegetables and fruits after harvesting and processing could be used as sources of protein, energy and other nutrients in feeding animals and poultry. The benificial application of untraditional feedstuffs in poultry nutrition in developing countries has received considerable attention (Alagawany *et al.*, 2015).

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Sunflower meal (SFM) is a by-product of sunflower oil industry, and has been increasingly added to animal diets (Ali *et al.*, 2011; Bilal *et al.*, 2016). Moreover, SFM is potentially one of the most important protein sources in the world, and particularly in our country. This meal is commonly produced with 35-40% hull (shell) and 60-65% protein core (kernel). SFM contains about 30-34% crude protein, 20-25% cellulose and 8-10% lignin. As the result of such a high share of hulls in SFM, with about 50% cellulose and 25% lignin, the nutritional value of SFM is drastically reduced in animal nutrition (Slavica *et al.*, 2006). The key challenge of incorporation of SFM in broiler diets is the high fiber content (NRC, 1994), which may negatively affects on growth performance and carcass yeild.

SFM can be used as a feedstuff to replace SBM in poultry diets. A major factor of using SFM in poultry diets, is a cheap price as compared to SBM, also it is free from toxic molecules and anti-nutritional factors which may affect productive performance (Gheyasuddin *et al.,* 1970; Khedr *et al.,* 2016). SFM could be used profitably up to 200g/kg of broiler diets with no adverse impacts on growth performance and feed utilization (Sherif *et al.,* 1995). Vetesi *et al.* (1998) recorded that live body weight, feed conversion ratio, and carcass values of geese and ducks did not significantly change even at 100% replacement of SBM with SFM. But, there are some restrictions about using the high inclusion levels of SFM in poultry diets due to high fiber, low metabolizable energy (ME), and low lysine contents (Nassiri *et al.,* 2012).Therfore, the aim of the present experiment is studying the substituting effect of SFM for SBM on growth performance, feed utilization, carcass characteristics and economics of broiler chickens throughout the growing period.

MATERIALS AND METHODS

Birds, Design, Experimental Diets and Management

The study was carried out at Poultry Research Farm, Faculty of Agriculture, Zagazig University, Egypt, during the winter season (2014). A total number of 120 unsexed one week old broiler (Hubbard) chicks were randomly distributed into 4 treatment groups of 30 chicks each with 5 replicates each of 6 chicks. Chicks of all experimental groups had nearly the same initial average live body weight. A completely randomized design was conducted including four levels of sunflower meal (0, 25, 50 and 75% of SFM replacing SBM) throughout the growing period (1-6 weeks of age).The experimental diets were formulated based on the NRC (1994) requirements for broiler chickens and were isocaloric and isonitrogenous during the starter (1-3 wks of age) and finisher (4-6 weeks of age) phase. Chicks were housed in conventional type cages with feed and water provided for *ad libitum* consumption and fed a diet formulated to meet nutrient requirements recommended commercially (Table 1). Lighting was 23 hr., light and 1 hr., darkness. Vaccination and medical programs were done according to the different stages of age under supervision of a veterinarian.

Data Collection and Calculations

Birds were individually weighed at 1, 3 and 6 wks of age. Feed intake (FI), and feed conversion ratio (FCR) (feed intake g/ weight gain g)were measured and calculated.At the end of growing period (42-d of age), four birds were randomly chosen from each group, fasted overnight, individually weighed, then slaughtered by sharp knife to complete bleeding, and their feathers were removed of an autopsy, the abdominal cavity was opened, and the liver, heart, gizzard and abdominal fat were removed and weighed. Their weights were recorded in grams and calculated as (%) of carcass weighed. The eviscerated carcass was individually weighed and the carcass percentage was recorded.

Economic Evaluation

At the end of experiment economical evaluation of each experimental calculated group was from the input and output analysis based upon the differences in growth rate and feeding cost (Heady and Jensen, 1954).

Where:

Total feed cost = feed intake × cost of kg feed

Meat market price = total body weight gain × cost of kg meat (10 LE).

Net return = difference between meat market price and total feed cost.

Economic efficiency = (net return / total cost) ×100.

Statistical Analysis

Data were subjected to the ANOVA procedure for a completely randomized design using the GLM procedures of SPSS (2008). Duncan's new multiple range test (Duncan, 1955) was used for comparison among significant means. Statements of statistical significance are based on $P < 0.05$ unless other-wise stated.

RESULTS AND DISCUSSION

Growth Performance

Live body weight and body weight gain

Data presented in Table 2 show that the averages of initial live body weight at 1st wk of age were nearly similar and had ranged between

Table 1. Composition and chemical analysis of the experimental diets (starter and finisher diets)

Item	Dietary SFM[1] levels as substitute for SBM (%)							
	Starter				Finisher			
	0	25	50	75	0	25	50	75
Ingredient (%)								
Maize	57.59	56.00	54.41	52.90	64.73	63.70	62.53	61.41
Soybean meal	30.00	22.50	15.00	7.50	20.00	15.00	10.00	5.00
Gluten meal	4.61	6.20	6.90	7.60	4.15	5.24	6.30	7.40
SFM	0.00	7.50	15.00	22.50	0.00	5.00	10.00	15.00
Fish meal	3.00	3.00	4.00	5.00	5.00	5.00	5.00	5.00
Di-calcium ph.	1.30	1.00	0.60	0.15	1.12	0.95	0.73	0.55
Limestone	1.07	1.27	1.37	1.51	0.99	1.05	1.23	1.36
Vit-min Premix[2]	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
NaCL	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
DL-Methionine	0.14	0.14	0.14	0.13	0.01	0.00	0.01	0.00
L-Lysine	0.14	0.31	0.43	0.56	0.10	0.21	0.32	0.43
Soybean oil	1.55	1.48	1.55	1.55	3.30	3.25	3.28	3.25
Determined analysis (%)[3]								
Dry matter	84.22	87.08	86.16	85.53	87.94	88.73	88.58	89.01
Organic matter	93.43	93.03	92.60	91.64	94.64	93.92	93.89	93.64
Crude protein	23.00	23.00	23.18	22.99	19.91	20.06	20.16	19.96
Ether extract	7.54	6.74	7.10	9.61	5.75	5.88	5.86	7.30
Crude fiber	4.74	4.62	5.81	7.79	3.75	4.03	4.88	6.02
Ash	6.56	6.96	7.39	8.35	5.01	6.07	6.10	6.35
Calculated analysis (%)[4]								
Crude protein	23.00	23.00	23.00	23.00	20.00	20.01	20.01	20.02
ME Kcal/kg diet	3001	2999	3004	3004	3200	3200	3201	3200
Calcium	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.01
Phosphorus (Avai.)	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
Lysine	1.30	1.30	1.30	1.30	1.10	1.10	1.10	1.10
Met+Cys	0.92	0.92	0.92	0.92	0.72	0.72	0.72	0.72
Crude fiber	3.43	5.14	6.84	8.54	2.88	4.02	5.16	6.30
Linoleic acid	1.38	1.32	1.25	1.29	1.50	1.46	1.41	1.37

[1]SFM: sunflower meal; [2]Growth vitamin and Mineral premix Each 2.5 kg contains: Vit A 12000, 000 IU; Vit D3, 2000, 000 IU; Vit. E. 10g; Vit k3 2 g; Vit B1, 1000 mg ; Vit B2, 49g ; Vit B6, 105 g; Vit B12, 10 mg; Pantothenic acid, 10 g; Niacin, 20 g , Folic acid , 1000 mg ; Biotin, 50 g; Choline Chloride, 500 mg, Fe, 30 g; Mn, 40 g; Cu, 3 g; Co, 200 mg; Si, 100 mg and Zn , 45 g; [3]Determined according to AOAC (2003), [4]Calculated according to NRC (1994).

Table 2. Growth performance ($\overline{x}$ ±SE) as affected by different levels of sunflower meal

Item	Dietary SFM (%) substitution for SBM				Sig.
	0	25	50	75	
Live body weight (g)					
1 wk	124.93±0.51	124.16±0.49	124.91±0.39	125.33±0.67	NS
3 wk	580.33±13.53	595.91±14.35	576.91±10.95	566.83±6.39	NS
6 wk	1950.33±37.26^{b}	2097.66±33.50^{a}	2108.66±29.47^{a}	1945.16±37.08^{b}	**
Body weight gain (g)					
1-3 wk	32.52±0.94	33.69±1.01	32.28±0.77	31.53±0.43	NS
4-6 wk	65.23±1.53^{b}	71.51±2.03^{a}	72.94±1.14^{a}	65.63±1.84^{b}	**
1-6 wk	52.15±1.05^{b}	56.38±0.95^{a}	56.67±0.83^{a}	51.99±1.07^{b}	**

Means in the same raw within each classification bearing different letters are significantly different ($P \leq 0.05$).

124 to 125 g indicating the random distribution of individuals among the treatment groups at the beginning of experiment. Meanwhile, this created suitable conditions to appraise the effect of sunflower meal (SFM) on the performance of broiler chickens. Moreover, SFM levels had insignificant effect on LBW, at 3 wks of age. While, at 6 wks of age, live body weight was significantly ($P<0.01$) increased with increasing SFM up to 50% substitution for SBM in broiler diets. In comparison with the control group, the average of live body weight of broiler chickens given diets containing SFM at 25 or 50% replacing soybean meal (SBM) were heaver by about 7.53 and 8.10%, respectively, while the chickens fed diets containing SFM at 75% were similar with control group.

Several studies have been conducted to evaluate the use of SFM at different inclusion levels in broiler diets (Abbas and Yagoub, 2008; Peric et *al.,* 2010). Our results are in agreement with those obtained by Rad and Keshavarz (1976) who stated that about 50% of SBM protein could be replaced by SFM protein without drastic effect on growth rate of broiler chicks. Moreover, Arija *et al*. (1998) and Suresh *et al.* (2000) reported no adverse effects due to feeding broilers on diets contain sunflower seed hulls up to 50 and 120 g/kg, respectively. SFM can be used in broiler chicken diets at levels up to 140 g/kg without adverse effects on performance or other parameters (Nassiri *et al.,* 2012).

The inclusion levels of SFM at 6 and 8% in grower diet of broilers had no effects on growth parameters, while at 10% and 16% in finisher diet, body weight gain was statistically affected ($P<0.05$). On the other hand, studies involving the use of SFM have confirmed, and recommended that the high levels of SFM can be used effectively in broiler diets (Senkoylu and Dale, 1999). Sherif *et al.* (1995) demonstrated the possibility of replacing SBM with SFM up to 70% in broiler chickens diets during grower and finisher stages and supplemented with methionine, lysine and fat without adverse impacts on growth performance. The treated and untreated form of SFM in broiler diets had no drastic effects on body weight, also no significant adverse impact was observed on growth rate and feed conversion ratio of broiler chickens at 28 or 49 days of age (Dessouky1996).

The results in Table 2 indicate that body gain was statistically ($P<0.01$) improved with increasing SFM up to 50% as substitution for SBM in broiler chicken diets through the finisher period (4 to 6 wks of age) and throughout the overall period (1 to 6 wks of age). However, increasing SFM in the diets from 50 to 75% resulted significant ($P<0.01$) decrease in body weight gain when compared with the other dietary treatment groups (25 or 50% SFM). These findings are in agreement with those obtained by Rajesh *et al.* (2006) who stated that growth parameters including body weight and body weight gain revealed that SFM can be used in broiler chicken diets up to 30% with no adverse impact on growth rate. On the same context, some studies have consistently reported positive growth performance results when SFM was added to broiler chicken diets. Findings from an early study by Salih and Taha (1989) showed that body weight gain was similar in all treatments when broiler chickens fed diets contained different levels of SFM (0, 10, 20 or 40%). However, there were contradictory results in this respect due to mainly the quality of SFM processing or variety of the birds or animal used as reported by Campbell *et al.* (1989). Contrarily, the inclusion levels of SFM at 6 and 8% in grower diet of broilers had no effects on growth parameters, while at 10% and 16% in finisher diet, body weight gain was significantly ($P<0.05$) affected (Horvatovic *et al.*, 2015).

Feed intake

The inclusion of SFM at a level of 75% in broiler chicken diets significantly ($P<0.01$) increased feed intake as compared with the birds fed diets containing 25 and 50% SFM as substitution for SBM, during the periods from 4-6 and 1-6 wks of age. But, using level of 25 % resulted in significant ($P<0.01$) decrease in feed intake compared with control. On the other hand, during 1-3 wks of age, feed intake was insignificantly affected with SFM inclusion in broiler diets. Therefore, it could be concluded that, the increase in SFM inclusion from 25 to 50 to 75 % at 4-6, 1-6 wks of age caused a considerable increase in feed intake. However, there were no significant difference in feed intake between chicks fed diets containing 0 or 75% SFM during the same periods studied (Table 3). Previous studies investigating the impacts of the use of SFM meal as a replacement for SBM show inconsistent results. Mandal *et al*. (2003) showed that inclusion of un-decorticated SFM at 0, 50 and 100 g/kg in broiler chicken diets replacing part of SBM had no significant impact on feed intake throughout the fattening period (starter and finisher). On the other hand, feed intake of birds ranged from 420 to 520g/week with increasing levels of SFM from 0% to 75%, respectively. Moreover, feed efficiency was unaffected by the dietary SEM inclusions during the fattening period. Thus, SFM can replace SBM and groundnut cake up to 75% level without adverse impacts on growth performance of broiler chickens (Adejumo and Williams, 2006).

Feed conversion ratio

Feed conversion ratio was significantly ($P<0.01$) improved due to SFM incorporation at levels of 25 and 50% instead of SBM in broiler diets compared to the control group, during the periods 4-6 and 1-6 wk-old. The high (75%) level of SFM recorded the worst value of feed conversion ratio in comparison with other levels (Table 3). Generally, it can be concluded that broiler chicks fed diets containing 25 or 50% SFM had lower feed intake and improve values of feed conversion ratio than those in control or 75% SFM. A similar trend was observed in the experiments of Salari *et al.* (2009) who reported that feed intake and feed conversion ratio were improved when broiler chickens were fed different inclusions of sunflower seed in the starter (1-3 wks of age) and finisher (3-7 wks of age) diets. On the other hand, high inclusions of SFM up to 20% in grower and finisher broiler diets had no impact on feed conversion ratio (Peric *et al.,* 2010). Similarly, Salih and Taha (1989) showed that feed intake and feed efficiency were similar in all treatments when broiler chickens fed diets contained different levels of SFM (0, 10, 20 or 40%).

Carcass traits

All carcass traits studied including carcass, dressing and giblets percentages were not significantly ($P>0.05$) affected by feeding on the SFM diet (Table 4). These results agree with those obtained by Vetesi *et al.* (1998) who found that carcass traits of geese and ducks did not significantly change even at 100% replacement of SBM with SFM. On this context, Salari *et al.* (2009) reported that the percentage weight of giblets was not affected by dietary treatments which contained different levels of full fat sunflower seed; while, liver weight (%) was significantly ($P<0.05$) decreased. Furthermore, Ozen and Erdem (1992) replaced also SBM by SFM in younger chicken diets at levels of 0, 25, 50, 75 and 100 during period 4-8 weeks of age and did not find significant differences among groups in the percentages of dressing and edible

Table 3. Feed intake and feed conversion ratio ($\overline{X}$ ±SE) as affected by different levels of sunflower meal

Item	Dietary SFM (%) substitution for SBM				Sig.
	0	25	50	75	
Feed intake (g)					
1-3 wk	56.01±1.33	56.26±0.72	56.53±1.02	55.65±0.58	NS
4-6 wk	122.57±4.08^{ab}	114.62±1.26^{c}	119.87±2.97^{bc}	128.73±2.22^{a}	**
1-6 wk	95.95±2.61^{ab}	90.88±0.71^{c}	94.53±1.83^{bc}	99.50±1.36^{a}	**
Feed conversion (g feed: g gain)					
1-3 wk	1.73±0.08	1.64±0.03	1.75±0.05	1.76±0.03	NS
4-6 wk	1.88±0.09^{a}	1.61±0.05^{b}	1.64±0.05^{b}	1.97±0.08^{a}	**
1-6 wk	1.84±0.08^{a}	1.61±0.03^{b}	1.66±0.03^{b}	1.91±0.05^{a}	**

Means in the same raw within each classification bearing different letters are significantly different (P≤0.05).

Table 4. Carcass characteristics ($\overline{X}$ ±SE) as affected by different levels of sunflower meal

Item	Dietary SFM (%) substitution for SBM				Sig.
	0	25	50	75	
Pre-slaughter weight	1950.01±37.26^{b}	2097.02±00.33^{a}	2108.11±29.47^{a}	1945.23±37.08^{b}	**
Carcass (%)	67.24±0.75	67.18±0.76	66.53±0.94	68.43±0.60	NS
Dressing (%)	73.47±0.59	73.11±0.69	72.35±1.03	74.24±0.70	NS
Giblets (%)	6.22±0.34	5.92±0.29	5.82±0.23	5.81±0.20	NS

Means in the same raw within each classification bearing different letters are significantly different (P≤0.05).

parts. On the contrary, Ologhobo (1991) observed that substituting SFM for SBM at levels 50, 75, and 100% decreased the percentages of carcass, dressing and total edible meat.The inclusion of SFM (0, 8, 16, and 24%) in broiler diets negatively influenced performance and carcass parameters (Araujo *et al.,* 2015).

Economic efficiency

Values of economic efficiency of broiler chickens as affected by dietary SFM during 1-6 wks of age are given in Table 5. The present data clearly demonstrate that, there was a marked increase in both of net revenue and economic efficiency values of broiler chickens fed diets containing SFM when compared with control.

The results show that chicks fed diet containing 75% SFM as a substitute for SBM recorded the worst net revenue and economic efficiency comparing with the diets containing 25 and 50% SFM. Economic efficiency during the whole experimental period (1-6 wks of age) was increased by 60.31, 74.60 and 44.44% for diets containing 25, 50 and 75% SFM respectively compared with control diet.

The observed improvement in economic efficiency of chicks fed diets containing 25 or 50% SFM may be related to the improvement of body weight gain and fed conversion ratio as previously explained (Tables 2 and 3) compared with the other treatments. In accordance with our results, Abdel-Hakim *et al.* (2008) recommend that the incorporation of sunflower

Table 5. Economic evaluation as affected by different levels of sunflower meal

Items	Dietary SFM (%) substitution for SBM			
	0	25	50	75
Price/kg feed (LE)	3.65	3.40	3.15	3.00
Price/kg meat (LE)	11.00	11.00	11.00	11.00
Feed conversion	1.84	1.61	1.66	1.91
Price of feed to produce one kg meat (LE)	6.71	5.47	5.23	5.73
Net return (LE)[1]	4.28	5.52	5.77	5.27
EF[2]	0.63	1.01	1.10	0.91

[1]Net return = Difference between meat market price and total feed cost.

[2]EF: Economic efficiency= (net return/ total cost)*100.

meal to replace 30% of soybean protein to reduce feed costs without adverse impacts on growth performance and feed utilization. On the contrary, Tavernari *et al*. (2008) found that the lowest feed cost per kilogram of body weight gain and the highest economic efficiency were obtained by the birds received diets contained 0% sunflower meal, which are consistent with the results of Furlan *et al*. (2001). Recently, Araujo *et al.*, (2015) observed that the inclusion of sunflower meal in poultry diets improved the economic efficiency index.

Conclusion

In view of the above findings and discussion, it could be concluded that increasing SFM level in the diets up to 50% instead of SBM improved the growth performance and economic feasibility of broiler chickens throughout the fattening period, while the higher SFM level (75%) negatively affected growth performance and feed utilization.

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أداء النمو وصفات الذبيحة واقتصاديات كتاكيت التسمين المتأثرة بعليقة كسب عباد الشمس

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أُجريت التجربة على ١٢٠ كتكوت تسمين (هبرد) غير مجنس عمر أسبوع في الفترة من ١ إلى ٦ أسابيع (٢٠١٤) باستخدام التصميم الاحصائي التام العشوائية لتقييم تأثير مستويات مختلفة من كسب عباد الشمس على أداء النمو وصفات الذبيحة والكفاءة الاقتصادية لكتاكيت التسمين، وتشتمل العلائق التجريبية علي أربع مستويات من كسب عباد الشمس: صفر (العليقة الضابطة)، ٢٥، ٥٠، ٧٥ % بدلا من كسب فول الصويا، وتقسم المعاملات إلى ٥ مكررات واستمرت التجربة مدة ٥ أسابيع، وتتلخص أهم النتائج في الآتي: تحسن كل من وزن الجسم الحي والوزن المكتسب ومعامل التحويل الغذائي معنويا (P<0.01) بزيادة مستوي كسب عباد الشمس إلى ٥٠% بدلاً من كسب فول الصويا خلال فترة النمو، لم تتأثر صفات الذبيحة تحت الدراسة وتشمل نسبة الذبيحة والتصافي ومجموع القلب والكبد والقانصة معنوياً (P>0.05) بالتغذية علي علائق كسب عباد الشمس، تحسنت الكفاءة الاقتصادية خلال التجربة بمقدار ٦٠.٣١ ، ٧٤.٦٠ ، ٤٤.٤٤ % مع العلائق المحتوية على ٢٥ ، ٥٠ ، ٧٥% كسب عباد شمس علي الترتيب بالمقارنة بالعليقة الضابطة، لذلك نستخلص من الدراسة أن زيادة مستوي كسب عباد الشمس في العليقة إلى ٥٠% بدلا من كسب فول الصويا يحسن أداء النمو، الاستفادة من الغذاء، واقتصاديات كتاكيت التسمين.

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