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USING SUNFLOWER MEAL IN THE DIETS OF MUSCOVY DUCKLINGS

Mohamed I. El-Dalil*, M.M. El-Hindawy, A.I. Attia and I.I. Ismail

Poult. Dept., Fac. Agric., Zagazig Univ., Egypt

ABSTRACT

A 5×2 factorial design experiment was performed including five levels (0.00, 25.00, 50.00, 75.00 and 100.00%) of sunflower meal (SFM) instead of the same percent of soybean meal (SBM); and two levels of enzyme supplementation (0 or 0.5 g/kg diet). A total number of 300 unsexed one week old Muscovy ducklings were randomly distributed into equal ten treatment groups (three replicates each of 10 ducklings). Results showed that live body weight and body weight gain of Muscovy ducklings fed 25% dietary SFM as a substitution level for SBM was better ($P \leq 0.01$) that that of the control and other treatment groups. Complete replacement of SBM with SFM resulted in significant ($P \leq 0.01$) decrease in live body weight (LBW) and body weight gain (BWG) when compared with control and other dietary treatment groups. Replacing SBM in the control diet by SFM up to 75% did not exert any determinant effect on feed intake. SFM levels did not affect the proportional weights of carcass, dressing, gizzard and abdominal fat. Effects of enzyme supplementation and the interaction between SFM levels and enzyme supplementation were not significant on the majority of growth performance and carcass traits studied. In conclusion, it could be concluded that using SFM up to 75% (20.48% in the diet) during the starter period (1-3 weeks of age) and 100% (20% in the diet) during the growing period (4-9 weeks of age) substitution for SBM had no adverse effect on growth performance of growing Muscovy ducklings.

Key words: Sunflower meal, Muscovy ducklings, growth performance, carcass.

INTRODUCTION

Soybean meal has long been considered an outstanding source of supplementary protein in diets for livestock and poultry. In fact, soybean meal is sometimes referred to as the "gold standard" because other protein sources are often compared to it. Soybean meal is rich in highly digestible protein, which is composed of a superior blend of amino acids, the building blocks of body protein for livestock and poultry. The price of this ingredient hit an all-time record high. Therefore, an urgent need for affordable and nutritious feed. The best strategy to reduce costs is the development of diet formulation using alternative, locally available ingredients, thereby decreasing feed cost.

Sunflower meal (SFM) is commonly produced with 60-65% portion core (kernel) and 35-40% hull (shell). And contains about 30-34% of crude protein, 20-25% cellulose and 8-10% lignin (Sredanovic *et al*., 2012). As the result of such a high share of hulls in SFM, with about 50% cellulose and 25% lignin, the nutritive value of SFM is drastically reduced in animal and poultry nutrition (Ali *et al*., 2011). Sunflower meal can be used as a feedstuff to replace soybean meal (SBM) in poultry diets (Soliman, 1997). A major factors of using SFM in poultry diets is a cheap price compared to SBM, also it is free from toxic molecules and anti-nutritional factors which may affect productive performance (El-Barbary, 1997). According to Lipiec (1991) SFM can be used in monogastric animal nutrition in the amount of 50 to 150 g/kg diet. SFM could be used profitably up to 200 g/kg of broiler diets with no adverse impacts on growth performance and feed utilization (Sherif *et al*., 1995). The higher inclusions of SFM at 85 and 100 % as a

* **Corresponding author: Tel. :** +201004751183
E-mail address: mohmed_daliel@yahoo.com

replacement for SBM were stated with laying hens (Rama *et al*., 2009). Vieira *et al*. (1992) found that the high amounts of SFM can be successfully used in diets of laying hen and broiler chicken if adequate concentrations of dietary metabolizable energy (ME) and lysine are provided. Vetesi *et al.* (1999) recorded that live body weight, feed conversion ratio, carcass value as well as egg production and hatchability percentages of geese and ducks did not significantly change even at 100% replacement of SBM with SFM. But, there are some restrictions/ limitations about using the high inclusion levels of SFM in poultry diets *viz.*, high fiber, low ME content, and low lysine content (Biesiada-Drzazga *et al.*, 2010). It has been stated that SFM can be included in poultry diets at relatively high levels without any adverse impact on productive performance and egg quality criteria (Rezaei and Hafezian, 2007).

Great efforts have been made to improve the nutrients bioavailability from different feedstuffs *via* supplementation of enzymes. Which may not be produced with large concentrations by the birds, and thus are suggested to be added to poultry diets (El-Deek *et al*., 1999). Since, SFM contains substantial concentrations of cell-wall material and a high level of fiber that could affect its nutritive value, the use of an exogenous enzyme may be justified to improve the accessibility of cell contents to digestive enzymes (Brenes *et al*., 2008). Recently, supplementation of enzymes in poultry feeds has considerably increased, but few investigations are available on the influences of enzyme on utilization of SFM in poultry. On the other hand, Attia *et al.* (2003) have reported that commercial enzymes with various activities from pectinase, glucanase, xylanase and cellulose *etc.* did not result in significant improvements in broiler growth performance, but in some reports it was found beneficial effects on apparent metabolizable energy (AME) and feed efficiency values (Mandal *et al.*, 2005). The present study aimed to investigate the effect of using graded levels of SFM to replace the same level of SBM in the diet with or without enzyme supplementation on the growth performance and carcass traits of growing Muscovy ducks.

MATERIALS AND METHODS

The present experiment was carried out at a private Poultry farm near the Faculty of Agriculture, Zagazig University, El-Sharkia Governorate, Egypt from the beginning of March to the mid of May, 2014. A 5×2 factorial design experiment was performed including five levels of SFM (0.0, 25.0, 50.0, 75.0 and 100.0%) instead of the same percent of soybean meal (SBM); and two levels of dietary enzyme supplementation (0 or 0.5 g/kg diet). A total number of 300 unsexed one week old Muscovy ducklings were randomly distributed into ten treatment groups of 30 ducklings each with three replicates each of 10 ducklings. All the experimental duckling groups had nearly the same initial average live body weight and were not statistically different. Ten isocaloric-isonitrigenous diets were formulated to cover the nutrient requirements of Muscovy ducklings during the starter (1-3 weeks of age) and growing (4-9 weeks of age) periods according to NRC (1994). Within each dietary SFM, each level was fed with or without enzyme supplementation. Enzyme used in this study was "Gallazyme" (containing beta-glucanse 2300 U/g, xylanase 20000 U/g, cellulase-complex 3000 U/g, alpha-amylase 400 U/g, protease 200 U/g). Enzyme was purchased from Multivita Company, Sixth of October city, Cairo, Egypt. The composition of the starter and growing diets are presented in Tables 1 and 2.

Ducklings were allocated on floor pens and kept under similar managerial conditions throughout the different phases in suitable heated floor pens with chopped wheat straw litter from one week to six weeks of age. Artificial light source was used, giving a total of 23 light/ 1 dark hours of light of day. Ducklings were fed on the farm diet during the 1st week, while the experimental diets were offered during the experimental period from 1-9 weeks of age. Feed and clean water were offered *ad libitum* all over the experimental period. Ducklings were vaccinated against Duck Plague during the 7th day of age *via* muscle injection; and against Fowl Cholera at 18th day *via* drinking water.

Ducklings were individually weighed at the initial (one week old), 3, 6 weeks of the age and

Table 1. Composition and calculated analysis of the starter diets for growing ducks (1-3 weeks of age)

Ingredient (%)	Sunflower meal (%)				
	0	25	50	75	100
Yellow corn	58.57	57.38	56.28	54.68	53.58
Soybean meal (44%)	27.30	20.48	13.65	6.83	0.00
Sunflower meal	0.00	6.83	13.65	20.48	27.30
Gluten meal (62%)	4.00	4.30	4.50	5.00	6.00
Wheat bran	3.20	3.20	3.20	3.20	3.20
Fish meal	1.50	2.50	3.70	5.00	5.00
Choline chloride	0.20	0.20	0.20	0.20	0.20
Di Calcium phosphate	2.00	1.60	0.95	0.60	0.40
Salt	0.30	0.30	0.30	0.30	0.30
Limestone	1.10	1.05	1.25	1.30	1.50
Antitoxins	0.10	0.10	0.10	0.10	0.10
Soybean oil	1.00	1.20	1.20	1.20	1.10
Vit-min Premix*	0.30	0.30	0.30	0.30	0.30
DL Methionine	0.20	0.20	0.20	0.20	0.20
L-Lysine	0.23	0.37	0.52	0.62	0.82
Calculated analysis**					
CP (%)	21.26	21.16	21.13	21.25	21.06
ME Kcal/kg diet	2905.00	2924.00	2929.00	2931.00	2923.00
Ca (%)	1.08	1.02	1.07	1.01	1.04
P (Available) (%)	0.53	0.53	0.50	0.51	0.52
Lysine (%)	1.25	1.2	1.21	1.20	1.20
M+C (%)	0.91	0.91	0.91	0.92	0.91
CF (%)	2.47	4.04	5.60	7.20	8.75

* Growth vitamin and mineral premix each 2.5 kg contain of :

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.

** Calculated according to NRC (1994).

Table 2. Composition and calculated analysis of the growing diets for growing ducks (4-9 weeks of age)

Ingredient (%)	Sunflower meal (%)				
	0	25	50	75	100
Yellow corn (8.5%)	64.30	63.09	61.89	61.02	60.06
Soybean meal (44%)	20.00	15.00	10.00	5.00	0.00
Sunflower meal	0.00	5.00	10.00	15.00	20.00
Gluten meal (62%)	2.50	3.20	4.00	4.80	5.90
Wheat bran	4.00	4.00	4.00	4.00	4.00
Fish meal	4.00	4.60	5.00	5.00	5.00
Choline chloride	0.20	0.20	0.20	0.20	0.20
Di Calcium phosphate	1.30	1.00	0.80	0.60	0.40
Salt	0.30	0.30	0.30	0.30	0.30
Limestone	1.00	1.10	1.18	1.30	1.42
Antitoxins	0.10	0.10	0.10	0.10	0.10
Soybean oil	1.70	1.70	1.70	1.70	1.50
Vit-min Premix*	0.40	0.40	0.40	0.40	0.40
DL Methionine	0.10	0.10	0.10	0.10	0.10
L-Lysine	0.10	0.21	0.33	0.48	0.62
Calculated analysis**					
CP (%)	19.02	19.14	19.22	19.12	19.19
ME Kcal/kg diet	3017.00	3019.00	3020.00	3021.00	3013.00
Ca (%)	0.99	0.99	0.99	0.99	0.99
P (Available) (%)	0.46	0.46	0.46	0.46	0.46
Lysine (%)	1.04	1.04	1.04	1.04	1.04
M+C (%)	0.77	0.78	0.77	0.77	0.77
CF (%)	2.00	3.20	4.35	5.50	6.65

* Growth vitamin and mineral premix each 2.5 kg contain of :

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.

** Calculated according to NRC (1994).

the final of experimental period (9 weeks of the age). Daily body weight gain for each period (1-3, 4-6, 7-9 and 1-9 weeks of age) was calculated by subtracting the average initial live body weight of each replicate from the average final body weight for the same replicate and divided by the number of days within the period. Feed intake (g) and feed conversion (g feed/ g gain) were weekly calculated. At the end of the experimental period, three birds from each group were randomly selected, fasted overnight and weighed then slaughtered by a sharp knife to complete bleeding then followed by plucking the feather and finally weighed. The studied carcass traits were giblets (liver, gizzard and heart) carcass and dressing weights (dressed weight = carcass weight plus giblets weight)/ 100 / pre-slaughter weight.

Data were statistically analyzed on a (5 × 2) factorial design basis according to Snedecor and Cochran (1982). The following model was used:

$$Yijk = \mu + A_i + S_j + AS_{ij} + e_{ijk}$$

Where:

Y_{ijk} = an observation, μ = the overall mean, A_i = effect of SFM substitution for SBM (i =1 to 5), S_j = effect of enzyme supplementation (j=1 and 2), AS_{ij} = the interaction between SFM substitution for SBM and enzyme supplementation levels, e_{ijk}= random error (ij = 1-10).

Differences among means within the same factor were tested by using Duncan's New Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Live Body Weight and Body Weight Gain

Effect of SFM level

Live body weight (LBW) at the start of the experiment were nearly similar and had ranged between 252.29 to 255.86 g indicating the random distribution of individuals among the treatment groups.

However, data presented in Table 3 showed that LBW values were significantly (P≤0.01) affected by SFM substitution instead of SBM at 3, 6 and 9 weeks of age. It is worthy noting that at 3 weeks of age, LBW of Muscovy ducklings fed 25% dietary SFM as a substitution level for SBM was better (P≤0.01) than that of the control and other treatment groups. On the other hand, each of 50, 75 and 100% replacement of SBM with SFM resulted in significant (P≤0.01) decrease in LBW when compared with the control and other dietary treatment groups. This may be attributed to the declined feed intake.

At 6 and 9 weeks of age (growing period), data clearly showed that feeding Muscovy ducklings on diets containing 25% SFM resulted in significant (P≤0.01) heavier LBW as compared with control and other treatment groups. However, there were no significant variation among duckling groups fed diets contained 50, 75 or 100% SFM instead of SBM at the same period. However, average LBW of Muscovy ducklings given diets contained 25% SFM substituted for SBM were heavier by 11.31, 15.77 and 12.16% at 3, 6 and 9 weeks of age, respectively when compared with the control group.

Table 4 indicated effects (P≤0.01) in BWG of Muscovy ducklings due to SFM levels in the diets at 1-3, 4-6 and 1-9 weeks of age, while at 7-9 weeks of age BWG values were not significantly affected. The average weight gain followed nearly the same observed trend with LBW, whereas, replacing SBM with 25% SFM resulted in significantly (P≤0.01) increase in BWG by 16.44, 18.06 and 13.24% during 1-3, 4-6 and 1-9 weeks of age, respectively. During 1-3 and 1-9 weeks of age, BWG was not significantly affected due to replacing SBM by SFM at 50 or 75 % as compared with control. Complete replacement of SBM by SFM in Muscovy ducklings' diet decreased (P≤0.01) BWG at 1-3 and 1-9 weeks of age, while no significant effect on daily BWG at 4-6 weeks of age as compared with control.

It is worth noting that growth performance (live body weight and body weight gain) of Muscovy ducklings fed 25% dietary SFM was better than that of the control and other treatments. From the previous results, it could be concluded that replacing SBM in the control diet with SFM up to 75% (20.48% in the diet) during the starter period (1-3 weeks of age) and 100% during the growing period (3-9 weeks of age) did not exert any determinant (P≤0.01) effects on growth performance (live body weight and

Table 3. Body weight, ($\overline{X}$ ±SE) g of Muscovy ducklings as affected by sunflower meal, enzyme supplementation and their interaction

Treatment		Age in weeks: 1 (initial)	3	6	9
SFM substitution (%) for SBM		NS	**	**	**
0		252.79±1.39	701.07±5.04[b]	1957.62 ± 21.63[b]	3334.42± 97.49[b]
25		254.00±1.30	790.43±19.74[a]	2324.00 ± 71.82[a]	3796.10± 60.96[a]
50		255.86±1.29	699.29±9.06[b]	1957.62 ± 58.07[b]	3269.45± 77.75[b]
75		255.36±1.12	666.31±9.16[b]	1900.83 ± 47.38[b]	3180.05± 70.99[b]
100		252.29±1.18	606.07±15.28[c]	1825.24 ± 56.45[b]	3121.42± 62.69[b]
Enzyme supplementation (g/kg)		NS	NS	NS	NS
0.00		253.66±0.85	694.66±16.89	2000.73 ± 60.03	3325.21± 75.79
0.50		254.46±0.81	690.61±18.46	1985.39 ± 51.94	3355.37± 80.25
Interaction effect					
SFM	**Enzyme**	NS	NS	NS	*
0	**0.00**	251.00±1.36	691.43±2.18	1935.24 ± 42.32	3132.38± 40.23[d]
	0.50	254.57±2.16	710.71±5.39	1980.00 ± 6.81	3536.45± 71.29[bc]
25	**0.00**	252.57±2.34	802.57±19.61	2386.28 ± 113.36	3856.60± 49.58[a]
	0.50	255.43±0.99	778.29±37.62	2261.72 ± 95.21	3735.60± 111.63[ab]
50	**0.00**	257.14±0.00	700.24±3.72	1884.29 ± 91.78	3240.20± 45.29[cd]
	0.50	254.57±2.57	698.33±19.88	2030.95 ± 55.31	3298.69± 165.28[cd]
75	**0.00**	253.86±1.98	655.95±3.55	1938.10 ± 77.64	3243.95± 48.95[cd]
	0.50	256.86±0.28	676.67±17.31	1863.57 ± 61.70	3116.14± 136.82[d]
100	**0.00**	253.71± 1.98	623.10± 20.48	1859.76± 43.43	3152.90± 104.70[d]
	0.50	250.86± 1.03	589.05± 21.39	1790.71± 113.37	3089.95± 87.75[d]

Means in the same column within each classification bearing different letters are significantly different (P<0.05).
*= Significant (P<0.05), ** = Significant (P<0.01) and NS = Not significant.

body weight gain). Only complete replacement of SBM by SFM in the diets of Muscovy ducklings resulted in significant (P≤0.01) decrease in live body weight at 3 weeks of age and body weight gain during starter period.

The negative effects of high inclusion of SFM during the starter period may be related to the increased level of non-starch polysaccharides (NSP) which is known to possess anti-nutritional effects (Choct, 2006). On the other hand, high inclusion of SFM (20% in the diet) during the growing period had no negative effects on LBW and BWG which suggests that SFM can replace 100% of SBM and birds can tolerate this increase in crude fiber without any negative effects on growth performance (Soliman *et al*., 1996).

Although a substantial amount of fiber is needed for normal digestive function, high fiber ingredients are mainly avoided in poultry diets; because of their low energy values. The acceptable range of dietary CF is 3 to 5% in practical Muscovy ducklings. The crude fiber of SFM, depending on the extent of dehulling, appears to be the most critical aspect in chicks' diets (Sen Koylu and Dale, 2006). It is clear from Table 3 that during the period of (1-3 weeks of age), no adverse effect was observed on LBW and BWG when CF was increased from 2.47% in the control diet (0% SFM) to 7.20% in the diet contained 75% SFM substitution for SBM. Adverse effects were observed when CF was increased to 8.75% in the diet contained 100% SFM substituted for SBM (27.30% SFM in the diet). The high level of fiber is always associated with slow passage rate for feed in the digestive system which may depress performance of the birds. Increasing dietary fiber contents may decrease the availability of amino acids and almost decrease feed intake (Soliman *et al*., 1996).

Rama *et al*. (2006) reported no effect on BWG when replacing SBM (318 and 275 g/kg in the starter and grower/finisher periods, respectively) completely with SFM in broilers. Sen Koylu and Dale (2006) concluded that SFM can successfully be added to broiler diets to replace 50% to 100% of SBM, depending on the type of diet and the nature of other ingredients. In maize based diets, Kalmendal *et al*. (2011) reported that BWG between 15 to 31 days of age was linearly increased with high- fiber sunflower cake inclusion at levels of 0, 10, 20, and 30%. Araujo *et al.* (2014) fed males of Cobb broilers on the diet containing different levels of SFM (0, 8, 16 and 24%) and found that increasing dietary addition of SFM reduced weight gain during 21- 42 days of age. While, Amerah *et al.* (2015) reported that high inclusion level of SFM (60 and 100 g/kg SFM for starter and grower/finisher diets, respectively) of broiler chicks, negatively influenced the weight gain.

Effect of enzyme supplementation

Results in Tables 3 and 4 proved that LBW at 3, 6 and 9 weeks of age and BWG during all the experimental periods studied (1-3, 4-6, 7-9 and 1-9 weeks of age) were not significantly affected by enzyme supplementation in the diet Muscovy ducklings.

Similar results were reported by Araujo *et al.* (2014) and Ghanim (2016) who indicated that enzyme preparation failed to obtain a significant increase in LBW of broiler and growing quails. However, other investigations found an improvement in broiler and quail chicks' growth performance with enzyme supplementation of diet including high level of fiber (Amerah *et al.*, 2015).

Interaction effects

From the results in Tables 3 and 4, it seems that there were no significant differences between the treatment groups due to the interaction effects between dietary SFM level and enzyme supplementation on LBW at 3 and 6 weeks of age and BWG through all the experimental periods studied (1-3, 4-6, 7-9 and 1-9 weeks of age), while the interaction was significant (P≤0.05) on LBW of Muscovy ducklings at 9 weeks of age for those fed on diets containing 25% SFM instead of SBM with or without enzyme supplementation. However, the lowest value of LBW at 9 week of age was showed for ducklings fed on diet contained 100% SFM (20% SFM in the diet) without enzyme supplementation. Mushtaq *et al*. (2008) observed a significant effect due to SFM× enzyme interaction on BWG of broiler chicks at 1-21 days of age. However, Abdelrahman and Saleh (2007) and Tavernari *et al*. (2008) demonstrated that interaction effects between SFM and enzyme supplementation were not significant on performance of broiler chicks.

Table 4. Daily body weight gain, g/day ($\overline{X}$ ±SE) of Muscovy ducklings as affected by sunflower meal, enzyme supplementation and their interaction

Treatment	Age in weeks	1-3	4-6	7-9	1-9
SFM substitution (%) for SBM		**	**	NS	**
0		32.02± 0.27[b]	59.84 ± 0.98[b]	65.56 ± 4.21	52.47± 1.56[b]
25		38.32± 1.38[a]	73.03 ± 3.37[a]	70.10 ± 2.69	60.48± 1.09[a]
50		31.67± 0.60[b]	59.92 ± 2.82[b]	62.47 ± 3.13	51.36± 1.27[bc]
75		29.35± 0.63[b]	58.79 ± 2.49[b]	60.92 ± 2.51	49.69± 1.12[bc]
100		25.27± 1.05[c]	58.06 ± 2.26[b]	61.73 ± 3.86	48.35± 1.07[c]
Enzyme supplementation (g/kg)		NS	NS	NS	NS
0.00		31.50± 1.21	62.20± 2.37	63.07 ± 1.84	52.25± 1.32
0.50		31.15± 1.29	61.66± 1.82	65.24 ± 2.46	52.68± 1.39
Interaction effect					
SFM	**Enzyme**	NS	NS	NS	NS
0	**0.00**	31.46± 0.07	59.23± 2.10	57.01 ± 2.14	49.23± 0.65
	0.50	32.58± 0.23	60.44± 0.09	74.12 ± 3.32	55.71± 1.13
25	**0.00**	39.29± 1.25	75.42± 6.27	70.02 ± 4.84	61.57± 0.73
	0.50	37.35± 2.65	70.64± 3.40	70.19 ± 3.57	59.39± 2.06
50	**0.00**	31.65± 0.27	56.38± 4.54	64.57 ± 2.29	50.87± 0.69
	0.50	31.70± 1.31	63.46± 2.56	60.37 ± 6.27	51.84± 2.70
75	**0.00**	28.72± 0.36	61.06± 3.55	62.18 ± 1.37	50.65± 0.81
	0.50	29.98± 1.22	56.52± 3.64	59.65 ± 5.29	48.72± 2.17
100	**0.00**	26.38± 1.47	58.89± 2.34	61.58± 6.19	48.95± 1.80
	0.50	24.16± 1.45	57.22± 4.39	61.87± 6.00	47.75± 1.45

Means in the same column within each classification bearing different letters are significantly different ($P<0.05$).
** = Significant ($p<0.01$) and NS = Not significant.

Feed Intake and Feed Conversion

Effect of SFM level

Table 5 reveals that feed intake had significantly ($P \leq 0.05$) affected by the level of SFM inclusion in the diet of ducklings through the periods of 1-3 and 1-9 weeks of age as compared to control. However, feed intake was not significantly affected through 4-6 and 7-9 weeks of age. From 4-6 weeks of age, results indicated that feed intake was insignificantly decreased by increasing SFM in the diet up to 100%.

It could be concluded from Table 5 that replacing SBM in the diet by SFM up to 75% did not exert any determinal effect on feed intake, but complete replacement of SBM with SFM in Muscovy ducklings diets (20% SFM in the diet) resulted in significant ($P \leq 0.05$) decrease in feed intake as compared with control. The reduction in daily feed intake for ducklings fed SFM replaced 100% of SBM may be due to high fiber contents which cannot be tolerated at early stages of duckling age; also diets containing high levels of fiber occupied more space in the crop resulted in a less feed intake (Mayer and Cheeke, 1975). Findings obtained herein agree with Tavernari *et al*. (2008) who did not find any significant differences in feed intake due to the level of 20 and 25% SFM inclusion, respectively, for the starter and grower phases or total experimental periods in broilers.

In contrast, Abdelrahman and Saleh (2007) obtained higher feed intake for broiler chicks with the inclusion of 10% SFM compared with our results. Mushtaq *et al*. (2008) stated that feed consumption of broilers chicks was increased when dietary SFM was increased from 200 to 300 g/ kg of the diet during 1-42 days of age.

Results in Table 6 indicate that SFM inclusion levels significantly ($P \leq 0.05$ or $P \leq 0.01$) improved feed conversion ratio of Muscovy ducklings through 1-3, 4-6 and 1-9 weeks of age. However, feed conversion ratio was not significantly affected during 7-9 weeks of age. It is worth noting that feed conversion ratio was improved by 22.73, 16.73, 8.71 and 15.38% in Muscovy ducklings fed 25% SFM instead of SBM during 1-3, 4-6, 7-9 and 1-9 weeks of age, respectively. The improvement of feed conversion ratio by 25% SFM instead of SBM may be due to the increase in LBW of ducklings as a result of SFM inclusion. However high levels of SFM inclusion in grower and finisher broiler diets up to 20% had no effect on feed conversion ratio (Horvatovic *et al*., 2015). Tavernari *et al*. (2008) found that the highest levels of SFM inclusion (20%) in the diet improves feed conversion ratio and attributed to the fact that, the oil inclusion level was increased in order to supply bird's energy needs and have improved digestibility.

Contradicting results were obtained by Rama *et al*. (2006) who reported that when replacing SBM (318 and 275 g/kg in the starter and grower/finisher periods, respectively) completely with SFM, feed efficiency was depressed progressively with increasing SFM (33, 67 and 100% SFM replacement of SBM) and this depression reached significant at 67% level as compared to the control in Vanaraja chicken. Amerah *et al.* (2015) found that feed conversion ratio was negatively affected by 30% SFM inclusion in broiler diets.

Effect of enzyme supplementation

Data in Table 5 reveal that average daily feed intake of Muscovy ducklings during 1-3, 4-6, 7-9 and 1-9 weeks of age were 72.90 and 74.12, 167.05 and 168.06; while the corresponding estimates were 210.29 and 211.16; 150.08 and 151.11 g for ducklings fed on diet without and with enzyme supplementation, respectively. It is worth noting that feed intake increased by 1.65, 0.61, 0.41 and 0.68% for ducklings fed the diet supplemented with enzyme during the same four periods, respectively when compared with unsupplemented diets.

Table 6 shows that feed conversion ratio was not significantly affected by enzyme supplementation compared to the unsupplemented one although it improved by about 2.08 during 7-9 weeks of age. Supplementation with an appropriate enzyme can partially degrade feed endosperm cell wall, giving a more rapid and extensive digestion of starch, protein and other nutrients in the small intestine and consequently a high feed intake and better feed conversion efficiency (Petterson and Aman, 1989). In addition,

Table 5. Feed intake, ($\overline{X}$ ±SE) g/day of Muscovy ducklings as affected by sunflower meal, enzyme supplementation and their interaction

Treatment \ Age in weeks		1-3	4-6	7-9	1-9
SFM substitution (%) for SBM		*	NS	NS	*
0		77.64± 1.93[a]	167.78±1.94	214.24±1.53	153.22± 1.41[a]
25		71.09± 3.67[ab]	169.17±0.99	211.72±2.30	150.66± 1.61[abc]
50		72.50± 2.80[ab]	167.52±1.55	207.06±2.41	149.03± 1.20[bc]
75		77.90± 1.80[a]	167.79±1.16	212.07±3.31	152.59± 0.95[ab]
100		68.42± 4.54[b]	165.51±1.25	208.52±2.01	147.48± 1.46[c]
Enzyme supplementation (g/kg)		NS	NS	NS	NS
0.00		72.90± 1.41	167.05± 0.98	210.29±1.68	150.08± 0.68
0.50		74.12± 2.63	168.06± 0.80	211.16±1.47	151.11± 1.21
Interaction effect					
SFM	**Enzyme**	*	NS	NS	*
0	**0.00**	74.37± 2.78[ab]	164.79± 2.43	213.40±1.63	150.85± 2.03[abc]
	0.50	80.91± 0.33[ab]	170.78± 1.97	215.09±2.90	155.59± 0.38[a]
25	**0.00**	69.45± 1.12[bc]	169.17± 1.50	212.40±1.87	150.34± 0.55[abc]
	0.50	72.74± 7.96[ab]	169.17± 1.63	211.03±4.75	150.98± 3.55[abc]
50	**0.00**	69.16± 5.22[bc]	167.90± 2.59	207.48±3.51	148.18± 1.80[bc]
	0.50	75.83± 0.88[ab]	167.13± 2.26	206.64±4.07	149.87± 1.81[anc]
75	**0.00**	74.24± 1.14[ab]	167.19± 2.52	212.78±7.21	151.40± 1.59[abc]
	0.50	81.55± 1.25[a]	168.40± 0.07	211.37±1.47	153.77± 0.77[ab]
100	**0.00**	77.26± 2.74[ab]	166.20± 2.58	205.37± 1.63	149.61± 1.63[abc]
	0.50	59.57± 4.14[c]	164.82± 0.81	211.67± 2.76	145.35± 1.84[c]

Means in the same column within each classification bearing different letters are significantly different (P<0.05).
*= Significant (P<0.05) and NS = Not significant.

enzyme supplementation increases the rate of passage, which may improve feed intake (Bernes *et al*., 1993).

The present results are in agreement with those of Araujo *et al*. (2014) and Ghanim (2016) who indicated that Avizyme preparation failed to obtain significant improvement in feed intake and feed conversion ratio.

Bernes *et al*. (1993) found that enzyme addition of Roxazyme and Avizyme to diets containing Bedford barely improved feed /gain ratio by 5% over a 6 weeks period for both male and female broilers.

Mushtaq *et al*. (2008) observed that enzyme supplementation to broiler chicks' diets during 1-42 days decreased the feed intake and improved feed/gain ratio. Also, Amerah *et al.* (2015) observed that using enzyme supplementation in broiler chicks' diet improved feed conversion ratio as compared with the unsupplemented diets.

Interaction effects

It seems that the interaction due to SFM levels and enzyme supplementation had a significant ($P \leq 0.05$) effect on feed intake of Muscovy ducklings only through 1-3 weeks of age and the whole experimental period (1-9 weeks of age). Feed intake was not significantly affected through the growing period (3-9 weeks of age). During the whole period, it is worth noting that ducklings fed on diet without SFM inclusion with enzyme supplementation had the highest feed intake value. While, the lowest one was for ducklings fed 100% SFM substitution to soybean meal with enzyme supplementation.

With regard to feed conversion ratio, results in Table 6 did not show any significant effects on feed conversion ratio of Muscovy ducklings due to the interaction between dietary SFM level and enzyme supplementation through all the experimental periods studied. Tavernari *et al*. (2008) found no significant interaction between dietary SFM level and enzyme complex on feed intake and feed: gain ratio in none of the periods studied. Araujo *et al.* (2014) demonstrated that the inclusion of enzyme blend did not affect feed intake of broiler chicks ($P \leq 0.05$) in SFM diets. Abdelrahman and Saleh (2007) also did not find any significant influence of the inclusion of glucanase in SFM diets of broiler chicks. Amerah *et al*. (2015) stated that no interactions ($P>0.05$) between SFM inclusion level and enzyme supplementation were observed for feed intake and feed conversion ratio of broiler chicks at any periods studied.

On the other hand, Raza *et al*. (2009) obtained better feed conversion ratio when adding carbohydrases to SFM diets fed to broilers. Mushtaq *et al*. (2008) found that enzyme supplementation at 300 g SFM/ kg improved feed: gain ratio of broiler chicks during 1-12 days of age. These inconsistent results may be explained by the different broiler genetics, basal diets (wheat or corn), feed form (mash or pellet), oil extraction method and the NSP levels of the SFM. According to the previous results, it could be suggested that replacement rate of SFM up to 75% of SBM (20.48% in the diet) and 100% (20% in the diet) during the starter and growing periods, respectively may be recommended in growing Muscovy ducklings.

Carcass Traits

Effect of SFM level

The experimental groups fed different SFM levels for proportional weight of carcass traits showed significantly effects ($P \leq 0.05$ or $P \leq 0.01$) on relative weights of giblets and liver (Table 7). On the other hand, SFM levels did not affect the proportional weights of carcass, dressing, gizzard and abdominal fat. It is worth noting that the highest record values of relative weight of liver was recorded by ducklings fed diet containing 75% SFM instead of SBM compared with control. Differences between control and 25, 50 and 100% SFM substitutions of SBM were not significant. Replacing SBM with SFM in duckling diets up to 75% did not have any significant effect on giblet percentage values. However, ducklings fed on SFM replaced 100% of SBM in the control diet showed significant ($P \leq 0.05$) decrease in giblets percentage as compared with control.

Results of SFM effect on carcass traits of Muscovy ducklings agreed with those obtained by Mushtaq *et al*. (2008) and Tavernari *et al*. (2009) who did not find any influence on carcass traits due to SFM levels of 25% and 30%,

Table 6. Feed conversion ratio, ($\overline{X}$ ±SE) g feed/g gain of Muscovy ducklings as affected by sunflower meal, enzyme supplementation and their interaction

Treatment \ Age in weeks		1-3	4-6	7-9	1-9
SFM substitution (%) for SBM		**	*	NS	**
0		2.42± 0.05[ab]	2.81 ± 0.05[a]	3.33 ± 0.21	2.86± 0.06[a]
25		1.87± 0.14[c]	2.34 ± 0.09[b]	3.04 ± 0.11	2.42± 0.07[b]
50		2.29± 0.10[b]	2.83 ± 0.16[a]	3.36 ± 0.16	2.83± 0.06[a]
75		2.66± 0.05[a]	2.88 ± 0.12[a]	3.51 ± 0.15	3.02± 0.07[a]
100		2.72± 0.18[a]	2.87 ± 0.12[a]	3.44 ± 0.19	3.01± 0.07[a]
Enzyme supplementation (g/kg)		NS	NS	NS	NS
0.00		2.37± 0.11	2.73± 0.09	3.37 ± 0.10	2.82± 0.07
0.50		2.42± 0.10	2.76± 0.08	3.30 ± 0.12	2.82± 0.07
Interaction effect					
SFM	**Enzyme**	NS	NS	NS	NS
0	**0.00**	2.36± 0.09	2.79± 0.11	3.76 ± 0.17	2.97± 0.08
	0.50	2.48± 0.02	2.83± 0.04	2.91 ± 0.13	2.74± 0.04
25	**0.00**	1.77± 0.05	2.27± 0.17	3.06 ± 0.19	2.37± 0.03
	0.50	1.97± 0.30	2.40± 0.09	3.02 ± 0.15	2.47± 0.14
50	**0.00**	2.19± 0.18	3.02± 0.27	3.23 ± 0.17	2.81± 0.01
	0.50	2.40± 0.07	2.65± 0.14	3.48 ± 0.29	2.84± 0.14
75	**0.00**	2.59± 0.07	2.76± 0.15	3.43 ± 0.14	2.92± 0.05
	0.50	2.73± 0.07	3.00± 0.19	3.59 ± 0.28	3.11± 0.12
100	**0.00**	2.94± 0.12	2.83± 0.15	3.40± 0.31	3.05± 0.10
	0.50	2.50± 0.31	2.91± 0.22	3.48± 0.27	2.97± 0.13

Means in the same column within each classification bearing different letters are significantly different (P<0.05).
*= Significant (P<0.05), ** = significant (P<0.01) and NS = Not significant.

respectively as well as there were no significant differences in weight gain of broiler chicks, which explains carcass results. Amerah *et al.* (2015) suggested that moderate inclusion of SFM (50 and 80 g/kg during starter and finisher period, respectively) had no negative effects on carcass characteristics of broiler chicks.Araujo *et al.* (2014) found that inclusion SFM levels of 0, 8, 16 and 24% in broiler feeds negatively influenced carcass parameters P<2. Aboul Ela *et al.* (2000) found significant differences in percentages of carcass, dressing, and giblets of broiler chicks due to the inclusion of SFM in the diet.

Effect of enzyme supplementation

Results in Table 7 proves that all studied carcass traits were not significantly affected by enzyme supplementation in the diets of growing Muscovy ducklings. Similarly to those of Aboul Ela *et al*. (2000) in broilers. In accordance with our results those of Araujo *et al*. (2014) and Rabie and Abo El-Maaty (2015) who found that dietary addition of enzyme did not significantly affect carcass traits of broilers and Japanese quails. In contrast, Amerah *et al.* (2015) reported that dietary enzyme supplementation had a positive effect on carcass traits of broiler and Japanese quail chicks.

Table 7. Some carcass characteristics ($\overline{X}$ ±SE), (%) of Muscovy ducklings as affected by sunflower meal, enzyme supplementation and their interaction at 9 weeks of age

Measurement / Treatment		Carcass (%)	Dressing (%)	Heart (%)	Liver (%)	Gizzard (%)	Giblets (%)	Abdominal fat (%)
SFM substitution (%) for SBM		NS	NS	NS	**	NS	*	NS
0		67.79 ± 0.50	73.82 ± 0.59	0.59 ± 0.03	2.68 ± 0.07[bc]	2.76 ± 0.12	6.04 ± 0.16[a]	0.95 ± 0.29
25		66.77 ± 0.60	73.57 ± 0.66	0.63 ± 0.05	3.12 ± 0.13[ab]	3.04 ± 0.22	6.79 ± 0.25[a]	1.36 ± 0.38
50		64.11 ± 1.31	70.40 ± 1.15	0.55 ± 0.02	2.97 ± 0.21[abc]	2.78 ± 0.09	6.29 ± 0.24[a]	0.67 ± 0.18
75		66.51 ± 1.07	73.24 ± 1.23	0.54 ± 0.03	3.42 ± 0.17[a]	2.78 ± 0.13	6.73 ± 0.29[a]	0.84 ± 0.30
100		65.99 ± 1.80	71.69 ± 1.71	0.51 ± 0.04	2.50 ± 0.11[c]	2.68 ± 0.16	5.70 ± 0.21[b]	1.20 ± 0.40
Enzyme supplementation (g/kg)		NS	NS	NS	NS	NS	NS	NS
0.00		65.95 ± 0.66	72.24 ± 0.62	0.58 ± 0.02	2.91 ± 0.13	2.81 ± 0.08	6.29 ± 0.14	1.06 ± 0.22
0.50		66.52 ± 0.85	72.85 ± 0.89	0.55 ± 0.02	2.97 ± 0.12	2.81 ± 0.11	6.33 ± 0.21	0.95 ± 0.18
Interaction effect								
SFM	**Enzyme**	NS	NS	NS	NS	NS	NS	NS
0	**0.00**	67.48 ± 0.92	73.60 ± 1.05	0.60 ± 0.06	2.60 ± 0.06	2.92 ± 0.13	6.12 ± 0.17	1.57 ± 0.19
	0.50	68.09 ± 0.55	74.04 ± 0.77	0.58 ± 0.02	2.77 ± 0.12	2.60 ± 0.18	5.96 ± 0.30	0.33 ± 0.05
25	**0.00**	66.09 ± 0.94	72.47 ± 0.80	0.68 ± 0.08	3.02 ± 0.24	2.68 ± 0.21	6.38 ± 0.22	1.41 ± 0.84
	0.50	67.46 ± 0.66	74.66 ± 0.61	0.58 ± 0.06	3.21 ± 0.14	3.41 ± 0.26	7.20 ± 0.32	1.30 ± 0.18
50	**0.00**	62.91 ± 1.84	69.12 ± 1.72	0.53 ± 0.02	2.95 ± 0.18	2.73 ± 0.16	6.21 ± 0.12	0.43 ± 0.10
	0.50	65.31 ± 1.94	71.69 ± 1.43	0.57 ± 0.04	2.98 ± 0.43	2.83 ± 0.13	6.38 ± 0.52	0.92 ± 0.30
75	**0.00**	65.38 ± 0.23	72.26 ± 0.63	0.54 ± 0.01	3.56 ± 0.26	2.78 ± 0.24	6.88 ± 0.42	0.53 ± 0.14
	0.50	67.64 ± 2.09	74.23 ± 2.49	0.53 ± 0.07	3.28 ± 0.24	2.78 ± 0.16	6.59 ± 0.46	1.16 ± 0.57
100	**0.00**	67.89 ± 1.43	73.75 ± 1.09	0.54 ± 0.05	2.40 ± 0.17	2.92 ± 0.23	5.87 ± 0.34	1.36 ± 0.63
	0.50	64.09 ± 3.25	69.62 ± 3.04	0.48 ± 0.05	2.60 ± 0.16	2.44 ± 0.10	5.52 ± 0.25	1.05 ± 0.63

Means in the same column within each classification bearing different letters are significantly different (P<0.05).
*= Significant (P<0.05), ** = Significant (P<0.01) and NS = Not significant.

Interaction effect

The interaction between dietary levels of SFM and enzyme supplementation did not have any significant effect on any of studied carcass traits. Results obtained herein agreed with those reported by Tavernari *et al*. (2008) and Horvatovic *et al.* (2015) who demonstrated that, there was no significant effect of SFM inclusion with or without enzyme supplementation on carcass characteristics.

Contradicting results were obtained by Khan *et al*. (2012) who showed that enzymes treated sunflower-corn based diets improved ($P \leq 0.05$) the dressing percentage of birds. Abbas (1992) found that enzyme supplementation to fibrous diet improved the growth rate, thereby increasing the dressing percentage of broiler chicks.

Conclusion

It could be concluded that using SFM up to 75% (20.48% in the diet) during the starter period (1-3 weeks of age) and 100% (20% in the diet) during the growing period (4-9 weeks of age) instead of SBM had no adverse effect on growth performance of growing Muscovy ducklings.

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استـــخدام كســـب دوار الشمـــس فـــي عـــلائـــق كتـــاكيـت البـــط المســـكــوفــي

محمد إبراهيم الدليل - محمد محمد الهنداوي - عادل إبراهيم عطية - إسماعيل السيد إسماعيل

قسم الدواجن – كلية الزراعة – جامعة الزقازيق – مصر

تم تصميم تجربة عاملية ٥×٢ ضمت ٥ مستويات لإحلال كسب دوار الشمس محل كسب فول الصويا بنسب (صفر، ٢٥، ٥٠، ٧٥ و ١٠٠%)، ومستويين من الانزيم (صفر و ٠.٥ جم/كجم علف)، تم استخدام عدد ٣٠٠ كتكوت بط مسكوفي غير مجنس على عمر أسبوع، وزعت الطيور عشوائيا على عشرة مجموعات تجريبية بكل منها ٣٠ كتكوت مقسمة على ثلاث مكررات بكل منها ١٠ كتاكيت، أظهرت النتائج أن وزن الجسم ومعدل الزيادة في وزن الجسم لمجموعة كتاكيت البط المسكوفي المغذاة على ٢٥% كسب دوار الشمس إحلالا محل كسب فول الصويا كان أفضل عند درجة معنوية (٠.٠١) من مجموعة المقارنة وباقي المجموعات التجريبية، أدى الإحلال الكامل لكسب دوار الشمس محل كسب فول الصويا إلى انخفاض معنوي (٠.٠١) في وزن الجسم ومعدل الزيادة في وزن الجسم إذا ما قورن بمجموعة المقارنة وباقي المعاملات، لم يؤدي استخدام ٧٥% من كسب دوار الشمس محل كسب الصويا إلى تأثيرات سيئة على الغذاء المأكول، لم يعطي استخدام كسب دوار الشمس أي تأثيرات معنوية على الأوزان النسبية للذبيحة والتشافي والقانصة ودهن البطن، لم يكن تأثير إضافة الانزيم للعلف ولا التداخل بين الانزيم ومستويات احلال كسب دوار الشمس معنويا على غالبية صفات أداء النمو ولا صفات الذبيحة المدروسة، يمكن التوصية بإحلال كسب دوار الشمس محل كسب فول الصويا حتى مستوى ٧٥% (٢٠.٤٨% في العليقة) خلال مرحلة البادئ (١-٣ أسابيع من العمر) و ١٠٠% (٢٠% في العليقة) خلال مرحلة النامي (٤-٩ أسابيع من العمر) دون أي تأثيرات عكسية على أداء النمو لكتاكيت البط المسكوفي النامي.

المحكمـــــون:

١- أ.د. خليـــل الشـحات شـــريـــف أستاذ تغذية الدواجن – كلية الزراعة – جامعة المنصورة.

٢- أ.د. غريب أحمد عبدالمجيد الصياد أستاذ رعاية الدواجن – كلية الزراعة – جامعة الزقازيق.