SUNFLOWER MEAL AS AN ALTERNATIVE PROTEIN SOURCE TO GROUNDNUT MEAL IN LAYING HENS' RATION

By

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Abstract: *An experiment was conducted to study the substitution of groundnut meal (GNM) by sunflower meal (SFM). GNM was substituted by SFM by inclusion of either 0% sunflower meal (SFM 0%), 50% (SFM 50%) or 100% (SFM 100%) of the total plant protein in the diet. Ninety hens of 24 weeks old white leghorn commercial layers (Lohman strain) were used. The hens were randomly assigned into three treatments with three replicates. Three approximately iso-nitrogenous and iso-caloric rations containing either 0%, 13% or 26% sunflower meal were formulated. Feed intake, body weight gain and total egg mass were weekly measured. Final egg weight, yolk weight, albumin and shell weight and shell thickness were done. Eggs number was recorded daily, feed conversion ratio and laying % and specific gravity were calculated. The substitution of GNM by 50% of SFM recorded significantly (P≤0.05) better feed intake, body weight gain, egg number, egg mass, feed conversion ratio and laying %. The egg weight and yolk weight were significantly (P≤0.05) better in 100% substitution of GNM by SFM. Albumin and shell weight, shell thickness and egg specific gravity were insignificantly (P>0.05) affected by inclusion of SFM in the diet. The feed costs per hen were generally lower for the SFM groups.*

Key words: Sunflower meal; layers; feed conversion ratio; shell thickness; specific gravity.

INTRODUCTION

Feed constitutes the major production cost in poultry production process, and often accounts for 65-70% of total costs of commercial egg production. Soybean meal is internationally the conventional protein source in layer diets, and it is influenced by external fluctuations. Increasing ingredient prices remain the greatest single item that determines profit margins in poultry production (**Casartelli, *et al.*, 2006**). In Sudan soybean meal is not available and if found it is very expensive, however, groundnut meal (**GNM**) is widely available and is usually used, but it has anti-nutritional properties and is highly oxidative if not stored in controlled environment without using antioxidants. Groundnut meal is also highly susceptible to aflatoxin contamination which is very harmful to poultry and specially chickens. **El Boushy and Raterink (1989)** found that growth was depressed, and feed efficiency was poorer as the percentage of GNM in the diet increased from 5 to 15%, even with a slight excess of Lysine and Methionine supplements. Although the GNM used in their study tested negative for aflatoxin but was high in iron. They concluded that the decrease in performance was due to the high iron content, which was 6.5 times the recommended level **(National Research Council**, **1994).** Replacement of groundnut cake in the diet of growing chickens by sunflower cake improved growth rate and efficiency of utilization of energy and protein **(Singh and Parasad, 1979)**, a mixture of sunflower and groundnut cakes

gave decidedly higher weight gain than either of the two cakes alone.

Sorghum (Feterita), groundnut cake, sesame cake and wheat bran are considered as the main source of energy and protein in poultry diets in Sudan (**Babiker et al., 2009)**. Huge amounts of groundnut meal are discarded yearly because of aflatoxin which results in increasing the poultry rations prices. So the best strategy to reduce production costs is using alternative sources, locally available, in ration formulation such as sunflower meal. Sunflower grain output increased sharply by 71.4% to reach 12 thousand tons in, 2004/05 seasons compared with 7 thousand tons in the previous season **(Central Bank of Sudan, 2005)**. This was due to the increase of 73.3% in area under cultivation from 15 thousand feddans in, 2003/04 to 26 thousand feddans in, 2004/05 seasons. In Sudan three local hybrids of sunflower were released for commercial production under irrigated conditions in the central clay plains of Sudan. Therefore, local seed production will be a safeguard for sunflower production against foreign political constraints concerning seed importation **(Mohamed, 2010)**.

The use of sunflower meal (**SFM**) in poultry diets is limited by variations in chemical composition, and the two main components apparently restricting its usage are the high fiber/ low energy and low lysine contents **(Senkoylu and Dale, 1999)**. Working on layers **Michael and Sunde (1985)** reported that sunflower meal is relatively rich in sulphur amino acids but is deficient in two limiting amino acids, lysine, and threonine. **Karunajeewa *et al*. (1989)** did not find significant effects of inclusion of sunflower meal in number of eggs produced, egg mass or feed conversion ratio. **Vieira *et al.* (1992)** found that egg weight, eggshell quality, and number of eggs were not affected by gradual levels of sunflower meal inclusion in layer diets (13.5, 27, or 40.5%), although positive linear effects were observed for feed intake and feed conversion ratio with sunflower meal inclusions. Substitution of sunflower meal for cotton seed meal and sesame meal did not generally affect the egg production, feed consumption, and feed conversion nor did it have any effect on the quality of eggs as measured by Haugh Units (**HU**) and yolk index **(Aslam Mirza and Sial, 1992)**. Egg shell thickness was improved by increasing the dietary levels of sunflower meal. The feed costs per hen were generally lower for the sunflower meal group compared to cotton seed meal and sesame meal. **Serman *et al.* (1997)** used 24% decorticated sunflower meal in layer diets, and observed that when lysine and energy were supplemented, birds performances were similar or higher as compared to birds fed diets with no sunflower meal. However, lysine supplementation to sunflower meal-based layer diets does not appear to be as critical as in broiler diets because their lysine requirement is much lower **(Senkoylu and Dale, 1999)**. **Tsuzuki *et al*. (2003)** used whole sunflower seeds and suggested that sunflower seed can be included in commercial layer rations up to 5.6% without affecting performance or egg quality. **Senkoylu *et al*. (2004)** concluded that high oil sunflower meal could be included at 20% to replace full fat soybean. Sunflower meal addition in commercial layer diets did not influence the layers' performance **(Casartelli *et al*., 2006)**. They added that sunflower meal can be used up to 12% in layer diets without impaired performance and egg quality parameters. It was concluded that 10% of high fiber sunflower meal can be used in laying hen diets without adverse effect on performance and egg parameters **(Rezaei and Hafezian, 2007)**. **Rao *et al.* (2009)** found that soybean meal could be replaced completely with sunflower meal as the principal protein source in layer chick diet (1 to 28 d of age).

However, in broiler chickens, **Furlan *et al*. (2001)** found that soybean meal could be replaced by sunflower up to a level of 30% in diets with equal energy and amino acid

(digestible methionine + cysteine and lysine) ratios. Similar results were found by **Pinheiro *et al.* (2002),** who added 0%, 4%, 8%, or 12% of sunflower meal in broiler chicken diets and didn't observe changes in weight gain and feed intake from 3 to 42 days of age. Sunflower meal significantly reduced feed intake in the starter phase and total period, weight gain was not different in these phases **(Tavernari *et al*., 2008).** Feed: gain ratio was improved by adding sunflower meal to broiler diets in all feeding phases. Replacement of ground nut meal with decorticated sunflower meal at 50 and 100% had insignificant effect (P>0.05) on body weight gain, feed consumption and feed efficiency of broiler chicks during starter and finisher periods **(Talha and Yagoub, 2008)**. They concluded that decorticated sunflower cake can replace up to 100% of groundnut meal in broiler chicks starter and finisher diets.

The general objective of this experiment was to study the effect of partial and complete substitution of sunflower meal (**SFM**) for groundnut meal (**GNM**) in commercial layers ration. The specific objectives were to study the effect on the performance of layers in terms of feed intake, total egg production, egg mass, feed conversion ratio and laying %. Also to study some egg's traits, (egg weight, yolk and albumin weight and shell weight, shell thickness and egg specific gravity).

MATERIALS AND METHODS

The experimental site and birds

This experiment was carried out on July at Elbashair farm south Medani town in Gazera Sudan. The prevailing temperature was ranging from 27°C to 33°C at night and from 34°C to 44°C at day time. A total number of 90 commercial layers (Lohman strain) at 23 week of age were distributed randomly into 9 groups of 10 hens based on hen's average weight. These groups were then assigned according to the completely randomized design (CRC) into three treatments with three replicates each.

The experimental diets

The experimental diets were formulated according to the nutrient requirements of the commercial layers as outlined by the **(National Research Council**, **1994)**. The experimental diets formulation and chemical analysis are shown in Table 2. All hens were fed on a ration that was formulated on basis of sunflower inclusion to replace groundnut meal on *ad-libtum* feeding system during the whole experimental period which was extended for seven weeks.

These treatments included the following:-

i. **SFM 0%:** The control groups, where the hens were fed on diets containing 100% groundnut meal during the whole experimental period and without sunflower inclusion.

i. **SFM 50%:** The hens were fed o*n* a layer ration where sunflower substitutes 50% of groundnut meal inclusion.

ii. **SFM 100%:** The hens were fed on a layer ration where sunflower substitutes 100% of groundnut meal inclusion.

Data collection and statistical analysis

Data collected included the following:

1. Feed intake was recorded daily at 8:00 am, weekly feed intake was calculated by adding the feed consumed during that week. Cumulative feed intake was calculated for the feed consumed during the experimental period.

2. Live body weight was taken weekly; weekly body weight gain was calculated and the total body weight gain was calculated by subtracting the initial body weight from the final body weight.

3. Eggs were collected three times a day and weekly calculated. The total eggs number, egg mass and laying percentage were calculated at the end of the experimental period.

4. Feed conversion ratio was calculated weekly by dividing the weekly feed intake by the weekly eggs mass. Cumulative feed conversion ratio was calculated by dividing the total feed intake by total eggs mass.
5. Average eggs weights were measured weekly and samples of average weights were used for further measurements of albumin, yolk and shell weight. The shell thickness was measured and the specific gravity was calculated as well.
6. An economical visibility study was done to evaluate using sunflower meal as a substitute to groundnut meal in layers feeding.

Statistical analysis

Data were analyzed statistically by using MSTAT (**Russel, and Eisensmith, 1983)**. Differences among treatment means were compared using Duncan's multiple range tests as designed by **Steel and Torrie, (1980).**

RESULTS AND DISCUSSION

Layers Performance

The chemical composition of decorticated sunflower seed meal as shown in Table (1) revealed that it contains the same CP % (30.71 versus 30.62%) but higher EE % (13.2 versus 11.52%) compared to that of **Mahmoud *et al.* (1993)**. Variations in the chemical composition of sunflower meal might be attributed to location, micro and macro environmental factors or to the different processing methods which determine the composition of this ingredient used as feedstuff. Effect of feeding different levels of sunflower meal on commercial layers performance are shown in Table (3). Results obtained showed different responses of layers to ration with different inclusion of sunflower seed meal (Table 3). The total feed intake/hen during the whole experimental period was significantly ($P \leq 0.05$) affected by sunflower meal inclusion. The hens fed on rations with 13% sunflower meals (50% substitution to groundnut meal), consumed significantly ($P \leq 0.05$) the highest amount of feed. This high feed consumption could be attributed to the palatability of sunflower meals, which is positively converted to high production traits (Table 3). However, the hens fed on 26% sunflower meals (100% substitution to groundnut meals), consumed the least amount of feed. This is because they consumed little amounts of feed during the first three weeks, although during the last two weeks they consumed the highest amount of feed. The control group of hens fed on rations with 0% sunflower meal consumed the mildest amount of feed. The **SFM 50%** group of birds recorded significantly ($P \leq 0.05$) the highest average body weight gain / hen during the whole experimental period.

However, there were insignificant ($P > 0.05$) differences between the **SFM 100%** and the **SFM 0%** groups of birds on average body weight gain. These results are on accord with **Vieira *et al.* (1992)**, **Aslam Mirza and Sial (1992)** and **Serman *et al.* (1997)**. Research work done on broilers (**Ibrahim and Elzubeir, 1991; Elzubeir, 1992; Musharaf, 1992; Senkoylu and Dale, 1999; Tavernari *et al.*, 2008 and Rao *et al.*, 2009**) can by far support our findings in that sunflower meal can be used in layers ration and that layers will benefit more from sunflower meal inclusion in their diets.

The total number of eggs/ hen, the weight of the total eggs /hen (g) and the laying percentages, which are considered as production and economical traits, were significantly ($P \leq 0.05$) affected by SFM inclusion in the diet. The **SFM 50%** group of hens had significantly ($P \leq 0.05$) the highest laying percentage which was proven by the highest number of eggs and consequently the highest egg mass. This might be attributed to variation of amino acids in the two meals, and that they compensate each other. These results confirm that sunflower meal can substitute groundnut meal in layers ration without altering the laying hens' performance (**Karunajeewa et *al.*, 1989; Vieira *et al.*,**

1992; Aslam Mirza and Sial, 1992; Senkoylu and Dale, 1999; Casartelli *et al.*, 2006 and Talha and Yagoub 2008). However, these authors found that sunflower could completely substitute soya bean meal which is more nutritionally rich and valuable compared to groundnut meal. These findings support our suggestion in substituting groundnut meal by sunflower meal.

Egg Physical Traits

The egg physical traits were measured in terms of egg weight, albumin weight, yolk weight, shell weight, shell thickness and egg specific gravity (Table 4). The **SFM 100%** group of hens had significantly ($P \leq 0.05$) the highest egg weight and yolk weight. However, there were insignificant ($P > 0.05$) differences in albumin and shell weights, shell thickness and egg specific gravity. These findings coincide with that of previous authors (**Karunajeewa *et al.*, 1989; Vieira *et al.*, 1992; Aslam Mirza and Sial, 1992; Mahmoud *et al.*, 1993; Senkoylu and Dale, 1999 and Casartelli *et al.*, 2006**). The results of the present study support the suggestion of **Casartelli *et al.*, (2006)** in that layers appear to tolerate the higher levels of SFM, despite its higher crude fibre content, with no decrease in performance or egg quality parameters, which can be explained by the fact that layers have more developed digestive system in terms of gut capacity as compared to broilers.

Economical Study

An economical study was done to evaluate the net profit of substituting groundnut meal with sunflower meal (Table 5). However, there is a positive marginal profit in substituting groundnut meal with sunflower meal, where the **SFM 50%** group of hens had the highest profit.

CONCLUTION

It can be concluded that sunflower meal can be used as an alternative protein source ingredient up to 26 % in layers diets and can replace 100 % of groundnut meal without hazard effects. Substitution of 50% groundnut meal or inclusion of 13% sunflower meal in layers diets resulted in the best performance of layers in terms of feed intake, body weight gain, egg number, egg mass, feed conversion ratio, laying, adding to that the highest profit. Substitution of whole groundnut meal by sunflower meal resulted in the heaviest egg weight and yolk weight. More research work can be adopted to study sunflower application with added lysine.

Table (1): Chemical composition of sunflower seeds meal in the Gezira State (Sudan)

Nutrient	Percentage
Dry matter	**93.8**
Crude protein	**30.71**
Ether extract	**13.2**
Crude fibre	**13.00**
Nitrogen free extract	**29.75**
Ash	**7.14**
Metabolisable energy ME kcal/kg*	**2622**

* Metabolisable energy (ME M cal/kg) was calculated according to the formula derived by Lodhi *et al.* (1976). ME= 1.549 + 0.0102 CP + 0.0275 oil + 0.0148 NFE – 0.0034 fibre

Table (2): Ingredients and chemical composition of commercial layer diets supplemented with different levels of sunflower meal

Ingredient %	Experimental diets		
	0 % SFM	50 % SFM	100 %SFM
Sorghum (Feterita)	56.0	53.0	50.0
Groundnut meal	16.6	8.3	0.0
Sunflower meal	0.0	13.0	26.0
Wheat bran	11.0	10.0	9.0
Super Concentrate *	5.0	5.0	5.0
Oyster Shell	8.3	8.3	8.3
Fat	2.5	1.8	1.1
Common salt (NaCl)	0.4	0.4	0.4
Vitamins and Minerals	0.2	0.2	0.2
Total	100.0	100.0	100.0
Calculated Chemical composition			
Dry matter (DM) %	93.2	93.2	93.5
Crude protein (CP) %	18.1	18.1	18.1
Ether extract (EE) %	6.0	6.0	6.0
Crude fibre (CF) %	5.0	5.4	6.0
Nitrogen free extract%	51.3	50.9	50.5
Ash	12.8	12.8	12.9
Calcium (Ca) %	3.5	3.5	3.5
Phosphorus available (Pav.) %	0.49	0.50	0.50
Metabolisable energy (ME) kcal/kg**	2640	2633	2625

* Super concentrate contains the following: 35% CP, 2% EE, 4% CF, 10% calcium, 4.5% available phosphorus, 5.7% lysine, 4.5% methionine and 4.9% methionine + cystine. Metabolisable energy 2000 kcal/kg, 2.6% Sodium with added vitamins and minerals.

** Metabolisable energy (ME M cal/kg) was calculated according to the formula derived by Lodhi *et al.* (1976). ME= 1.549 + 0.0102 CP + 0.0275 oil + 0.0148 NFE – 0.0034 fibre

0 %SFM **:** No substitution of groundnut meal by sunflower meal

50 %SFM **:** 50% of groundnut meal was substituted by sunflower meal

100 %SFM**:** 100% of groundnut meal was substituted by sunflower meal

Table (3): Effect of feeding different levels of sunflower meal on performance of commercial layers

Traits	Treatments			S.E.±	C.V.%	P
	0 % SFM	50 %SFM	100%SFM			
Total feed intake/hen (g)	4440 ab	4527 a	4333 b	36.5	1.83	*
Average body weight gain/hen (g)	70 b	90a	70 b	3.6	6.12	**
Total eggs number/hen	40 b	44 a	43 ab	0.52	1.37	**
Total eggs mass/hen (g)	2040 c	2265 a	2205 b	29.0	1.35	**
Average feed conversion ratio	2.20 a	1.99 b	1.97 b	0.03	0.27	***
Average laying %	81.6 b	90.0 a	87.7 ab	1.62	4.21	*

*,**,***and NS indicate significance at P≤0.05, P≤0.01, P≤0.001 and not significant, respectively. Means within each row followed by the different letters are significantly (P≤0.05) different according to Duncan's Multiple Range Test (1980).

0 %SFM **:** No substitution of groundnut meal by sunflower meal

50 %SFM**:** 50% of groundnut meal was substituted by sunflower meal

100 %SFM**:** 100% of groundnut meal was substituted by sunflower meal

Table (4): Effect of feeding different levels of Sunflower meal on some egg's traits

Traits	Treatments			S.E.±	C.V.%	P
	0 % SFM	50 % SFM	100 %SFM			
Average egg weight (g)	51.03 b	51.30 a	51.57 a	0.07	0.22	*
Average albumin weight/egg (g)	31.10	31.07	31.30	0.06	0.53	NS
Average yolk weight /egg (g)	14.04 c	14.14 b	14.21 a	0.03	0.29	**
Average shell weight /egg (g)	5.32	5.33	5.35	0.01	0.50	NS
Average shell thickness (µm)	0.40	0. 40	0.42	0.01	1.42	NS
Average egg specific gravity	1.073	1.075	1.077	0.002	0.05	NS

*,**and NS indicate significance at P≤0.05, P≤0.01and not significant, respectively.
Means within each row followed by the different letters are significantly (P≤0.05) different according to Duncan's Multiple Range Test (1980).
0 %SFM **:** No substitution of groundnut meal by sunflower meal
50 %SFM **:** 50% of groundnut meal was substituted by sunflower meal
100 %SFM**:** 100% of groundnut meal was substituted by sunflower meal

Table (5): Effect of feeding different levels of sunflower meal on net profit of commercial layers

Description	Treatments		
	0 % SFM	50 % SFM	100 %SFM
Total feed intake (kg)	133.2	135.8	130.0
Feed cost/kg (S.P.)	1.5	1.5	1.5
Total feed cost	200.0	204.0	195.0
Miscellaneous	100.0	100.0	100.0
Total cost	300.0	304.0	295.0
Total eggs number (Dozen)	100.0	110.0	107.5
Sale price/dozen egg (S.P.)	5.0	5.0	5.0
Total sale price (S.P.)	500.0	550.0	537.5
Net profit (S.P.)	200.0	246.0	242.5

S.P. : Sudanese Pound
0 %SFM **:** No substitution of groundnut meal by sunflower meal
50 %SFM **:** 50% of groundnut meal was substituted by sunflower meal
100 %SFM**:** 100% of groundnut meal was substituted by sunflower meal

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الملخص العربي

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صُممت تجربة لدراسة تأثير إستبدال أمباز الفول السوداني بأمباز زهرة الشمس في علائق الدجاج البياض. تم إستبدال أمباز الفول السوداني بأمباز زهرة الشمس بثلاث نسب (0% أمباز زهرة الشمس، 50% أمباز زهرة الشمس و 100% أمباز زهرة الشمس) من مصدر البروتين النباتي في العليقة. تم إستخدام 90 دجاجة بيض من سلالة الهوايت لق هورن التجاري (العترة *Lohman*)عمر 24 أسبوع ووُزعت عشوائيا علي ثلاث معاملات بثلاث تكرارات. تم تكوين عليقة دجاج بياض متماثلة البروتين و الطاقة وتحتوي علي ثلاث مستويات من أمباز زهرة الشمس 0%، 13% و26%. تم رصد المعلومات الآتية:

١. العلف المتناول يومياً، أسبوعياً وخلال الفترة الكاملة للتجربة

٢. جمع البيض ثلاث مرات في اليوم و خلال فترة التجربة

٣. وزن البيض المنتج في اليوم و خلال فترة التجربة.

٤. حساب متوسط وزن البيضة، وزن صفار البيض، بياض البيض و قشرة البيض و سمك قشرة البيض .

٥. تم حساب الكفاءة التحويلية ونسبة الإنتاج خلال فترة التجربة. وكذلك تم حساب الكثافة النوعية للبيض.

٦. تمت دراسة الجدوي الإقتصادية لإستبدال أمباز الفول السوداني بأمباز زهرة الشمس

أشارت النتائج للآتي:

١. إستبدال أمباز الفول السوداني بأمباز زهرة الشمس أظهر فروقات معنوية إيجابية في كلٍ من كمية العلف المتناول، زيادة في متوسط وزن الدجاجة، عدد البيض، الكفاءة التحويلية ونسبة الإنتاج حيث سجلت الجموعة 50% أمباز زهرة الشمس أفضل النتائج.

٢. كذلك أظهرت النتائج فروقات معنوبة إيجابية في وزن البيضة ووزن صفار البيض حيث سجلت المجموعة 100% أمباز زهرة الشمس أفضل النتائج.

٣. لم تظهر النتائج فروقات معنوعية في وزن بياض البيض، وزن قشرة البيض، سمك قشرة البيض والكثافة النوعية للبيض.

٤. أظهرت النتائج زيادة هامش الأرباح بإستخدام 50% أمباز زهرة الشمس و 50% أمباز الفول السوداني.