# A Study of Some Wool Traits of Barki Sheep Fed on *Nigella sativa* Cake under Desert Conditions

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## ABSTRACT

This study was conducted at Maryout Research Station, Desert Research Center (33 km south west of Alexandia), to investigate the effect of feeding *Nigella sativa* cake (NSC) as a protein source on wool production and characteristics of the growing male Barki lambs under the semi-arid conditions.

Twenty one growing male Barki lambs (3 months) weighing 22.90 kg were used in this study, from weaning up to sexual maturity (300 days). Animals were randomly distributed to three equal groups with seven lambs each. The first group was fed on concentrate feed mixture (CFM) containing 35% undecorated cotton seed meal (CSM) and served as a control group. The second (G2) and third (G3) groups were fed on the same concentrate mixture in which the protein source was partially replaced by 5 and 10 % of NSC, respectively.

The results revealed that using *Nigella sativa* cake as an alternative protein source at levels of 5% (G2) and 10% (G3) significantly improved final body weight, daily gain, greasy fleece weight and clean wool yield. It also improved ($P<0.01$) wool traits that including staple length, staple strength, point of staple break and staple elongation rate. Wool bulk and resilience were also improved by the two levels of NSC as both traits are considered as indicators for wool quality affecting carpet manufacture.

Keywords: **Nigella sativa cake, wool growth, fiber diameter, staple length, staple strength, bulk, resilience.**

## INTRODUCTION

The North West coast of Egypt is a semi-arid desert area that suffers of drought across the year except a few amounts of rain falls during winter season. This situation besides the highly degraded natural ranges in this area is the major constrains affecting animal productivity due to the insufficient feed resources. Therefore, one of the suggested solutions to solve this problem is the usage of agriculture byproducts.

*Nigella sativa* is a member of *Ranunculaceae* family and native to some regions of the Mediterranean basin. The plant is cultivated all over tropical regions of the world (Saganuwan, 2009).

*Nigella sativa* cake could be used to promote growth performance, improve feed conversion and reduce feed costs; hence increased economic efficiency (Abdel-Magid *et al*., 2007).

*Nigella sativa* seeds (Mandour, *et al*., 1995) or cake (Kalifah, 1995 and Zeweil, 1996) have been used as feed additive in poultry and in growing New Zealand White rabbits rations (Taha, 1997). Nutritive value of *Nigella sativa* cake was also evaluated in diets of many types of animals (Atwa, 1997).

In the present study, the effect of *Nigella sativa* cake supplementation as alternative source of protein on wool production and characteristics of Barki lambs under semi arid conditions were evaluated.

## MATERIALS AND METHODS

This study was carried out at Maryout Research Station; 33 km southwest of Alexandria, Desert Research Center, Agriculture and Land Reclamation Ministry, Egypt. Twenty one growing male Barki lambs with an initial live body weight averaged 22.90± 0.446 kg and aged 3 months old were used. The experiment lasted up to sexual maturity (300 days). Animals were randomly distributed to three equal experimental groups with7 lambs each.

The control group (G1) fed a ration containing 35% undecorticated cotton seed meal, 33% wheat bran, 22% yellow corn grain, 4% rice bran, 3% molasses, 2% limestone and 1% salt. In the other two groups, cotton seed cake (CSC) was partially replaced by *Nigella sativa* cake (NSC) at 5% and 10% in (G2) and (G3). Animals in all groups were given barseem hay as sole roughage. The rations were given according to Kearl (1982).

Lambs were housed in open- sheds with free access to mineral blocks. They were weighed at the beginning of the experiment and at biweekly interval thereafter. The total ration was adjusted every two weeks according to body weight changes. Drinking clean fresh water was available twice daily over the experimental period.

At the end of the experiment wool cotting and kemp score were evaluated; wool samples (10 x 10 cm) were collected adjacent to the skin from the right med-side of each animal by sharp fine scissors, then lambs were sheared and the greasy fleeces were weighed. The clean scoured yield was calculated according to the method of Chapman (1960).

Cotting level: four grades 0, 1, 2 and 3 representing no, low, medium and high cotting, respectively.

Kemp score: a scale of four grades based on eye estimate of the density of kemp fibers on the animal coat where zero "no kemp'', 1 "few", 2 "medium" and 3 "high" kemp content.

Fiber diameter: A section of 1 mm of each sample at a level of 2 cm from the base was cut and snippets were mounted in liquid paraffin oil and spread on a slide and covered. Relative humidity (RH%) and ambient temperature (ºC) were recorded and corrections were made (Anderson, 1955) to get the figures at the standard conditions (65% RH and 20 ºC). Not less than 500 snippets were measured using computerized image analyzer (LEICA Q500).

Medullation Index: (MI) was calculated for each sample according to the equation of Pilkington and Purser (1958) and adopted by Guirgis (1973).

$$MI = \frac{1}{10}\sum_{i=1}^{4} Pi$$

*Where i= 1, 2, 3 and 4 are scores for fine, coarse, hetrotype and kemp, respectively. Pi is the percentage of the $i^{th}$ class.*

Crimps: Crimp frequency per cm was counted along the fiber against millimeter ruler.

Bulk and resilience: wool sub samples of 10 grams of scoured and hand carded wool samples were used to estimate loose wool bulk and resilience by WRONZ loose wool bulkometer (Bedford *et. al.* 1977).

Staple length: Average length of ten staples from each sample was measured using millimeter ruler without stretching from the base of the staple to the base of the formed triangle at the tip of the staple (Booth, 1964).

Staple strength and position of staple break: A number of fifteen staples were taken at random from each greasy fleece, trimmed by cutting its tip and was subjected to the Agritest staple breaker (Agritest Pty. Ltd) to break it into two parts (tip and base). The measurement of the staple strength was calculated for each sample as of Newton/Kilotex (Heuer 1979 and Caffin 1980).

Position of staple break (POB) was assessed by the lengths of the tip and base of each broken staple in the staple strength test according to the following equation (Caffin 1980):

$$POB = \frac{Length\ of\ tip\ (cm)}{Length\ of\ tip\ (cm) + Length\ of\ base\ (cm)}\ x\ 100$$

Elongation rate is defined as the increase in staple length as a percentage of the original staple length before testing (El-Gabbas *at. al.*1999).

$$Elongation\ rate = \frac{Length\ of\ tip\ (cm) + Length\ of\ base\ (cm)}{staple\ Length\ (cm)}\ x\ 100$$

Data were analyzed by using general linear model (PROC GLM) of SAS (2014). The model included the fixed effect of different levels *Nigella sativa* cake supplementation on the studied traits. Differences between means were tested by Duncan Multiple Range test at 5% significance (Steal and Torrie, 1980).

## RESULTS AND DISCUSSION

The chemical composition of the tested rations as presented in Table (1) that demonstrated no considerable differences were found among the tested rations for all nutrient contents. However, slightly higher contents of crude protein and ether extract could be noticed in rations of G2 and G3 due to the replacement of CSM with NSC.

No significant differences among the initial live body weight of the three experimental groups were found (Table 2). On the other hand, animals of G2 and G3 had significantly higher final body weight than the control group (G1). Similarly average daily gain was higher ($P<0.05$) in G2 and G3 than in G1 with no significant difference between G2 and G3 groups (Table 2). The increase in final body weight and average daily gain could be due to the addition of NSC to the rations.

**Table 1: Chemical composition of experimental rations (on %, DM basis)**

| Experimental rations: | DM | OM | CP | CF | EE | NFE |
|---|---|---|---|---|---|---|
| Ration (1) | 90.4 | 90.7 | 15.4 | 12.7 | 3.2 | 59.4 |
| Ration (2) | 90.4 | 90.5 | 15.7 | 11.9 | 3.6 | 59.2 |
| Ration (3) | 90.4 | 90.3 | 16.1 | 11.1 | 4.0 | 59.1 |

DM: dry matter, OM: organic matter, CP: crude protein CF: crude fiber, EE: ether extract and NFE: nitrogen free extract

**Table 2: Least squares means and standard errors of initial body weight, final body weight and daily gain of male Barki lambs fed different levels of *Nigella sativa* cake.**

| Trait | G1 (0) | G2 (5%) | G3 (10%) |
|---|---|---|---|
| Initial body weight (kg) | 22.71±0.773 | 23.00±0.773 | 23.00±0.773 |
| Final body weight (kg) | 38.35±0.841 $^{c}$ | 42.64±0.841 $^{b}$ | 46.22±0.841 $^{a}$ |
| Daily gain (gm) | 52.13±2.037 $^{b}$ | 65.46±2.037 $^{a}$ | 77.40±2.037 $^{a}$ |

Least square means with different superscripts in the same row differ significantly.

In coincidence, the observed improvement in the daily body weight gain in sheep fed on rations containing NSC was previously reported by other investigators (El-Gendy et al., 2001; Abdel- Ghani 2003 and Ali 2003). Also, Youssef (2008) reported that feeding NSC increased both total body weight gain and the average daily gain of lambs.

Greasy fleece weight and clean yield increased in G2 and G3 ($P<0.01$) as compared with that of G1 (Table 3). The increase in Greasy fleece weight, and clean yield could be attributed to the inclusion of NSC in the ration. Although most of the factors that affecting wool growth are considered to be genetically determined, nutrition is the major environmental influence that affect the rate of cell division in the wool follicle bulb (Black and Reis, 1979). According to Tekeli (2014), *Nigella sativa* cake contains 298.4 g/kg crude protein; it can be an important protein source for animals with its proper amino acid content as it was found to contain a total of 23 amino acids (10 of which are essential) with a total value of 202g/kg. Additionally, it is a considerable rich source of the sulfur amino acid methionine (5.49 g/kg). Therefore, it is considered as a good protein source for animals with its proper amino acid content.

Reis (1989) reported that methionine plays is a vital component for wool growth besides being a source of cysteine (another limiting amino acid for wool protein synthesis) as methionine cannot be effectively replaced by cysteine by abomasal infusion. Reis and Sahlu (1994) stated that the major nutritional limitation to wool growth is the amount and composition of amino acids available to wool follicles where the supply of sulfur containing amino acids (cyst(e)ine and methionine) often limits wool growth. Stephenson *et al.,* (1991) found that methionine tended to increase wool productivity. Helal, (2004) reported that infusion of methionine tended to increase wool production by 20% compared with control animals. Ramadan *et. al.* (2017) reported a significantly higher clean wool production in Barki ewes due to the supplementation with methionine.

Al-Saadi *et. al.,* (2012) reported a higher greasy wool weight and clean wool weight in Awassi lambs fed on ration containing 7.5% of ground *Nigella sativa* seeds compared with the corresponding value of the control group that fed on ration free of ground *Nigella sativa* seeds.

Cotting did not differ among the experimental groups (Table 3). According to Ryder (1984), cotting in coarse wool fleeces were associated with the presence of short, loose and broken fibers in wool fleeces. During processing, cotted fleeces need extra opening process that increases breakage of fibers and increase processing costs hence; they decrease the commercial value of the fleeces. Guirgis *et. al.* (2001) reported that higher levels of cotting were associated with low values of S/P ratio, fiber diameter and medullation thickness. Moreover, no effect of NSC replacements was observed on kemp score (Table 3) and the estimated values of the experimental groups were low, averaging 1.47, 1.44 and 1.52 in the three groups, respectively.

Average fiber diameter increased ($p<0.01$) gradually by increasing NSC percentage in the experimental rations, accounting for 33.218, 34.943 and 36.744 µm in G1, G2 and G3, respectively (Table 4). This increment of fiber diameter may be due to the effect of methionine content of NSC (G2 and G3 rations).

**Table 3: Least squares means and standard errors of greasy fleece weight (GFW), clean yield, cotting level and kemp score of male Barki lambs fed different levels of *Nigella sativa* cake**.

| Trait | G1 (0) | G2 (5%) | G3 (10%) |
|---|---|---|---|
| GFW (kg) | $2.182 \pm 0.130^{b}$ | $2.520 \pm 0.130^{a}$ | $2.668 \pm 0.130^{a}$ |
| Clean Yield (%) | $51.38 \pm 6.989^{b}$ | $54.54 \pm 6.989^{a}$ | $55.22 \pm 6.989^{a}$ |
| Cotting level | $1.14 \pm 0.088^{a}$ | $1.22 \pm 0.088^{a}$ | $1.17 \pm 0.088^{a}$ |
| Kemp Score | $1.47 \pm 0.327$ | $1.44 \pm 0.327$ | $1.52 \pm 0.327$ |

Least square means with different superscripts in the same row differ significantly.

**Table 4: Least squares means and standard errors of average fiber diameter (AFD), medullation index (MI), prickle factor (PF) and crimps frequency, wool bulk and resilience of male Barki lambs fed different levels of *Nigella sativa* cake.**

| Trait | G1 (0) | G2 (5%) | G3 (10%) |
|---|---|---|---|
| AFD (µm) | $33.21 \pm 0.239^{c}$ | $34.94 \pm 0.239^{b}$ | $36.74 \pm 0.239^{a}$ |
| MI | $19.79 \pm 0.612^{b}$ | $21.88 \pm 0.612^{a}$ | $21.91 \pm 0.612^{a}$ |
| PF (%) | $41.30 \pm 1.306^{b}$ | $47.87 \pm 1.306^{a}$ | $48.09 \pm 1.306^{a}$ |
| Crimps/ cm | $2.96 \pm 0.083^{a}$ | $1.84 \pm 0.083^{b}$ | $1.53 \pm 0.083^{b}$ |
| Bulk | $31.71 \pm 0.189^{a}$ | $33.32 \pm 0.189^{a}$ | $33.06 \pm 0.189^{a}$ |
| Resilience | $10.54 \pm 0.136^{a}$ | $11.81 \pm 0.136^{a}$ | $11.24 \pm 0.136^{a}$ |

Least square means with different superscripts in the same row differ significantly.

In coincidence, Al-Saadi *et. al.*, (2012) reported a higher ($P<0.05$) fiber diameter in Awassi lambs when they were supplemented with *Nigella sativa* seeds in addition to concentrated diet. They referred the effect of the seeds to its high contents of sulfer amino acids (methionine and cystine) and to the high content of the antioxidant nutrient substrate (vitamin E). Ramadan *et. al.* (2017) revealed that supplementing adult Barki ewes with rumen protected methionine caused a significant ($P<0.05$) increase in fiber diameter. Similarly, Sahlu and Fernandez(1992) reported that infusion of methionine increased fiber diameter. Qi and Lupton (1994) reported that methionin could stimulate fiber growth by supplying cystine through trans-sulfuration and in other ways. Qi (1988) revealed that methionine acts as a chain initiator in protein synthesis besides its role as amino acid transporterand methyl donor(S-adinosylmethionine).

The higher average fiber diameter of G2 and G3 resulted in an increased prickle factor ($p<0.01$) in G2 (47.171%) and G3 (48.895%) compared to G1 (44.302%). Prickle factor is described as a sensation arises from the coarse fibers that cause distortions of the skin (Lamb, 1997). The percentage of fibers greater than 30 micrometers is a useful predictor of prickle response (Naylor, 1992). According to Hansford (1992), prickle factor is highly correlated to average fiber diameter. El-Gabbas (1998) estimated the overall average prickle factor of Barki wool to be 45.1%. Helal (2013) mentioned a significant nutritional induced fluctuation around this average ranging between 37.2 and 46.6%.

In coincidence with the increased fiber diameter, medullation index increased ($p<0.01$) in G2 (21.88) and G3 (21.91) than in G1 (19.79) (Table 4). Medullation index is considered as an easy method to evaluate the content of medullated fibers in the fleece (Taha *et. al.* 2006).

Crimps frequency per centimeter decreased ($p<0.01$) in G2 and G3 in coincidence order with the increased NSC percentages (Table 4). Mortimer (1987) revealed that crimp frequency is moderately heritable and has a negative genetic correlation with fleece weight and fiber diameter. Fiber crimp in raw wool influences the processing and product performance of wool (Rottenbury *et. al.*1994). These decreases might enhance the indications to the nutrition improvement due to the NSC replacements. Campbell *et.al.* (1975) reported an increased crimps frequency of sheep fleeces on restricted nutritional level whereas the cystine and high-sulphur protein contents decrease.

Wool bulk is an important characteristic for the superior performance of many end products (Sumner *et. al.,* 1991). Supplementation with NSC increased ($p<0.01$) the values of loose wool bulk and resilience where their values in G2 and G3 were higher than that of G1 (Table 4). Tellioglu (1983) stated the association of bulk with resilience which is considered the most important property of the carpet wool that affects the durability of the carpet. Earlier studies showed loose wool bulk of ewe hoggets to be unaffected by nutrition (Sumner *et al.*, 1981). This might suggest an indirect effect of the rations on this trait via affecting the single fiber traits such as fiber crimps and average fiber diameter (Stubart and Sumner, 1991).

Staple length (SL) is an important indicator of wool processing performance (Gillespie and Flanders, 2010). The addition of NSC to rations increased ($p<0.01$) staple length of G2 and G3 compared with of G1 (Table 5). Al-Saadi *et. al.*, (2012) revealed that supplementing *Nigella sativa* seeds with concentrated diet of male Awassi lambs caused a significant ( $P< 0.05$ ) increase in staple length. Wool with long staple length are more commercially desirable as they tend to be easier to spin, give fewer stoppages and ultimately can form stronger and more even yarns when compared to shorter SL wools (Wood, 2010). In contrast, high levels of shorter SL wools result in surface fuzzing and piling in apparel fabric surfaces, and fiber loss from woollen carpets (Cottle, 2010). Schinckle (1962) referred changes in staple length to the number of cell divisions in the follicle bulb that is affected by the nutrients substances supplied by the blood vessels within the papilla. Khan *et. al.*(2012) reported that the two factors that functionally affect staple length are the individual fiber length and the number of crimps frequency where the fiber length component is related to growth rate and the duration of the growth period. Hynd (1989) indicated that fiber length may increase more than fiber diameter as wool growth is increased by nutrition manipulation.

There was a marked improvement ($p<0.01$) in staple strength in treated groups G2 and G3 compared with G1 (Table 5). This may be attributed to the higher fiber diameter of the NSC supplemented groups. Thompson (1998) and Thompson and Hynd (2009) established that an increase of 1 μm in minimum fiber diameter was associated with an increase in staple strength of about (5 N/ktex). Staple strength is a measure of the strength of fibers in a staple. According to Hansford and Kennedy (1988), finer fiber diameter was found to be associated with wool tenderness. Ramadan *et. al.* (2017) reported a significant increase in staple strength by adding methionine or lysine and methionine. Likewise, Bray *et. al.* (1993) stated that intra-peritoneal injection of methionine increased staple strength significantly.

Another improvement due to the treatment was noticed in the staple elongation rate (Table 5).

**Table 5: Least squares means and standard errors of staple length (SL), staple strength (SS), staple elongation rate (ELR) and point of the staple break (P.O.B) of male Barki lambs fed different levels of *Nigella sativa* cake.**

| Trait | G1 (0) | G2 (5%) | G3 (10%) |
|---|---|---|---|
| SL (cm) | 5.550 ± 0.130 [b] | 6.450 ± 0.130 [a] | 6.678 ± 0.130 [a] |
| SS (N/ktex) | 43.920 ± 3.264 [b] | 51.739 ± 3.264 [a] | 50.667 ± 3.264 [a] |
| ELR (%) | 39.120 ± 3.116 [a] | 45.581 ± 3.116 [a] | 46.173 ± 3.116 [a] |
| P.O.B (%) | 52.180 ± 2.256 [a] | 43.826 ± 2.256 [b] | 43.423 ± 2.256 [b] |

Least square means with different superscripts in the same row differ significantly.

It was higher ($P<0.01$) in groups supplemented with NSC (G2 and G3) than the control group (G1). The elongation rate is of importance to wool processing as it imply the elasticity of wool and expresses its ability to stretch without breaking (El-Gabbas *et. al* 1999). In addition, the point of staple break was positively affected by NSC replacements where G2 and G3 recorded lower ($P<0.01$) values than G1 (Table 5). The point of staple break occurred at 52.180, 43.826 and 43.423% of the tested staples lengths. The point of staple break is referred to the distance from the top at which the staple will break during processing. It is very useful indicator to the wool processing performance (Cottle, 2010). If this point is very near to the staple center, it is expected to produce two parts of short length that are not suitable for processing especially if the staple length was relatively short (El-Gabbas, 1999).

The present results were in agreement with those reported by Al-Saadi *et. al*. (2012). They found that feeding Awassi male lambs on 7.5% of *Nigella sativa* ground seeds as a mixed feed additive with concentrated diet resulted in a significant improvements in greasy and clean wool weight, fiber length, staple length and fiber diameter compared with the control group. They attributed the improvement in these traits to the improved metabolic condition as a result of *Nigella sativa* seeds which contain high ratio of protein with sulfur amino acids (methionin and cystine), also volatile fatty acids and vitamin E as anti- oxidant substance, which improved the health status of animals and enhanced the blood supply to the skin causing an increase in the activity and efficiency of wool follicles.

## CONCLUSION

Using *Nigella sativa* cake as an alternative protein source at levels of 5% and 10% improved Barki lambs' final body weight, daily body weight gain, greasy fleece weight and clean wool yield. Another improvement was observed in wool traits that involving processing operation as staple length, staple strength, point of staple break and staple elongation rate. Wool bulk and resilience were also improved by the two levels of replacement as indicator to gain wool of better quality to carpet manufacture. The present results may recommend that using *Nigella sativa* cake with levels of 5 and 10% as protein source to the growing lambs especially under poor ranges and limited feed resources conditions to maintain and improve the growth performance and wool production and characteristics of the growing lambs.

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## الملخص العربي

# دراسة لبعض صفات صوف الأغنام البرقي المغذاة على كسب حبة البركة تحت الظروف الصحراوية

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أجريت هذه الدراسة في محطة بحوث مريوط، مركز بحوث الصحراء (٣٣ كم جنوب غرب الإسكندرية)، لدراسة تأثير تغذية كسب حبة البركة كمصدر للبروتين على إنتاج وخصائص الصوف في ذكور حملان الأغنام البرقي النامية تحت الظروف الصحراوية الشبه قاحلة.

تم استخدام واحد وعشرين من ذكور الحملان البرقي ذات متوسط وزن جسم ٢٢,٩٠ كجم وعمر ٣ أشهر واستمرت الدراسة من الفطام حتى النضج الجنسي. وزعت الحيوانات عشوائيا إلى ثلاث مجموعات تجريبية متساوية العدد (ن = ٧). تم تغذية المجموعة الأولى خليط من العلف المركب يحتوي ٣٥٪ من كسب بذور القطن غير المقشور وعملت كمجموعة كنرول. تم تغيير مصدر البروتين في العلائق التجريبية جزئيا في المجموعتين الثانية و الثالثة حيث تم استبدال كسب بذور القطن غير المقشور جزئيا بكسب حبة البركة بنسب ٥٪ و ١٠٪ في المجموعتين الثانية و الثالثة على التوالي.

اظهرت نتائج الدراسة الحالية ان استخدام كسب حبة البركة كمصدر بديل للبروتين بمستويات ٥٪ و١٠٪ أدى لتحسن معنوي لوزن الجسم النهائي للحملان و الزيادة اليومية في وزن الجسم وكذلك في وزن الصوف الخام و وزن الصوف النظيف. كما تحسنت معنويا صفات الصوف التي ترتبط بعمليات التصنيع كطول وقوة الخصلة ونقطة قطع الخصلة ومعدل استطالة الخصلة. كما تحسنت القابلية للانضغاط واستعادة الصوف لحجمه بعد زوال الضغط في المجموعتين المعاملتين كمؤشر لتحسن خواص الصوف المرتبطة بصناعة السجاد.