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ADDITION OF SELENIUM NANOSCALE TO HIGH DIETS WITH WHEAT BRAN AND ITS EFFECT ON MILK PRODUCTION AND COMPOSITION IN AWASSI EWES

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ABSTRACT

The study was conducted to investigate the effect of nano selenium on feed utilization of ration containing a high ratio of wheat bran. Fifteen Awassi ewes were used with an average body weight of 51.58 ± 1.71 kg and age ranged between 3-4 years. The ewes were distributed into three groups, five in each. Through the study that lasted 72 days, ewes were fed with a restricted amount of feed, 1.5 kg of dry matter per day. The first group (control) was fed a diet high in barley grains with an optimal ratio of wheat bran (17%), while ewes in the second and third groups were fed with diets higher in wheat bran (37%) with a dosage 0.3 mg nano-selenium/ewe for ewes in third group. The results indicated that increasing the wheat bran ratio in the ewe diet led to a significant decrease ($P \leq 0.05$) in milk production in the second group 301.71 g/day, as compared to the control 390 g/day. The addition of selenium led to an improve milk production which reached to 455.15 g with a difference of 16.71%, as compared to the control. In general, milk composition of fat, protein, lactose, and solid non-fat were not affected significantly by treatments. However, the somatic cell count was significantly lower in the second period of the study in the second and third groups as compared to the control.

Keywords: Nano Selenium, wheat bran, Awassi ewes, milk.

INTRODUCTION

Milk composition and body weight of ewes are usually affected by nutrition and additives to the diet (Saadi and Hasan 2019; Mustafa *et al.,* 2023; Saadi *et al.,* 2024). To achieve the goal of animal rearing which is represented by the economic return from milk yielded after weaning lambs or solding animals, feeding costs should be lowered because it equals about two-thirds of breeding. Cheap alternative feeds are a good choice for the breeders. Spelled wheat bran produced from grain processing is an essential component in the diet of animals and one of the most exploited feed alternatives in this area. The percentage of its use in diets may reach 50%, because its cost is about 60-70% of the grains. Wheat bran contains a good percentage of protein up to 17%, high in fiber, as its content of neutral detergent fiber (NDF) is 42.5% and acid detergent fiber (ADF) is 15.5% (National Research Council, 2007). The benefit of high-fiber materials in the diets is improved milk fat in the ewes due to the increase in the production of acetate in the rumen (Adesogan *et al.,* 2019). But in fact, these desired benefits of using wheat bran

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are not achieved for several reasons, related to the nature of the wheat bran contents from some active compounds (Satinder Kaur *et al.,* 2011). Wheat bran contains anti-nutrients such as glutens, β-glucans and phenols, and that high concentrations can reduce the digestion and absorption of protein and starch in the gut (Hesselman and Åman, 1986). Although bacteria, protozoa and fungi in the rumen play a major role in removing these substances that reduce feed utilization (Wang and McAllister, 2002), the deterioration or negative impact on production continues (Abdullah *et al.,* 2019). This problem is not related to a specific feed material, but it is a general problem in animal nutrition. For treating this nutrition problem, enzymes were added to the feed to improve digestion, absorption and support more nutrients for production (Liang *et al.,* 2022). On the other hand, for the purpose of enhancing the efficiency of the use of feed materials containing high fiber content, there is a need to provide a suitable environment for microorganisms in the rumen to work effectively and increase the produced microbial protein (Ban and Guan, 2021). This is usually done through the use of classic additives such as buffers and yeast that activate microorganisms in the rumen (Soltan and Patra, 2021). It has been noted through previous studies that selenium has an important role in improving rumen fermentations, microbial activity and digestion (Shi *et al.,* 2011; Xun *et al.,* 2012). Also, it was shown that pregnant animals are susceptible to diseases as a result of low immunity due to metabolic stress, and milk gland is often the most vulnerable part of the body to infections (Tüfekci and Sejian, 2023), which leads to a decrease or cessation of the animal production. These problems can be treated or avoided by supporting the animal's diet with nano selenium, which leads to improving the animal's immunity and maintain the integrity of the milk gland and the quality of the milk produced due to the transfer of selenium to milk, which is an important factor to promote the health of newborns that get milk or even the health of humans consuming milk (Novoselec *et al.,* 2018). According to the data mentioned above, this study was designed to investigate the effect of supplementation of Awassi ewes with nano selenium, along with a diet high in wheat bran, on milk yield and composition.

MATERIALS AND METHODS

This study was conducted in the animal field at the Department of Animal Production / College of Agriculture and Forestry / University of Mosul. Fifteen Awassi ewes were used with an average initial weight of 51.58 ± 1.71 kg and their ages ranged between 3-4 years. At the beginning, ewes' weight was recorded and milk yield was determined for two sequence days, then according to that ewes were distributed into three homogenized groups, five ewes in each group. Ewes were fed gradually for 10 days as an adaptation period, and through study period which lasted 72 days feed intake was restricted to 1.5 kg dry matter concentrate feed per ewe in each group and the roughage feed (wheat straw) was offered by quantity 0.5 kg/ewe/day. the first group (control) was fed on a diet containing high barley grains and a suitable proportion of wheat bran (17%) (National Research Council, 2007). The second and third groups ewes were fed a diet that contained less barley and higher percent of wheat bran (37%). In addition, ewes in the third group was supplemented daily with 0.3 mg/ewe of nano-selenium (purity of 99.9% and a size of less than 80 nm and manufactured by (NANOSHEL LLC Wilmington DE- 19808 United States). The quantity of nano selenium was dissolved with 5 ml distilled water then was adminstered after the morning meal. Concentrate and roughage feed was provided twice daily, the first meal at 08:00 am and the second at 04:00 pm. Also, fresh water and mineral salt were offered continuously for the animals. In addition, all ewes were grazed daily for 3 hr. in alfalafa artificial pasture near the animal pens. For measuring milk production, lambs were isolated for 12 hr, then ewes were milked in the morning, weighed using an electronic scale. A sample of milk was transferred in a 50 ml plastic container directly to the laboratory. The amount of milk was multiplied by (×2) to calculate the produced milk within 24 hours. Fresh milk samples were analyzed directly to determine their protein, fat, non-fat solids and lactose using the (Milk Scan Lacto device). Somatic cells were determined using (Mini Milk Analyzer-Somatos) system.

Table 1: Components and chemical composition of the concentrated feed.

Feedstuffs	Control Group	Wheat bran groups	
		- Selenium Nanoparticles	**+Selenium Nanoparticles**
Crushed barley	68.75	50	50
Wheat bran	17	37	37
Soybean meal	11	10	10
Urea	0.75	0.5	0.5
salt	1	1	1
Limestone	1	1	1
Sodium bicarbonate	0.5	0.5	0.5
Chemical analysis based on dry matter%			
Dry matter	90.98	91.12	
Ash	5.75	6.05	
crud protein	16.01	16.40	
crud fiber	7.20	7.89	
Ethar extract	1.54	1.75	
Nitrogen free extract	54.36	52.24	
Metabolic energy Mj/ kg	10.35	10.15	

Chemical analysis of the components of the concentrated feed according to (AOAC, 2000), the energy value of the concentrate feed was calculated according to (MAFF 1975).

Statistical Analysis

The data were statistically analyzed by computer using complete randome designe (CRD), the significance differences between groups were determined using (Duncan, 1955).

RESULTS

The results in Table (2) indicate that the average final weight of ewes at the end of the study period was close between groups 53.15, 52.19 and 52.23 kg, respectively. The amount of dry matter of concentrated feed intake was 1.50 kg/ewe per day and roughage feed (wheat straw) was 0.5 kg/day.

Table 2: Effect of wheat bran and nano selenium on ewes weights.

Traits	First group (control)	Wheat bran groups	
		- Selenium Nanoparticles	**+ Selenium Nanoparticles**
initial weight(kg)	51±3.11	51.37±3.07	52.03±2.94
Final weight (kg)	53.15±3.18	52.19±3.34	52.23±3.34
Concentrated feed intake (kg) dry matter	1.500	1.500	1.500
Roughage feed intake (kg)	0.500	0.500	0.500

The milk yield was compared between the 3 groups during the experiment duration, 72 days, which was further divided into 3 consecutive periods (Table 3). Although milk production did not differ significantly between groups in the first period (1-24 days) 255, 285 and 324 g/day, there was an increase of about 13% and 30.98% in the second and third groups, as compared to the control. During the second period (24-48 days) the adverse effect of wheat bran on ewe performance was clear, where milk yield was decreased to 354 g/day, as compared to the control (446 g/day) and significantly (P≤0.05) decreased when compared to G3 supplemented with nano selenium (509 g/day). This effect continued during the third period (48-72 days), where the milk production decreased (P≤0.05) in the ewes fed with high wheat bran (259 g/day), as compared to other groups 415 and 480 g/day.

The mean of total milk production during the study (1-72 days) illustrates that feeding a diet containing high wheat bran led to a significant (P≤0.05) decrease in milk production to 301g/day as compared to the control (low wheat bran) 390 g/day, although the ewes in the two groups eat the same quantity of energy and protein. Moreover, the ewes fed a combination of a high wheat bran diet with nano selenium can improve the mean milk production to 455 g/day which represents about 151% of the high wheat bran diet alone. The supplementation with nano selenium leads to enhanced milk production by 16% more than the control.

Table 3: The effect of wheat Bran and nano selenium on milk production.

Milk production / Period	**First group (control)**	**Wheat bran groups**	
		- Selenium Nanoparticles	**+ Selenium Nanoparticles**
The first period (1-24 days)	255±23.09	285±38.68	324±90.06
The second period (24-48 days)	446±31.97 ab	354±41.21 b	509±31.48 a
The third period (48-72 days)	415±41.01 a	259.6±27.57 b	480±23.39 a
The entire period (1-72 days)	390±28.95 a	301.76±22.86 b	455.15±30.86 a

Different letters within the same row were significantly different (P≤0.05).

The results in Table (4) indicate that milk fat was 5.08, 6.08 and 4.15% during the first period. The differences in milk fat were significant, and a higher percentage was recorded in the milk of the second group with a significant (P≤0.05) increase, as compared to other groups. Whereas the lowest significant (P≤0.05) percentage was in the third group, compared to the control. Milk fat in the second and third periods was not affected significantly between groups. Also, no significant differences were found between groups in the mean milk fat during periods 1-72 days.

Table 4: The effect of wheat bran and nano selenium on milk fat.

Milk fat % / Period	**First group (control)**	**Wheat bran groups**	
		- Selenium Nanoparticles	**+ Selenium Nanoparticles**
The first period (1-24 days)	5.08±0.26 b	6.08±0.06 a	4.15±0.38 c
The second period (24-48 days)	4.84±0.14	5.44±0.40	5.38±0.34
The third period (48-72 days)	3.44a0.45	3.02a0.36	3.7±0.51
The entire period (1-72 days)	4.36a0.27	4.65a0.42	4.45±0.31

Different letters horizontally indicate significant differences (P≤0.05).

The results of the statistical analysis in Table (5) showed that lactose percent in the first period was close between the first and second groups 4.52 and 4.55%, respectively. These values were less (P≤0.05) than that of the third group 4.82%.

Except for the first period, no significant differences were found between groups in the second period 5.01, 4.62, and 4.77% and third periods 4.93, 5.08, 4.80 and mean lactose values during 1-72 days of study 4.80, 4.78, and 4.79%, respectively.

Table 5: Effect of wheat bran and nano selenium on milk lactose.

Milk lactose/period	First group (control)	Wheat bran groups	
		- Selenium Nanoparticles	+Selenium Nanoparticles
The first period (1-24 days)	4.52±0.13 b	4.55±0.04 ab	4.82±0.02 a
The second period (24-48 days)	5.01±0.13	4.62±0.31	4.77±0.08
The third period (48-72 days)	4.93±0.07	5.08±0.10	4.80±0.08
The entire period (1-72 days)	4.86±0.08	4.78±0.13	4.79±0.04

Different letters horizontally indicate significant differences (P≤0.05).

The results of the statistical analysis in Table (6) showed a significant increase in the percentage of milk protein in the third group 5.09%, as compared to the control 4.77%, but not significantly in the second group 4.82%. On the other hand, we found that the differences between the protein percentage during the second period of the study were not significant 5.29%, 4.89%, and 5.04%, respectively. And so during the third period 5.20%, 5.36% and 5.07%, respectively. Similarly, in the mean value of protein through the entire period was 5.04%, 5.05% and 5.06%, respectively.

Table 6: Effect of wheat bran and nano selenium on milk protein.

Milk Protein/period	First group (control)	Wheat bran groups	
		- Selenium Nanoparticles	+Selenium Nanoparticles
The first period (1-24 days)	4.77±0.14 b	4.82±0.04 ab	5.09±0.02 a
The second period (24-48 days)	5.29±0.14	4.89±0.33	5.04±0.09
The third period (48-72 days)	5.20±0.08	5.36±0.11	5.07±0.09
The entire period (1-72 days)	5.14±0.08	5.05±0.14	5.06±0.04

Different letters horizontally indicate significant differences (P≤0.05).

The non-fat solids in milk showed a significant superiority (P≤0.05) in G3 of ewes that were fed the diet containing high wheat with nano selenium (10.75%), as compared to the control (10.05%) and to the ewes fed with high wheat bran only, 10.13%. Similar to other milk ingredients, the proportion of solid non-fat did not differ significantly between the experimental groups during the second period 11.17%, 10.30% and 10.79%, respectively, the third period 10.99%, 11.34% and 10.71%, respectively. The same for the mean solid non-fat percentage 1-72 days 10.85%, 10.66% and 10.75% respectively.

Somatic cell count in milk

During the first period (1-24 days), the number of somatic cells was close between the experimental treatments (822.6, 984.05 and 888.8 $\times10^3$ cells/ml), respectively (Table 7). Also, in the second period, the differences were non-significant (382.64, 390.4 and 321.74 $\times10^3$ cells/ml), respectively. During the third period, the number of somatic cells were significantly low (P≤0.05) in the second and third groups (229.66 and 252.12 $\times10^3$ cells/ml) compared to the control (577.4 $\times10^3$ cells/ml). The mean somatic cell count in the entire period was lower in the milk of ewes fed with high wheat bran in the ration 465 and 425 $\times10^3$, as compared to high grain diet 559.07 $\times10^3$ cells/ml.

Table 7: Effect of wheat bran and nano selenium on somatic cell count in milk.

Somatic cell count/period	First group (control)	Wheat bran groups	
		- Selenium Nanoparticles	+Selenium Nanoparticles
The first period (1-24 days)	822.6±216.15	984.05±297.88	888.8±195.6
The second period (24-48 days)	382.64±47.71	390.4±42.90 a	321.74±34.96
The third period (48-72 days)	577.4±53.57 a	229.66±33.66 b	252.12±37.89 b
The entire period (1-72 days)	559.07±69.28	465.75±104.54	425.82±85.13

Different letters horizontally indicate significant differences (P≤0.05).

DISCUSSION

The results in Table (2) showed no significant effect of ration on ewes' weight, similar to the studies in goats (Marcos *et al.,* 2020) and dairy cows (Kaltenegger et al., 2020). It has been observed that the use of a mixture of cereal and citrus processing residues did not lead to significant differences in body weight (Ibáñez-Forés *et al.,* 2023). Similarly (Kasim *et al.,* 2023) showed that selenium added to ewes diets did not lead to significant differences in body weight.

From the results of milk production in Table (3) during the first period of milk production, there were no significant differences between the groups, while decreased significantly in ewes fed with high wheat bran during other periods of the study. Wheat bran may have a negative effect on the digestion and absorption of protein and some mineral elements such as calcium, magnesium and iron (Iqbal *et al.,* 2022). The results obtained in this study were consistent with previous studies (Fegeros *et al.,*1995; Gaillard *et al.,* 2017; Aloueedat *et al.,* 2019), who reported a decrease in milk production with the addition of grain processing residues or other processing residues as an alternative to grains in diets, despite the energy and protein values are similar to the diet. On the contrary, some researchers (Marcos *et al.,* 2020; Whelan *et al.,* 2017; Condren *et al.,* 2019; Al zubadi *et al.,* 2023) found an arithmetic or significant improvement in milk production with feeding feed substitutes for cereals. In this regard, a similar study on lambs that were fed high levels of bran lead to a significant decrease in weight gain due to its effect on the rumen (Islam and Khan, 2021; (Abdullah *et al.,* 2019). Moreover, replacing spelled bran with rice bran led to an improvement in lambs' growth performance (Bishwass *et al.,* 2023). Also, the increase in the wheat bran, A significant decrease in dry matter and fiber contents of cattle meat (Friedt *et al.,* 2014). Regarding the effect of selenium, many studies reported significantly improved milk production after addition of selenium or nano selenium to diets compared to control (Abdullah *et al.,* 2019; Zhang *et al.,* 2020; Gaafar *et al.,* 2021; Khalil *et al.,* 2023).

The results in Table (4) indicate that the percentage of milk fat improved in the second group fed high wheat bran. This may be due to the increase in its fiber content, activating the metabolic pathways in the rumen to the produce more acetic acid, which is a main source for the production of 50% of fat in milk (Murphy, 2000; Mustafa *et al.,* 2023).

The results of the statistical analysis in Table (5) show a significant effect of the diet on the lactose percentage in the first period of the study, While the differences between groups for other periods were significant.

The results of the statistical analysis in Table (6) indicated a significant increase in the percentage of milk protein in favor of the high wheat bran group and selenium in the third group during the first period of the study only, and the reason for that is not clear. This could be attributed to a positive effect of the nano selenium. However, this effect was not continued in the following periods.

We noticed from the data that milk components were superior in the third group (high bran+ nano selenium) as compared to other groups, this may be attributed to the role or importance of the health status of animals in production, as ewes are usually in a state of metabolic and productive stress after birth. Selenium or nano selenium is essential for ewes and improves their immune status (Sharadamma *et al.,* 2011), is considered an oxygen-free radical scavenger (Khalil *et al.,* 2023), increases the efficacy and function of mitochondria in cells (Na *et al.,* 2018) and improves absorption in the intestine (Gangadoo *et al.,* 2020). All these factors may explain the difference in the third treatment compared to the other two. During the second phase of the study, the stress effect is expected to be minimal due to the change in metabolic status towards positive energy balance with increased intake of green fodder from pasture. Also, it is noted that the introduction of wheat bran as a substitute for barley has a negative impact on milk production, but this problem can be addressed and better milk production performance can be achieved when nanoselenium is added to the bran diet. This improvement may be associated with improved fiber digestion as selenium improves the activity of fibrolytic bacteria in the rumen and absorption in the intestine (Rabee *et al.,* 2023). The results reached in the current study are consistent with those of Gaillard *et al.,* (2017) and Condren *et al.,* (2019), as reducing the proportion of grains in the diet and replacing them with grain processing residues led to a significant increase in the percentage of fat in milk without affecting the rest of milk components. However, other studies did not observe a significant effect of replacing grains with grain processing residues or citrus files on milk components (Marcos *et al.,* 2020; Whelan *et al.,* 2017; Aloueedat *et al.,* 2019).

Also, some studies in which selenium nanoscales were added to diets, significant superiority was observed in milk composition compared to control treatment (Kasim *et al.,* 2023; Gaafar *et al.,* 2021; Khalil *et al.,* 2023; Najafnejad *et al.,* 2013). However, this significant improvement was not reported in many other studies (Hashemi *et al.,* 2018; Han *et al.,* 2021; Liu *et al.,* 2024), which is consistent with the results of the current study.

In this study, the number of somatic cells in milk (Table 7) was close to the values obtained by (*Kaskous,* 2000) in Awassi sheep, which were about 344 × ($\times 10^3$ cells/ml) and 467.27 ($\times 10^3$ cells/ml) in the right and left part of the udder, respectively. The pattern of somatic cells during the stage of milk production is consistent with Kaskous *et al.,* (2022), where the number of somatic cells rises at the beginning and the end of milk production period in ewes. The number of somatic cells in ewes milk during winter season is higher than spring (Abbood, 2016) and the values found close to the values obtained in this study. The results of this study were consistent with (Condren *et al.,* 2019), where the use of feed substitutes of grains manufacture as an alternative to cereals did not lead to significant differences in the number of somatic cells.

CONCLUSION

Through this study, we conclude that the use of wheat bran in a ration of more than the optimal ratio of 15% can adversly affect ewes performance. Nano selenium can overcome the negative effect, and can enhance milk components of local Awassi ewes.

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اضافة السلينيوم النانوي الى العلائق المرتفعة بنخالة الحنطة واثره في انتاج الحليب وتركيبه في النعاج العواسية

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أجريت الدراسة للبحث في تاثير السلينيوم النانوي في تحسين الاستفادة من العليقة المرتفعة بنخالة الحنطة وذلك باستخدام ١٥ نعجة عواسية متوسط معدل اوزانها ٥١,٥٨ ± ١,٧١ كغم واعمارها تروحت بين ٣-٤ سنوات. قسمت النعاج الى ثلاث مجاميع كل مجموعة ضمت خمسة نعاج، غذيت النعاج خلال مدة الدراسة التي بلغت ٧٢ يوما وكانت كمية العلف المقدمة للنعاج بما يعادل ١,٥ كغم مادة جافة لكل نعجة يوميا. المجموعة الأولى (الضابطة) غذيت على عليقة مرتفعة بحبوب الشعير وذات نسبة مثالية من نخالة الحنطة، في المجموعة الثانية غذيت النعاج على عليقة احتوت نسبة اقل من الشعير مع رفع نسبة النخالة الى ٣٥% من مكونات العليقة، بينما كانت المجموعة الثالثة تغذى على عليقة مشابهة للعليقة الثانية مع تجريع النعاج يوميا بكمية ٠,٣ ملغم/ نعجة من النانو سلينيوم. اشارت النتائج الى انخفاض انتاج الحليب معنويا ($P\leq0.05$) في المجموعة الثانية ٣٠١,٧١ غم/ يوم بالمجموعة الأولى (الضابطة) ٣٩٠ غم/ يوم وان إضافة السلينيوم الى العليقة المرتفعة بالنخالة أدت الى تحسن انتاج الحليب الى ٤٥٥,١٥ غم وبفارق حسابي بلغت نسبته ١٦,٧١%. نسب الدهن والبروتين واللاكتوز والمواد الصلبة اللادهنية بالحليب عموما لم تتاثر معنويا بالمعاملات فيما عدا الفترة الأولى من الدراسة، وكان عدد الخلايا الجسمية اقل معنويا بالفترة الثانية من الدراسة في مجموعتي النخالة والسلينيوم مقارنة بالمجموعة الضابطة. وتخلص هذه الدراسة الى امكانية زيادة نسبة نخالة الحنطة مع اضافة النانو سيلينيوم للحصول على انتاج حليب افضل من استخدام نخالة الحنطة فقط، كوسيلة للاستفادة من المنتجات الثانوية لصناعة الحبوب كبدائل للحبوب في التغذية.

الكلمات الافتتاحية: *السيلينيوم ، نخالة القمح ، نعاج العواس ، الحليب*