



The relationship between the genetic of the beta-adrenaline receptor gene (ADRB3) and hair color and the productive performance of local goats

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Abstract

This study investigated the effect of the genetic characteristics of the beta-3 adrenergic receptor (*ADRB3*) gene and hair color on milk production and its components, as well as the body dimensions of both goat and offspring. The experiment was conducted at the animal farm of the Animal Production Department, College of Agriculture, University of Diyala, and lasted for five months, from October 1, 2024, to March 1, 2025. Forty-two local Iraqi female goats were used, collected from local markets in Diyala Governorate. Single nucleotide polymorphism (SNP) technology was used to detect genetic variation in the beta-3 adrenergic receptor gene among the studied sample, with the aim of linking this variation to differences in productive traits such as milk production and its components, and body dimensions. However, the results of the molecular analysis showed no genetic variation in this gene. Based on this finding, the analysis was directed towards investigating the effect of hair color on the studied traits. The goats were classified into three color groups according to hair color (white, red, and black). The results of the statistical analysis showed that there was no significant effect of hair color on most of the studied traits, whether productive (milk production and its components) or physical (weights and measurements), with the exception of the height of the rump, which recorded significant differences in favor of the white goats, then the red ones, compared to the black ones, where the averages reached (72.50, 72.11, and 67.66) cm.

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Introduction

Goats are among the most important farm animals in Iraq, representing a primary source of milk and meat production, as well as possessing a high capacity for adapting to harsh environmental conditions compared to other farm animals. Goats are characterized by high reproductive efficiency and short generation periods, making them an important economic resource that can be developed using modern genetic improvement methods (1,2). Goat milk is also gaining increasing nutritional importance due to its easier digestibility and its closer composition to human breast milk compared to cow's milk. Furthermore, it contains higher levels of protein, fats, and essential fatty acids, especially

when goats are raised on natural pastures (3-5). Hair color is an important phenotypic trait in goats, as it depends on the type and concentration of melanin pigment (eumelanin and pheomelanin). Studies have shown a relationship between hair color and certain productive and adaptive traits, in addition to the great diversity in hair patterns and colors among goats (6,7). Within the global trend towards applying molecular genetics to animal improvement, the importance of studying candidate genes associated with productive traits has emerged. Among these genes, the beta-3 adrenergic receptor (*ADRB3*) gene stands out due to its key role in regulating metabolic processes, particularly lipolysis and thermogenesis in brown and white adipose tissue. The *ADRB3* gene consists of two exons and encodes a membrane

protein from the G protein-coupled receptor family, composed of approximately 408 amino acids (8). Previous studies indicate that the *ADRB3* gene (beta-3 adrenergic receptor) plays a pivotal role in regulating energy metabolism, lipolysis, and maintaining metabolic homeostasis. This gene is important for studying productive traits in ruminants, particularly those related to growth, feed conversion, and carcass composition (9). In a study on sheep, the distribution of the $\beta 3$ receptor in different tissue types was analyzed. Clear differences in gene expression levels were observed between tissues, with a notable increase in deep adipose tissue compared to subcutaneous tissue, which supports the hypothesis of a regulatory role for the gene in fat storage based on anatomical location (10).

Despite the economic importance of domestic goats and the growing interest in studying productive traits using genetic markers, scientific studies clearly indicate a scarcity of research addressing the beta-3 adrenergic receptor (*ADRB3*) gene in goats compared to sheep and cattle. Most previous research has been limited to characterizing the gene in other ruminants and studying the effect of its genetic polymorphisms on traits such as cold tolerance or fiber characteristics (11,12). There is no documented scientific information on the relationship between hair color and metabolic genes such as *ADRB3*, or whether hair color can be a phenotypic indicator related to thermoregulation or metabolic processes controlled by this gene. This reveals a clear knowledge gap: the lack of molecular data on the *ADRB3* gene in local goats, the absence of a link between the gene's genetic variation and productive traits, and the lack of any analysis examining the interaction between hair color and genetic diversity. Addressing this gap will be highly beneficial for implementing marker-assisted selection programs, improving the efficiency of local breeds, and supporting food security. Therefore, this study is the first in Iraq to investigate the role of the beta-3 adrenergic receptor gene (*ADRB3*) in improving the productive traits of local goats and to examine whether hair color is directly or indirectly related to gene activity or its impact on productive traits.

Materials and methods

Ethical approval

This research has been reviewed and approved by the Ethical Committee for Animal Research Studies, College of Agriculture, University of Diyala under Ethical Approval Number 165, and Recorded Number 716, 31.07.2024.

Protocol of research

This study was conducted at the field belonging to the College of Agriculture, University of Diyala, from October 1, 2024, to March 1, 2025, on a sample of 42 pregnant local goats aged 1.5-2 years. The animals were subject to a proper

health and veterinary regime. The study was conducted in two phases: the first was a field experiment, and the second was a laboratory (molecular) study to analyze the *ADRB3* gene. The coat color was visually assessed, and the animals were classified into three color groups (white, red, and black).

The data collected included weekly milk production during the first eight weeks, milk composition during the first two months, colostrum composition, doe body dimensions, and the weights and dimensions of their offspring at birth and weaning. Newly born does were housed in a separate pen immediately after giving birth. The animals were fed green and concentrated fodder twice daily (morning and evening). The newborn's weight was taken 12 hours after birth, and the weaning weight was taken two months postpartum. Total weight gain was calculated by subtracting the birth weight from the weaning weight. Body dimensions of the doe and newborn were measured at birth and weaning according to the method of (13,14). Milk production was measured weekly by hand milking each doe after separating the newborns from their goats overnight for 12 hours and milking them in the morning for two months.

This process was repeated for two months. The components of milk and colostrum (protein, lactose, fat, non-fat solids, and minerals) were analyzed after the samples were collected in special plastic tubes, labeled, and frozen at -20°C until the analysis. The samples were then thawed at room temperature and analyzed using a Milk Analyzer Master Pro, manufactured by Milkotester Ltd. (Bulgaria), at the Al-Khalis Grand Dairy Station. The results were recorded in the experiment log for statistical analysis.

Forty-two adult blood samples were collected. The blood collection area was first cleaned and sterilized with alcohol. Then, 5 ml of blood was withdrawn from each goat via the jugular vein using a sterile syringe into a 6 ml tube containing the anticoagulant (EDTA-K3). The samples were stored in a refrigerated container and then transferred to freezing at -20°C until extraction in the laboratory. The laboratory part was carried out in the Genetics and Biotechnology Laboratory in the Department of Animal Production /University of Diyala / College of Agriculture, which included extracting the genetic material and using electrophoresis, then performing polymerase chain reaction technology to detect the genetic polymorphism of the studied gene and sending the PCR product to the Korean company Macrogen to perform sequencing technology to read the sequence of nitrogenous bases and detect, diagnose, and infer regions of variation through bioinformatics programs by computer.

DNA Extraction

DNA was extracted from blood samples using a kit, following the recommendations of the manufacturer, Geneproof, Germany.

Primer

The gene segment size was 374 bp, a base pair in intron (AF-109928.2). The primer:

F: 5'-GCACAGAGTAGGGAATCAAAGT-3'

R: 5'-CCTTCGGGGGCTATCAGACTTTC-3'

for the *ADRB3* gene was determined based on (15).

Polymerase chain reaction (PCR)

The amplification program for the required fragment was determined using PCR technology with a thermal cyclic reagent for molecular detection analysis of the *ADRB3* gene. The reaction mixture used for molecular detection using PCR for the studied gene was 25 μ L. (Master Mix 12.5 μ L, Starter F 1 μ L, R 1 μ L, Deionized Distilled Water 5.5 μ L, DNA 5 μ L). The aforementioned reaction materials were then placed in small tubes and mixed using a VORTEX mixer. The tubes were then transferred to a PCR machine where the reaction conditions were determined for each gene segment. The reaction program for the initial mutated gene was as follows: initial cleavage: 95 °C for 5 minutes and 5 cycles; cleavage: 94 °C for 35 seconds; fusion: 53 °C for 30 seconds; elongation: 72 °C for 45 seconds and 25 cycles; terminal elongation: 72 °C for 10 minutes and 2 cycles; final elongation: 10 °C for 4 minutes. The degree of attachment of the primer to its complementary sequence in the template DNA was determined for each region. DNA samples were added to each tube containing the reaction mixture, and then the tubes were placed in the PCR machine under the pre-set conditions.

After the allotted reaction time, the polymerase chain reaction (PCR) product is transferred to confirm the presence of PCR products. The same 1.5% agarose gel preparation method used for DNA transfer is employed, but with a 2% agarose concentration and a different loading method for the PCR product. Marker Ladder DNA (374 bp) of known molecular weight is loaded into the first well of the polymerase chain reaction gel. Then, 5 microliters of PCR product are loaded into each of the pre-prepared wells of the gel. The electrophoresis device is operated at 100 volts for one hour. The movement of DNA fragments from the negative to the positive electrode is then observed. These DNA bands are visualized using a UV light transilluminator to observe the gene fragments and are imaged with a special camera. The bands appear stained orange with ethidium bromide (Figure 1).

Detection of genetic mutations using DNA sequencing technology

After identifying the AF109928.2 region fragment using PCR technology, the 20 microliter volume of PCR product, consisting of 42 samples, was sent to the Korean company Macrogen (via Rukan Al-Rawan Company in Baghdad/Karrada Dakhil) for reading the DNA nitrogenous

base sequences and detecting genetic mutations in the studied fragment.

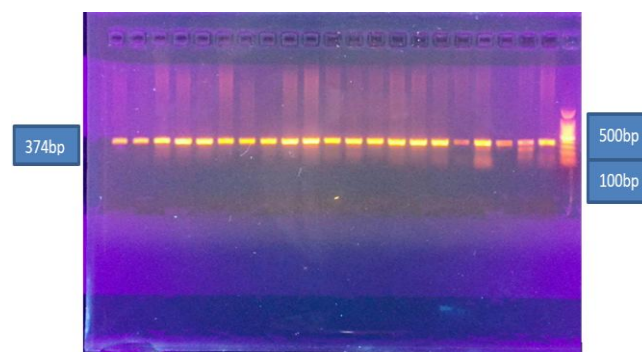


Figure 1: caused a chain reaction of polymerase chain reaction.

Statistical Analysis

The data were statistically analyzed using the (16) statistical software to study the effect of hair color on the studied traits using a completely randomized design (CRD). Significant differences were compared between the means using (17) multiple-choice test according to the following equation:

$$Y_{ij} = \mu + A_i + \varepsilon_{ij}$$

Y_{ij} = milk traits and components.

μ = Overall mean.

A_i = Hair color.

ε_{ij} = Random error

Results

After performing DNA sequencing, we received the results via email. Genious Software was used to analyze the results on the GenBank website www.ncbi.nlm.nih.gov and the curve file to determine the phenotypic polymorphism of the *ADRB3* gene. The results of the genetic analysis of the beta-3 adrenergic receptor gene (*ADRB3*) in local goats showed no genetic mutations or polymorphisms within the examined gene segment. All samples were identical in their genetic sequence, and no nucleotide-level differences indicating polymorphism were recorded, indicating a high degree of genetic homogeneity at this locus. Accordingly, the study moved to examining the effect of hair color as a potential phenotypic factor associated with productive traits. Statistical comparisons showed no significant differences between different hair colors in milk production and its components (fat, protein, lactose, and total solids). Furthermore, hair color did not have a clear effect on colostrum composition during the first hours after birth, with darker hair colors exhibiting higher protein and fat content compared to lighter colors. The results also indicated no

significant differences in anthropometric measurements such as body length, chest circumference, shoulder height, and weaning weight. Darker hair colors were generally associated with higher values for these traits, while lighter

hair colors showed relatively lower values. This suggests that hair color can be considered an external indicator associated with the productive and physiological superiority of local goats (Table 1-7).

Table 1: Effect of hair color on weekly milk production of local goats (ml/animal)

Traits	Hair color white (n=19)	Hair color black (n=66)	Hair color red (n=14)	Significant level
Week1	1252.63 ± 104.33	1336.67 ± 257.69	1080.36 ± 122.98	N. S
Week2	957.89 ± 88.61	799.50 ± 153.62	1010.0 ± 165.18	N. S
Week3	852.89 ± 73.16	706.66 ± 121.91	791.07 ± 118.99	N. S
Week4	803.15 ± 78.19	695.0 ± 101.61	798.21 ± 118.10	N. S
Week5	681.31 ± 48.09	713.33 ± 118.42	818.57 ± 161.90	N. S
Week6	613.68 ± 30.55	695.0 ± 77.74	731.78 ± 131.37	N. S
Week7	519.47 ± 31.24	631.66 ± 134.91	715.0 ± 111.99	N. S
Week8	433.68 ± 28.79	507.50 ± 66.25	539.28 ± 74.91	N. S

N.S =indicates that there are no significant differences between the treatments.

Table 2: Effect of hair color on milk components for the first month of production for local goats

Traits	Hair color white (n=19)	Hair color black (n=6)	Hair color red (n=14)	Significant level
Protein%	4.16 ± 0.16	4.13 ± 0.14	3.94 ± 0.07	N. S
Fat%	4.71 ± 0.53	4.81 ± 0.46	4.26 ± 0.36	N. S
Lactose%	6.08 ± 0.11	6.25 ± 0.20	5.86 ± 0.09	N. S
Density g/cm3	38.82 ± 0.42	38.53 ± 1.09	37.17 ± 0.78	N. S
Non-fat solids	11.32 ± 0.42	11.33 ± 0.38	10.81 ± 0.15	N. S
Minerals	0.90 ± 0.03	0.88 ± 0.02	0.86 ± 0.01	N. S

N.S =indicates that there are no significant differences between the treatments.

Table 3: Effect of hair color on milk components in the second month of production for local goats

Traits	Hair color white (n=19)	Hair color black (n=6)	Hair color red (n=14)	Significant level
Protein%	3.73 ± 0.07	3.95 ± 0.11	3.57 ± 0.13	N. S
Fat%	4.24 ± 0.46	4.25 ± 0.28	4.26 ± 0.19	N. S
Lactose%	5.70 ± 0.10	5.83 ± 0.19	5.40 ± 0.19	N. S
Density g/cm3	35.47 ± 0.93	35.90 ± 1.13	33.94 ± 1.02	N. S
Non-fat solids	10.32 ± 0.20	10.43 ± 0.29	9.76 ± 0.31	N. S
Minerals	0.83 ± 0.01	0.85 ± 0.02	0.80 ± 0.03	N. S

N.S =indicates that there are no significant differences between the treatments.

Table 4: Effect of hair color on colostrum components of local goats

Traits	Hair color white (n=19)	Hair color black (n=6)	Hair color red (n=14)	Significant level
Protein%	6.18 ± 0.39	6.45 ± 0.48	5.47 ± 0.38	N. S
Fat%	6.09 ± 0.39	4.71 ± 0.63	5.78 ± 0.48	N. S
Lactose%	9.03 ± 0.60	8.87 ± 0.75	8.18 ± 0.56	N. S
Density g/cm3	53.63 ± 3.90	54.48 ± 5.62	49.46 ± 3.56	N. S
Non-fat solids	15.48 ± 1.05	15.85 ± 1.46	15.11 ± 1.10	N. S
Minerals	1.30 ± 0.08	1.31 ± 0.10	1.27 ± 0.09	N. S

N.S =indicates that there are no significant differences between the treatments.

Table 5: Effect of hair color on the body dimensions of the mother at birth for local goats (cm)

Traits	Hair color white (n=19)	Hair color black (n=6)	Hair color red (n=14)	Significant level
Body length	64.29 ± 2.42	57.16 ± 4.10	64.40 ± 3.07	N. S
Forefoot height	69.05 ± 1.29	66.83 ± 1.42	64.40 ± 1.42	N. S
Back height	72.50 ± 1.61 a	67.66 ± 0.79 b	72.11 ± 1.04 a	*
Chest circumference	81.64 ± 1.74	78.50 ± 2.56	79.33 ± 1.59	N. S
Abdominal circumference	84.76 ± 1.42	87.83 ± 3.36	86.93 ± 3.29	N. S

N.S =indicates that there are no significant differences between the treatments. *Different letters indicate significant differences within one column at the $P \leq 0.05$ level.

Table 6: Effect of fur color of local goats on the weight and body dimensions of the newborn at birth (cm)

Traits	Hair color white (n=20)	Hair color black (n=7)	Hair color red (n=15)	Significant level
Birth weight	3.28 ± 0.17	2.68 ± 0.24	3.14 ± 0.13	N. S
Body length	31.33 ± 1.07	28.0 ± 1.36	30.13 ± 2.17	N. S
Forefoot height	33.16 ± 0.89	30.85 ± 2.16	31.94 ± 0.84	N. S
Back height	33.66 ± 0.91	31.0 ± 1.71	32.82 ± 0.94	N. S
Chest circumference	37.16 ± 0.75	34.57 ± 0.36	35.76 ± 0.99	N. S
Abdominal circumference	37.50 ± 1.08	36.14 ± 1.07	37.82 ± 1.0	N. S

N.S =indicates that there are no significant differences between the treatments.

Table 7: Effect of hair color on the weight and body dimensions of the newborn at weaning of local goats (cm)

Traits	Hair color white (n=18)	Hair color black (n=6)	Hair color red (n=13)	Significant level
Weaning Weight	8.48 ± 0.43	7.88 ± 0.45	8.43 ± 0.71	N. S
Total Weight Gain	5.27 ± 0.45	5.05 ± 0.61	5.08 ± 0.40	N. S
Body length	44.15 ± 0.92	43.16 ± 1.07	43.80 ± 1.06	N. S
Forefoot height	41.53 ± 0.85	41.33 ± 1.60	41.70 ± 1.05	N. S
Back height	44.07 ± 0.86	44.0 ± 2.06	43.90 ± 1.36	N. S
Chest circumference	49.69 ± 0.75	46.50 ± 1.05	49.50 ± 1.35	N. S
Abdominal circumference	52.30 ± 0.87	51.0 ± 1.31	53.70 ± 1.16	N. S

Discussion

The results of this study showed the absence of any mutations or polymorphisms in the beta-3 adrenergic receptor (*ADRB3*) gene in local goats. This finding is consistent with (18), who demonstrated that this gene exhibits a high degree of genetic conservation in ruminants and a low mutation rate compared to other genes involved in metabolic processes. (19) also showed that mutations associated with lipolysis and improved energy efficiency are more commonly found in genetically enhanced breeds than in local breeds. (20,21) confirmed that regulatory genes responsible for lipid metabolism including *ADRB3* do not show a clear impact on productive traits, particularly milk production, in breeds not subjected to long-term selection programs. This aligns with (22) regarding the limited role of metabolic genes in local breeds. Thus, the absence of mutations in this gene in Iraqi local goats explains the lack of any correlation between it and milk production or its components in the results of the current study.

Consequently, shifting the focus to investigating the effect of fur color seems logical within the framework of searching for phenotypic factors that are actually linked to productive traits. The results of this study on Iraqi local goats regarding the effect of fur color on productive traits showed no significant differences between different fur colors in terms of milk production, its components, body weight, and dimensions. This indicates that fur color does not represent a direct influencing factor on productive traits under local environmental and management conditions, as shown in Tables 1, 2, 3, 4, 5, 6, and 7. This result is consistent with what (23) reported in Brazilian goats. Casey and (24) also confirmed that fur color is not a reliable indicator of productive efficiency, which aligns with the findings of (25), who demonstrated that fur color in local breeds is not a useful criterion for selection programs.

These results support (26), who stated that milk composition is influenced more by physiological factors, nutrition, and milking regimen than by morphological characteristics. (27), who confirmed that the animal's

morphological characteristics are not related to changes in milk or colostrum composition. Regarding colostrum, the literature has shown that its composition depends primarily on factors such as birth order, maternal age, and prenatal nutrition, as reported by (28-30), also indicated that phenotypic traits such as hair color do not affect colostrum quality, which aligns with the findings of the current study.

Furthermore, the study's results showed no effect of gene expression or hair color on body dimensions, a finding that supports (31) regarding the lack of correlation between phenotypic traits like color and body growth. This is consistent with (32), who stated that growth is primarily influenced by nutrition, environment, and overall health, rather than phenotypic characteristics. Similarly, no significant differences in weight were recorded based on hair color or gene variation, which is consistent with (33) findings in Nigerian goats, as well as with (32) assertion that weight is more influenced by herd management, nutrition, and health factors than by morphological traits.

These results collectively indicate that the Iraqi local breed exhibits a degree of productive consistency regardless of hair color or genetic variation in the ADRB3 gene, and that environmental and physiological factors are the most influential determinants of productive performance. These findings support the trend toward relying on actual productive criteria such as milk quantity and quality and growth rate in local goat improvement programs, rather than on morphological traits, in line with modern trends in local breed improvement (25).

Conclusions

These results may be related to the characteristics of different breeds that do not apply to the local Iraqi goat. Therefore, the lack of statistically significant differences in this study can be considered a logical outcome reflecting the non-determining role of hair color in assessing the growth potential of local goats within a stable administrative and nutritional environment. However, future studies with larger samples and under diverse environmental conditions are necessary to verify the generalizability of these findings.

Conflict of interest

The authors declare there is no conflict of interest.

Reference

1. Alkass JE, Juma KH. Small ruminant breeds of Iraq. In: Iniguez L, editor. Characterization of small ruminant breeds in West Asia and North Africa. Aleppo: International Center for Agricultural Research in the Dry Areas (ICARDA); 2005.
2. Safari E, Fogarty NM, Gilmour AR. A review of genetic parameter estimates for wool, growth, meat and reproduction traits in sheep. *Livest Prod Sci.* 2005;92(3):271–289. DOI: [10.1016/j.livprodsci.2004.09.003](https://doi.org/10.1016/j.livprodsci.2004.09.003)
3. Araz OB, Alkass JE, Barwary MS. Combined effect of flushing and hormonal treatment on reproductive performance of local goat. *Iraqi J Agric Sci.* 2023;54(5):1329–1338. DOI: [10.36103/ijas.v54i5.1834](https://doi.org/10.36103/ijas.v54i5.1834)
4. Getaneh G, Mebrat A, Wubie A, Kendie H. Review on goat milk composition and its nutritive value. *J Nutr Health Sci.* 2016;3(4):1–10. DOI: [10.15744/2393-9060.3.401](https://doi.org/10.15744/2393-9060.3.401)
5. Park YW, Jeanjulien C, Siddique A. Factors affecting sensory quality of goat milk cheeses: a review. *J Adv Dairy Res.* 2017;5(3):2–9. DOI: [10.4172/2329-888x.1000185](https://doi.org/10.4172/2329-888x.1000185)
6. Tripathi MK. Comforts in quality and production of goat milk. *J Adv Dairy Res.* 2015;3(1):1–2. DOI: [10.4172/2329-888x.1000e115](https://doi.org/10.4172/2329-888x.1000e115)
7. Ebozoje MO, Ikeobi CON. Colour variation and reproduction in the West African dwarf goats. *Small Rumin Res.* 1998;27(2):125–130. DOI: [10.1016/S0921-4488\(97\)00045-X](https://doi.org/10.1016/S0921-4488(97)00045-X)
8. Olfaz M, Tozlu H, Önder H. Effect of hair color variation on milk production and kid growth in Turkish Hair goat. *J Anim Vet Adv.* 2011;10(8):1025–1029. DOI: [10.3923/javaa.2011.1037.1040](https://doi.org/10.3923/javaa.2011.1037.1040)
9. Sponenberg DP. Genetics of goat color. Blacksburg, VA: Virginia-Maryland Regional College of Veterinary Medicine, Virginia Polytechnic Institute and State University; 2004.
10. Ebozoje MO, Ikeobi CON. Colour variation and reproduction in the West African dwarf (WAD) goats. *Small Rumin Res.* 1998;27(2):125–130. DOI: [10.1016/S0921-4488\(97\)00045-X](https://doi.org/10.1016/S0921-4488(97)00045-X)
11. Akpa GN, Osuhor CU, Olugbemi TS, Nwani PI. Milk flow rate and milking frequency in Red Sokoto goats. *Pak J Nutr.* 2003;2(3):192–195. DOI: [10.3923/pjn.2003.192.195](https://doi.org/10.3923/pjn.2003.192.195)
12. Gholibeikifard A, Aminafshar M, Hosseinpour M. Polymorphism of IGF-I and ADRB3 genes and their association with growth traits in the Iranian Baluchi sheep. *J Agric Sci Technol.* 2013;15:1153–1162. [\[available at\]](#)
13. Cam MA, Olfaz M, Soydan E. Body measurements reflect body weight and carcass yields in Karayaka sheep. *Asian J Anim Vet Adv.* 2010;5:120–127. DOI: [10.3923/ajava.2010.120.127](https://doi.org/10.3923/ajava.2010.120.127)
14. SAS Institute Inc. SAS/STAT user's guide for personal computers. Release 9.1. USA: SAS Institute Inc.; 2010.
15. Duncan DB. Multiple range and multiple F-test. *Biometrics.* 1955;11:1–42. DOI: [10.2307/3001478](https://doi.org/10.2307/3001478)
16. Al-Berzenji YMS, Zeinel FK. Genetic evaluation of milk production traits in local goats. *Iraqi J Agric Sci.* 2023;54(6):1548–1556. DOI: [10.36103/ijas.v54i6.1855](https://doi.org/10.36103/ijas.v54i6.1855)
17. Williams TJ, Ozoje MO, Okwelum N, Adewumi OO, Iyesere OS, Abioja MO, Awotedu OO. Milk yield in West African dwarf goats as influenced by coat colour, liveweight, week of lactation and udder circumference. *Niger J Anim Prod.* 2019;46(3):325–333. [\[available at\]](#)
18. Al-Kass JA, Mustafa KNS. Performance of native goats in the Kurdistan Region of Iraq: a review. *Mesopotamia J Agric.* 2023;51(3):11–21. DOI: [10.33899/mja.2023.142252.12591](https://doi.org/10.33899/mja.2023.142252.12591)
19. Ahmad BA, Al-Khazraji WJ. Relationship of the genetic polymorphism of two point mutations within HSP70 gene with the traits of milk and the thermal tolerance of the Holstein cows in Iraq. *Plant Arch.* 2020;20(2):401–404. [\[available at\]](#)
20. Scarso S, McParland S, Visentin G, Berry DP, McDermott A, De Marchi M. Genetic and nongenetic factors associated with milk color in dairy cows. *J Dairy Sci.* 2017;100(9):7345–7361. DOI: [10.3168/jds.2016-11683](https://doi.org/10.3168/jds.2016-11683)
21. Milovanovic B, Djekic I, Miocinovic J, Djordjevic V, Lorenzo JM, Barba FJ, Tomasevic I. What is the color of milk and dairy products and how is it measured?. *Foods.* 2020;9(11):1629. DOI: [10.3390/foods9111629](https://doi.org/10.3390/foods9111629)
22. Kipanyula MJ, Chuma IS, Brundtland E, Bårdsen K, Ulvund MJ. Genotyping of the prion protein (PrP) gene in Red Maasai and Black Head Persian sheep in Tanzania. *Small Rumin Res.* 2008;79(2–3):146–151. DOI: [10.1016/j.smallrumres.2008.07.020](https://doi.org/10.1016/j.smallrumres.2008.07.020)
23. Haenlein GFW. Goat milk in human nutrition. *Small Rumin Res.* 2004;51(2):155–163. DOI: [10.1016/j.smallrumres.2003.08.010](https://doi.org/10.1016/j.smallrumres.2003.08.010)

24. McGee M, Drennan MJ, Caffrey PJ. Effect of suckler cow genotype on cow serum immunoglobulin (Ig) levels, colostrum yield, composition and Ig concentration and subsequent immune status of their progeny. *Ir J Agric Food Res.* 2005;44:173–183. [\[available at\]](#)
25. El-Sherbiny HR, Hashem NM, Abdelnaby EA. Coat color affects the resilience against heat stress impacts on testicular hemodynamics, reproductive hormones, and semen quality in Baladi goats. *BMC Vet Res.* 2023;19(1):107. DOI: [10.1186/s12917-023-03653-w](#)
26. Ozoje MO, Mbereve G. Coat pigmentation effects in West African dwarf goats: live weights and body dimensions. *Niger J Anim Prod.* 2002;29(1):5–10. [\[available at\]](#)
27. Mia MM, Mondal AK, Chowdhury MS, Mia MM. A study on productive and reproductive performances of Black Bengal goat in relation to coat colors. *J Sylhet Agric Univ.* 2018;5:121–125. [\[available at\]](#)

علاقة التركيب الوراثي لجين مستقبلات بيتا-3 الأدرينالية ولون الشعر في الأداء الإنتاجي للماعز المحلية

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الخلاصة

هذه الدراسة هدفت الى دراسة تأثير التراكيب الوراثية لمستقبلات بيتا-3 الأدرينالية (ADRB3) ولون الشعر على إنتاج الحليب ومكوناته، بالإضافة إلى أبعاد جسم للام والمواليد. أجريت التجربة في الحقل الحيواني التابع لقسم الإنتاج الحيواني، كلية الزراعة، جامعة ديالى، واستمرت خمسة أشهر، من ١ أكتوبر ٢٠٢٤ إلى ١ مارس ٢٠٢٥. استُخدمت اثنتان وأربعون عنزة عراقية محلية، جُمعت من أسواق محافظة ديالى. استُخدمت تقنية تعدد أشكال النوكليوتيدات المفردة (SNP) للكشف عن التباين الجيني في جين مستقبلات بيتا-3 الأدرينالية بين العينة المدروسة، بهدف ربط هذا التباين بالاختلافات في الصفات الإنتاجية، مثل إنتاج الحليب ومكوناته، وأبعاد الجسم. إلا أن نتائج التحليل الجزيئي لم تُظهر أي تباين جيني في هذا الجين. وبناءً على هذه النتيجة، وُجّه التحليل نحو دراسة تأثير لون الشعر على الصفات المدروسة. صُنّفت العنيزات إلى ثلاث مجموعات لونية وفقاً للون شعرها (أبيض، أحمر، وأسود). أظهرت نتائج التحليل الإحصائي عدم وجود تأثير معنوي للون الشعر على معظم الصفات المدروسة، سواء الإنتاجية (إنتاج الحليب ومكوناته) أو البدنية (الأوزان والقياسات)، باستثناء ارتفاع المؤخرة، الذي سجل فروقاً معنوية لصالح الماعز البيضاء، ثم الحمراء، مقارنةً بالسوداء، حيث بلغ متوسط ارتفاع المؤخرة (٧٢,٥٠، ٧٢,١١، ٧٢,٦٦) سم.