Journal of Animal Science and Products (JASP)
International peer-reviewed journal

7 (1): 1-11, 2024

Type Traits of Holstein-Friesian and Red-Holstein Cows Raised Together in a Private Farm in Aydın Province

Frederic NDIHOKUBWAYO*[1], Atakan KOÇ[1]

[1]Aydın Adnan Menderes University, Faculty of Agriculture, Department of Animal Science, 09100, Aydın, Türkiye

Frederic NDIHOKUBWAYO, ORCID No: 0000-0003-4491-4464, Atakan KOÇ, ORCID No: 0000-0001-5324-4154

ARTICLE INFO

Research Article

This article was summerized from thesis research that still goes on.

Received: 03.01.2024
Accepted: 09.02.2024

Keywords

Dairy cattle
Linear type traits
Udder traits
Foot and leg traits
Conformation

*** Corresponding Author**

Ndihokubwayofrederic2017@mail.com

ABSTRACT

This study was aimed at comparing the conformation traits of two different cattle breeds such as Holstein-Friesian (HF) and Red-Holstein (RH) cows raised together in a farm in Aydın, Türkiye. In this study, 102 HF and 19 RH cows in different lactations numbers (LN) forming a total of 121 cows were used. The type traits were determined using Linear Type Traits (LTT) based on 9 points scoring system and non-linear 100 points method. The LTT were composed of body traits such as Stature (St), Chest Width (CW), Body Depth (BD), Rump Angle (RA), Rump Width (RW) and Body Condition Score (BCS); foot and legs traits: Rear Legs Set Angle (RLA), Rear Legs Rear View (RLV), Real Legs Knee Structure (RLS) and Foot Angle (FA); udder traits: Fore Udder Attachment (FUA), Rear Udder Height (RUH), Rear Udder Width (RUW), Central Ligament (CL), Udder Depth (UD), Rear Teat Placement (RTP), Fore Teat Length (FTL) and Mammary Acuity (MA); and according to the non-linear 100 points method: Dairy Strength (DS, 15%), Frame (20%), Foot and Legs (FL, 25%) and Udder (40%). The results of variance analysis showed that no differences between breeds and LN were found in body composite traits while, for Foot and Legs traits, only the RLA was found significant ($P<0.05$) between first and second lactations and the overall mean score was 5.64±0.91. As for udder traits, the FUA ($P<0.01$), RUW ($P<0.05$) and UD ($P<0.01$) for LN were found significant and averages were 5.01±1.02, 5.35±0.97, 7.52±1.82, respectively. For 100 scoring method, only udder traits were found significant ($P<0.05$) for LN and the mean was 83.51±1.10. As result, even though there wasn't any important difference between the type traits of breeds, significant differences were obtained between LN in most udder traits.

Aydın İlinde Bir İşletmede Birlikte Yetiştirilen Siyah-Alaca ve Kırmızı-Alaca İneklerin Tip Özellikleri

MAKALE BİLGİSİ

Araştırma Makalesi

Bu makale halen devam eden tez araştırmasından derlenmiştir.

Geliş: 03.01.2024
Kabul: 09.02.2024

ÖZ

Bu çalışmada, Aydın ilinde özel bir işletmede birlikte yetiştirilen Siyah-Alaca (SA) ve Kırmızı-Alaca (KA) ırkı süt sığırlarının dış görünüş özelliklerinin karşılaştırılması amaçlanmıştır. Çalışmada farklı laktasyon sırasında olan 102 baş SA ve 19 baş KA, toplamda da 121 baş inek kullanılmıştır. Tip özelliklerinin değerlendirilmesi, 9 puanlık sisteme (Doğrusal Tip Özellikleri, DTÖ) ve 100 puanlık sisteme göre yapılmıştır. DTÖ olarak Vücut yapısı için Sağrı

Lütfen aşağıdaki şekilde atıf yapınız / Please cite this paper as following;
Ndıhokubwayo, F., Koç, A., 2024. Type traits of Holstein-Friesian and Red-Holstein Cows raised together in a private farm in Aydın Province, Journal of Animal Science and Products (JASP) 7 (1): 1-11. DOI: 10.51970/jasp.1414198

Anahtar Kelimeler

Süt sığırı
Doğrusal tip özellikleri
Meme özellikleri
Ayak ve bacak özellikleri
Konformasyon

*** Sorumlu Yazar**

Ndihokubwayofrederic2017@mail.com

Yüksekliği (SY), Göğüs Genişliği (GG), Beden Derinliği (BD), Sağrı Eğimi (SE), Sağrı Genişliği (SG) ve Vücut Kondisyon Puanı (VKP); Ayak ve Bacak özellikleri için Arka Bacak Açısı (ABA), Arka Bacak Duruşu (ABD), Arka Diz Yapısı (ADY) ve Tırnak Taban Yüksekliği (TTY); Meme özellikleri için ise Ön Meme Bağlantı Açısı (ÖMBA), Arka Meme Yüksekliği (AMY), Arka Meme Genişliği (AMG), Meme Merkez Bağı (MMB), Meme Taban Yüksekliği (MTY), Arka Meme Başı Yerleşimi (AMBY), Ön Meme Başı Uzunluğu (ÖMBU) ve Meme Ariliği (MA) puanlanmıştır. Doğrusal olmayan 100 puanlık sisteme göre ise Süt Tipi (ST, %15), Beden (%20), Ayak ve Bacak (AB, %25) ve Meme (%40) özellikleri puanlanmıştır. Varyans analizi sonucuna göre, vücut yapı özelliklerinde ırk ve laktasyon sıraları arasında önemli bir farklılık bulunmazken, Ayak ve Bacak özelliklerinde sadece genel ortalaması 5.64±0.91 olan ABA özelliği için birinci ve ikinci laktasyon sıraları arasında önemli farklılık ($P<0.05$) elde edilmiştir. Meme yapısı bakımından ise laktasyon sırası etkisi ÖMBA ($P<0.01$), AMG ($P<0.05$) ve MTY ($P<0.01$) özellikleri için önemli bulunmuş ve bu özelliklerin genel ortalaması sırasıyla 5.01±1.02, 5.35±0.97 ve 7.52±1.82 dir. Laktasyon sırası etkisi 100'lük puanlama sisteminde sadece genel ortalaması 83.51±1.10 olan meme özelliği için önemli ($P<0.05$) bulunmuştur. Sonuç olarak ırkların tip özellikleri arasında önemli bir farklılık olmamasına karşın, meme özelliklerinin çoğunda laktasyon sıraları arasında önemli farklılıklar elde edilmiştir.

Introduction

Cattle production is of great importance in global incomes of the countries worldwide and cattle production generally means fertility, milk and beef productions. It is then preferable to achieve high production in order to increase benefits, allowing the cattle production industries to progress and contribute to national economies. The fact of cattle to withstand the high production for a long time is called longevity and needs a special structure of the cow, which is based on measurable external appearance. Duru (2005) confirmed that the fact of selecting breeding animals by appearance features is the oldest feature. The selection was held by focussing on appearance characteristics such as color of the coat, horniness and body size and such features were prioritized till mid 1900's while the productivity of the animal was taken as an auxiliary criteria (Künzi, 1994). The measurable external appearance characteristics are called type traits and constitute the subject of this study. Those appearance characteristics are generally transferred generation to generation by heredity and scientists have determined heritabilities for each characteristic of type trait. The type traits must be the selection tool in addition to genetics and type traits gained great importance while taking decision in terms of selection for reproduction (Schneider et al., 2003), milk production, longevity and culling (Zavadilová and Štípková, 2012) of dairy cows. The type traits are also predictors of body weight (Veerkamp and Brotherstone, 1997; Berry et al., 2004), fertility (Pryce et al., 1998; Royal et al., 2002; Harris, 2015) and health (Rogers et al., 1991; Pryce et al., 1998; Juozaitiene et al., 2006). Within this context, the classifiers must not evaluate cows as good or bad but focus on visible and measurable appearances and this kind of evaluation is used to grade the bulls by measuring the traits of their daughters (Boettcher et al., 1997; Güler et al., 2020).

The idea of using type traits in cattle was first introduced in 1976 and later implemented in 1979 using linear analysis 1979 (Lucas et al., 1984; Vinson et al., 1982). The type traits were

also used by the Holstein Association in 1983 and since then, every country developed its own linear appraisal system and later, in 1997, it was developed a basic standard system for Holstein cattle. Conformation recording in Türkiye began in 1995 and this activity started training a group of 10 persons by foreign experts till the year 1999 when a proper system was established and results were published by the Ministry of Agriculture and Rural Affairs in the year 2000 (Şahin, 2011). There are a lot of scoring scale systems. The one used by Funk and Hansen (1991) use the scoring scale from 1 to 50 scores. The other and common developed by the International Conformation Recording Association (ICAR, 2018) uses 1 to 9 scores. The preference for conformation traits is that cattle must have strong feet and legs to support the entire body, the body must also be strong and well developed and high capacity udder to withstand high milk production, and so on. In this context, studies have demonstrated that the type traits have a relationship with herd life, profitability, longevity, udder health, milk components and somatic cells in dairy cows (Gengler et al., 1997; Rogers et al., 1998). There are two developed method for determining the conformation traits such as Linear Type Traits (LTT) using 1-9 scale scoring system and 100 scoring method but this one is accused to be subjective and is no longer preferred for use in type traits recording. Wesseldijk (2004) confirmed that udder traits are nowadays widely accepted as selection tool and have gained great importance in most breeding schemes. In the same context, together with udder traits, the foot and legs traits were also given importance in dairy breeding selection but other traits such as body traits were not given great importance (Wesseldijk, 2004). This study had the objective of comparing the conformation traits of two different dairy cattle breeds such as Holstein-Friesian (HF) and Red-Holstein (RH) cows raised together in a private dairy farm in Aydın, Türkiye.

Materials and Methods

Sampling farm and animal materials

During this study, the animals that were used are from a private farm located in Cincin District, Koçarlı/Aydın/Türkiye, containing HF and RH dairy cows raised together, with the total number of animal n = 121 heads (102 HF and 19 RH) that are in different parities. The lactation numbers were grouped into four groups such as 1, 2, 3, 4+ but the fourth groups was including the cows in fourth parities and plus because there were few cows in fifth and plus parities.

Type traits

For the type traits, it was used the 100 points method and LTT (9 points system). The farm was visited once a month from February to August and after 2 h from the milking the cows whose lactation period is between 30-150 days were evaluated. The 100 points system is based on Dairy strength (DS, 15%), Frame (20%), Foot and leg (FL, 25%) and Udder (40%); while the linear (9 points) system refers to Stature, Chest Width, Body Depth, Rump Angle, Rump Width, Rear Legs Set Angle, Rear Legs Rear View, Rear Legs Knee Structure, Foot Angle, Fore Udder Attachment, Rear Udder Height, Rear Udder With, Central Ligament, Udder Depth, Fore Teat Length, Rear Teat Placement, Mammary Acuity and Body Condition Score. Each

character was measured alone and was given the score out of 9. For deep understanding, the used linear type traits were defined in Table 1.

Table 1. Definition of limit of the traits according to the scores as proposed by ICAR (2018)

Tablo 1. ICAR (2018) tarafından önerilen puanlara göre özelliklerin tanımlanması

		Scores		
Traits	**Abbreviations**	1-3	4-6	7-9
Stature	(St)	Lower	Intermediate	Higher
Chest Width	(CW)	Narrow	Intermediate	Wide
Body Depth	(BD)	Shallow	Intermediate	Deep
Rump Angle	(RA)	High pins	Intermediate	Low pins
Rump Width	(RW)	Narrow pins	Intermediate	Wide pins
Body Condition Score	(BCS)	Thin	Intermediate	Fat
Rear Legs Set Angle	(RLA)	Straight	Intermediate	Sickled
Rear Leg Knee Structure	(RLS)	Coarse	Intermediate	Fine & thin
Rear Legs Rear View	(RLV)	Toes out	Intermediate	Bow-legged
Foot Angle	(FA)	Low	Intermediate	Steep
Fore Udder Attachment	(FUA)	Loose	Intermediate	Strong
Rear Udder Height	(RUH)	Low	Intermediate	High
Rear Udder Width	(RUW)	Narrow	Intermediate	Wide
Central Ligament	(CL)	Weak	Intermediate	Strong
Udder Depth	(UD)	Deep	Intermediate	High
Fore Teat Length	(FTL)	Short	Intermediate	Long
Rear Teat Placement	(RTP)	Wide	Intermediate	Close
Mammary Acuity	(MA)	Defect	Intermediate	Perfect

Statistical model

The statistical model used for the analysis is as follows;

$$Y_{ijk} = \mu + a_i + b_j + e_{ijk} \quad (1)$$

Where; Y_{ijk} is the observation of the traits, a_i is the effect of breed (i= HF and RH); b_j is the effect of lactation number (j= 1, 2, 3 and 4+); and e_{ijk} is the random error. The data were analyzed using the GLM procedure of SAS (SAS, 2010) and the differences between the least-square means of fixed factor level were considered to be statistically significant at $P<0.05$ (2-tailed), based on Tukey's adjustment type I error rate.

Results and Discussion

The least square means, their standard errors and levels of significance of LTT and 100 system scores of animal data used in this study are presented in Tables 2, 3, 4 and 5. In this study, it was determined that the difference between the breeds was found not important ($P>0.05$) but most of the udder composite traits regarding the lactation numbers were found significant ($P<0.01$-0.05).

Linear Type Traits

Body, Foot and Legs composite traits

The least square means and standard errors of body and foot and legs composite traits are presented in Table 2 and Table 3 and their level of significance were also determined. According to the results of analysis, only the RLA was found significant (P<0.05) betwen first and second lactations and the overall mean was found to be 5.64±0.91 score and this score is intermediate but tends to be sickle hocked and is preferable for dairy cows. The RLA being the only one significant among body, foot and legs traits, there wasn't any important traits in body composite traits neither between breeds nor between different lactations. Even though most of the body and foot and legs traits were not found statistically significant, all scores were intermediate, no minimal or extremes were found in this herd made of HF and RH.

The mean RLA found here (5.64±0.91) was similar to some means found by Fatehi et al. (2003); less than the findings of Meyer et al. (1987); and a little higher than the findings of Baycan (2022) who found 4.74±0.16, also higher than other means found by Fatehi et al. (2003) for RLA but most of the found averages were ideal for dairy cows. The extremes for RLA (very staight or very sickled legs) are not ideal, because they limit the walking capability and can cause the disability of the cow (Şahin, 2011) and can also cause foot and legs lesions (Kumlu, 2000; Çerçi and Koç, 2006). That is why the intermediate legs' scores (4-6) are good and the score found here is included and ideal.

Table 2. Least-square means and standard errors of Body composite traits of Holstein-Friesian (HF) and Red Holstein (RH)

Tablo 2. Siyah-Alaca (SA) ve Kırmızı-Alaca (KA)'nın Beden özelliklerinin en küçük kareler ortalamaları ve standart hataları

Factors	n	St	CW	BD	RA	RW	BCS
Breed		NS	NS	NS	NS	NS	NS
HF	102	6.72±0.21	6.26±0.23	5.54±0.12	6.65±0.71	4.63±0.12	4.87±0.12
RH	19	6.76±0.43	6.21±0.28	6.07±0.25	6.71±0.56	5.55±0.24	5.28±0.25
LN		NS	NS	NS	NS	NS	NS
1	26	6.74±0.35	6.60±0.39	5.93±0.21	6.05±0.46	4.48±0.20	5.32±0.20
2	63	6.43±0.31	6.20±0.35	5.58±0.19	6.22±0.52	4.47±0.18	5.12±0.18
3	14	6.74±0.51	6.26±0.58	5.69±0.30	6.89±0.67	4.46±0.29	4.99±0.30
4+	18	7.05±0.40	5.89±0.45	6.03±0.24	7.55±0.52	4.95±0.22	4.87±0.23
Overall	121	6.61±1.68	6.26±1.90	5.55±1.00	6.44±2.19	4.57±0.95	4.98±0.98

NS: Not Significant.

St: Stature, CW: Chest Width, BD: Body Depth, RA: Rump Angle, RW: Rump Width, BCS: Body Condition Score, LN: Lactation number.

Table 3. Least-square means and standard errors of Foot and Legs traits of Holstein-Friesian (HF) and Red Holstein (RH)

Tablo 3. Siyah-Alaca (SA) ve Kırmızı-Alaca (KA)'nın Ayak ve Bacak özelliklerinin en küçük kareler ortalamaları ve standart hataları

Factors	n	RLV	RLA	RLS	FA
Breed		NS	NS	NS	NS
HF	102	5.24±0.14	5.65±0.11	5.64±0.14	4.84±0.10
RH	19	4.75±0.30	5.64±0.23	4.96±0.30	4.85±0.21
LN		NS	*	NS	NS
1	26	5.04±0.24	6.15±0.19[a]	5.58±0.24	4.77±0.17
2	63	5.15±0.22	5.52±0.17 [b]	5.28±0.22	4.77±0.17
3	14	4.47±0.35	5.42±0.28 [ab]	5.53±0.36	4.72±0.25
4+	18	5.30±0.27	5.50±0.22 [ab]	4.76±0.28	5.22±0.19
Overall	121	5.24±1.16	5.64±0.91	5.52±1.17	4.78±0.81

NS: Not significant.

*: Significant for P<0.05.

RLV: Rear Legs Rear View, RLA: Rear Legs Set Angle, RLS: Real Legs Knee Structure, FA: Foot Angle, LN: Lactation number.

Udder composite traits

The least square means and their standard errors of udder composite traits are presented in Table 4 and their level of significance were also determined. According to the results of analysis, the FUA (P<0.01), RUW (P<0.05) and UD (P<0.01) were found statistically significant regarding lactations numbers and the overall means were found to be 5.01±1.02, 5.35±0.97 and 7.52±1.82 scores, respectively for FUA, RUW and UD. According to these scores and as shown in Table 1, the FUA and the RUW scores were intermediate while the UD was high generally. The highness of udder is preferable in lactating cows especially in mastitis resistance because cows with deep udder are not generally resistant to mastitis.

In this study, the mean of FUA found here was similar to the one found by Klassen et al. (1992), smaller than Meyer et al. (1987), higher than Visscher and Godbard (1995), Van Dorp et al. (1998). UD higher than Meyer et al. (1987), Van Dorp et al. (1998), Pérez-Cabal and Alenda (2002). As for RUW, there were not availability of results found by other researchers for comparison of the current results but the found score was intermediate. The significance of the LN on UD found here is similar to the results of Güler et al. (2020) who found the importance of parity on UD (P<0.01-0.05) in their study aimed at evaluating LTT in Simmental cows reared on high altitude of Eastern Turkey. Williams et al. (2003) also found the significance of UD in dairy cows. The significance of parity on udder traits has generally been the common result found by many researchers, reason why it is of great importance to focus mostly on udder trait characteristics while selecting lactating cows.

Table 4. Least-square means and standard errors of Udder composite traits of Holstein-Friesian (HF) and Red Holstein (RH)
Tablo 4. Siyah-Alaca (SA) ve Kırmızı-Alaca (KA)'nın Meme özelliklerinin en küçük kareler ortalamaları ve standart hataları

Factors	N	FUA	RUW	RUH	CL	UD	RTP	FTL	MA
Breed		NS	NS	NS	NS	NS	NS	NS	NS
HF	102	4.94±0.134.	5.41±0.12	4.70±0.07	5.62±0.15	7.23±0.23	7.25±0.27	5.78±0.14	7.47±0.28
RH	19	97±0.26	5.62±0.25	4.71±0.15	5.39±0.30	6.87±0.46	6.44±0.55	5.80±0.28	6.75±0.57
LN		**	*	NS	NS	**	NS	NS	NS
1	24	5.55±0.21[a]	5.13±0.20 [a]	4.73±0.12	5.17±0.24	8.53±0.38[a]	6.70±0.45	5.70±0.23	7.33±0.46
2	63	5.01±0.19 [ab]	5.30±0.18 [ab]	4.86±0.11	5.40±0.22	7.70±0.34[ab]	7.13±0.40	5.60±0.20	7.07±0.42
3	14	4.87±0.31 [ab]	5.31±0.30 [ab]	4.72±0.18	5.67±0.36	6.82±0.55[ab]	6.88±0.66	6.08±0.33	6.50±0.68
4+	18	4.39±0.24 [b]	6.00±0.23 [b]	4.50±0.14	5.23±0.28	5.13±0.43[b]	6.66±0.51	5.78±0.26	7.54±053
Overall	121	5.01±1.02	5.35±0.97	4.76±0.59	5.53±1.18	7.52±1.82	7.21±2.17	5.69±1.09	7.38±2.23

NS: Not significant. *: Significant for P<0.05. **: Significant for P<0.01.
FUA: Fore Udder Attachment, RUH: Rear Udder Height, RUW: Rear Udder Width, CL: Central Ligament, UD: Udder Depth, RPT: Rear Teat Placement, FTL: Fore Teat Length, MA: Mammary Acuity, LN: Lactation number.

100 Scoring Method

The least square means and standard errors of 100 scoring method were presented in Table 5 and their level of significance were also determined. According to the results of analysis, udder traits were found significant (P<0.05) regarding lactation numbers and the overal mean was 84.08±1.43 score per 100. Other traits such us DS, Frame, FL and the general mean for 100 scoring method did not show any importance whether regarding breed effect or lactation numbers. By considering these and also previous results, it was remarked that udder traits variate with lactation numbers, fact wich is well understandable while considering the evolution of the mammary gland in dairy cows, from heifers to multiparous cows. The significance of udder in terms of parity was also found by Baycan (2022) but his means were generally lower. The mean score found here is as suitable as expected and is ideal for a dairy herd.

Generally, between different lactations, cows between first and second parities showed significant differences for RLA trait while for FUA, RUW, UD and Udder100 traits, only cows in first and in 4+ lactations were significantly different (P<0.01-0.05).

Table 5: Least-square means and standard errors of 100 scoring method of Holstein-Friesian (HF) and Red Holstein (RH)
Tablo 5. *Siyah-Alaca (SA) ve Kırmızı-Alaca (KA)'nın 100 puan sistemi ile en küçük kareler ortalamaları ve standart hataları*

Factors	n	DS	Frame	FL	Udder	Total Point
Breed		NS	NS	NS	NS 84.02±0.18	NS
HF	102	84.12±0.40	83.46±0.23	82.47±0.22	83.45±0.36	83.53±0.14
RH	19	82.86±0.82	83.64±0.46	81.60±45		82.93±0.28
LN		NS 83.53±0.38	NS	NS	*	NS
1	24	83.24±0.34	83.53±0.38	82.11±0.37	84.37±0.30[a]	83.32±023
2	63	83.43±0.56	83.24±0.34	82.41±0.33	84.02±0.27[ab]	83.38±0.21
3	14	83.94±0.43	83.43±0.56	81.35±0.54	83.57±0.44[ab]	83.11±0.34
4+	18		83.94±0.43	82.27±0.42	82.98±0.34[b]	83.11±0.26
Overall	121	83.80±3.22	83.38±1.82	82.50±1.76	84.08±1.43	83.51±1.10

NS: Not significant. *: Significant for P<0.05.
DS: Dairy Strength, FL: Foot and Legs, LN: Lactation number.

Conclusion

This study gave important information about type traits in dairy cows in general and HF and RH in particular. In this study, among LTT and 100 scoring method, the RLA, FUA, RUW, UD and Udder100 traits showed significant difference regarding lactation numbers. This is due to the fact that when the animals are getting older, disconformation occurs in the structure of the dairy cows' udder and also rear legs. This study also showed the importance of using type traits as a tool of classifying dairy cattle according to their lactation numbers by focussing on type traits in general and legs and udder traits in particular. There was not any significance of type traits between the breeds but most of the udder composite traits' variations were important

in different lactations either for LTT scoring or the 100 scoring method and such traits must be taken into account while classifying dairy cows. This non-significant differences between the two cattle breeds (HF and RH) can be explained by the fact that they have a common origin but their recording system was differentiated in the 1950's but till now after almost 70 years later, there are still not much significant differences between them.

Acknowledgment

The Authors thank Dr Onur Şahin for his training about conformation scoring and recording, the owner of the farm and other students who helped during the field works of this study.

References

Baycan, S. C., 2022. Türkiye'de Organik Süt Sığırı İşletmeleri İçin Seleksiyon İndeksi Geliştirilmesi. Doktora tezi. Bursa Uludağ Üniversitesi Fen Bilimleri Enstitüsü. 230p.

Berry, D. P., Buckley, F., Dillon, P., Evans, R. D. Veerkamp, R.F., 2004. Genetic relationships among linear type traits, milk yield, bodyweight, fertility and somatic cell count in primiparous dairy cows. Irish Journal of Agricultural and Food Research 43(2):161-176.

Boettcher, P. J., Jairath, L. K., Koots, K. R., Dekkers, J. C. M., 1997. Effects of interactions between type and milk production on survival traits of Canadian Holsteins. Journal of Dairy Science 80: 2984- 2995.

Çerçi, S., Koç, A., 2006. Aydin İlinde Bazı İşletmelerde Yetiştirilen Siyah-Alaca Süt Sığırlarının Dış Görünüşlerine Göre Sınıflandırılması. Adnan Menderes Üniversitesi Ziraat Fakültesi Dergisi 3(2), 61-68.

Duru, S., 2005. Siyah Alaca Sığırlarda Dış Görünüş Özelliklerine Ait Parametre Ve Damızlık Değer Tahmini. Doktora tezi. Uludağ Üniversitesi Fen Bilimleri Enstitüsü, 134p.

Fatehi, J., Stella, A., Shannon, J. J., Boettcher, P. J., 2003. Genetic parameters for feet and leg traits evaluated in different environments. Journal of Dairy Science 86: 661-666

Funk, D. C., Hansen, L. B., 1991. Inheritance of cow durability for linear type traits. Journal of Dairy Science 74: 1753-1759.

Gengler, N., Wiggans, G. R., Wright, J. R., Norman, H. D., Wolfe, C. W., 1997. Estimation of (co)variance components for Jersey type traits using a repeatability model. Journal of Dairy Science 80: 1801-1806

Güler, O., Diler, A, Yanar, M., Aydın, R., Koçyiğit, R., 2020. Appraisal of linear type traits in Simmental cows reared on high altitude of Eastern Turkey. Journal of Agricultural Sciences 26**:** 331-338

Harris, R. A ., 2015. Phenotypic Correlations Between Linear Type Conformation Traits, Production and Fertility in a Once-a-day Milk Dairy Cattle Herd. M.V.Sc. Thesis. Massey University (Unpublished), Palmerston Norton, New Zealand.

ICAR, 2018. Conformation Recording (Section 05). International Committee for Animal Recording Guidelines. https://www.icar.org/Guidelines/05-Conformation-Recording.pdf

Juozaitiene, V., Juozaitis, A., Micikeviciene, R., 2006. Relationship between somatic cell count and milk production or morphological traits of udder in Black-and-White cows. Turkish Journal of Veterinary and Animal Sciences 30(1): 47-51

Klassen, D. J., Monardes, H. G., Jairath, L., Cue, L. I., Hayes, J. F., 1992. Genetic correlations between lifetime production and linearized type in Canadian Holsteins. Journal of Dairy Science 75: 2272-2282

Kumlu, S., 2000. Damızlık ve Kasaplık Sığır Yetiştirme. Akdeniz Üniversitesi Ziraat Fakültesi Zootekni Bölümü, Setma Matbaacılık, Ankara, 166 s.

Künzi, N., 1994. Exterieur. (Ed. H. Kräußlich, Tierzüchtungslehre). Verlag Eugen Ulmer, Stuttgart: 147-153

Lucas, J. L., Pearson, R. E., Vinson, W. E., Johnson, L. P., 1984. Experimental linear descriptive type classification. Journal of Dairy Science 67: p. 1767.

Meyer, K., Brotherstone, S., Hill, W. G., Edwards, M. R., 1987. Inheritance of linear type traits in dairy cattle and correlations with milk production. Animal Production 44: 1-10

Pérez-Cabal, M. A., Alenda, R., 2002. Genetic Relationships between Lifetime Profit and Type Traits in Spanish Holstein Cows. Journal of Dairy Science 85: 3480-3491

Pryce, J. E., Veerkamp, R. F., Thompson, R., Hill, W. G., Simm, G., 1998. Genetic aspects of common health disorders and measures of fertility in Holstein Friesian Dairy cattle. Animal Science 65: 353-360. https://doi.org/10.1017/S1357729800008559

Rogers, G. W., Banos, G., Sander-Nielsen, U., Philipsson, J., 1998. Genetic correlations among somatic cell scores, productive life and type traits from the United States and udder health measures from Denmark and Sweden. Journal of Dairy Science 81: 1445-1453.

Rogers, G. W., Hargrove, G. L., Lawlor, T. L., Ebersole, J. L., 1991.Correlations among linear type traitsa and somatic cell count. Journal of Dairy Science 74: 4189-4194.

Royal, M. D., Pryce, J. E., Woolliams, J. A., Flint, A. P. F., 2002. The genetic relationship between commencement of luteal activity and calving interval, dody condition score, production, and linear type traits in Holstein-Friesian dairy cattle. Journal of Dairy Science 85: 3071-3080

Şahin, O., 2011. Süt Sığırlarında Tip Sınıflandırması ve Vücut Kondisyonu Değerlendirme. Türkiye Damızlık Sığır Yetiştiricileri Merkez Birliği Yayınları, (5).

SAS Institute Inc., 2010. SAS/STAT User's Guide: ver. 9.22. SAS Institute Inc., Cary, NC, USA.

Schneider, M. P., Dürr, J. W., Cue, R. I., Monardes, H. G., 2003. Impact of type traits on functional herd life of Quebec Holsteins assessed by survival analysis. Journal of Dairy Science 86(12): 4083-4089

Van Dorp, T. E., Dekkers, J. C. M., Martin, S. W., Noordhuizen, J. P. T. M., 1998. Genetic parameters of health disorders, and relationships with 305-day milk yield and conformation traits of registered-Holstein cows. Journal of Dairy Science 81: 2264-2270

Veerkamp, R. F., Brotherstone, S., 1997. Genetic correlation between linear type traits, food intake, live weight and condition score in Holstein-Friesian dairy cattle. Animal Science 64: 385-392.

Vinson, W. E., Pearson, R. E., Johnson, L. P., 1982. Relationships between linear descriptive type traits and body measurements. Journal of Dairy Science 65:p.995.

Visscher, P. M., Goddard, M. E., 1995. Genetic parameters for milk yield, survival, workability, and type traits for Australian dairy cattle. Journal of Dairy Science 78: 205-220

Wesseldijk, B., 2004. Secondary traits make up 26% of breeding goal. Holstein International, 11(6):8–11.

Williams, M., Sleator, R. D., Murphy, C. P., McCarthy, J., Berry, D. P., 2003. The Relative Importance of Linear Type Traits in Determining Survival Increases as Holstein-Friesian Dairy Cows Age. Proceedings of 12th World Congress on Genetics Applied to Livestock Production (WCGALP), 2847-2850 p. https://doi.org/10.3920/978-90-8686-940-4_690

Zavadilová, L., Štípková, M., 2012. Genetic correlations between longevity and conformation traits in the Czech Holstein population. Czech Journal of Animal Science 57:125-136.