



Factors affecting and estimates of repeatability for milk production and composition traits in several breeds of dairy cattle

HANI N HERMIZ* and JOSHAN M HADAD

Salahaddin University, Erbil, Kurdistan Region, Iraq

Received: 7 May 2019; Accepted: 23 September 2019

ABSTRACT

Production records (323) were collected during two calving seasons of Bokane, Friesian and Simmental cows bred at three herds. Cows milked twice daily and milk samples collected at the peak of production to determine fat, protein, lactose, solid non-fat (SNF) %. Data was analyzed for diagnosing the significant effects of the available factors on the studied traits. Repeatability of total milk production (TMP), compositions and correlations among them were estimated. Overall mean of TMP, fat, protein, lactose, and SNF were 3,752.3 kg, 3.129%, 3.065%, 4.507% and 7.688%, respectively. TMP affected by breed, herd, parity and year of calving significantly. Regression of TMP on age at first calving was not significant (–19.597 kg/mo.), whereas regressions on body weight at calving (12.567 kg/kg) and on calf birth weight (157.63 kg/kg) were significant. Breed affects fat and protein significantly. Differences between herds in their fat, lactose and SNF% were significant. Effect of parity was significant on all milk composition except lactose %. Year of calving affects all milk compositions significantly ($P < 0.01$). Effect of sex of calf was significant only on SNF. Highest estimate of correlation (0.73) ($P < 0.01$) was between lactose % and SNF % while lowest estimate (–0.57) ($P < 0.01$) was between TMP and fat %. Estimated values of repeatability for TMP, fat %, protein %, lactose % and SNF % were 0.67, 0.48, 0.26, 0.33, and 0.30 respectively.

Keywords: Correlation, Dairy cattle, Milk production and Composition, Repeatability

Total milk production and composition are an important economic trait in livestock species, it represents a major source of income in most dairy enterprises. To change the composition of milk, it requires knowledge of the relative influence of genetic and environmental factors affecting milk constituents. This can be achieved by an in-depth investigation of all factors affecting the composition of milk (Boro *et al.* 2016). Milk is composed of water, proteins, amino acids, vitamins, lipids, fatty acids and minerals (Schroeder 2012, Boro *et al.* 2016). These contents affected by several factors including breed or genetic group, milk production, stage of lactation, parity, feeding, season of calving (Simões *et al.* 2014).

The objectives of this research were to analyze genetic and non-genetic factors affecting milk production and composition in Friesian, Simmental and Bokane cattle bred at different locations, as well to estimate the repeatabilities of the traits and the correlations among them.

MATERIALS AND METHODS

The study conducted at three herds of dairy cattle—private sector belongs to Erbil governorate—Kurdistan Region, Iraq. The production records were collected during two calving seasons (2016–2017) and (2017–2018) and

includes 323 records of dairy cattle (72 Bokane, 188 Friesian, and 63 Simmental).

The herds were managed by the breeders themselves including feeding, reproductive (breeding system), and veterinary sanitation. Cows were fed to the available concentrates which was provided twice a day as well as providing free hay until the *ad lib*. Cows and heifers (26–30 months of age) were naturally inseminated (by sires). Milking of cows was initiated 4 days after calving and twice daily by machine. Lactating cows were dried off when they were seven month pregnant or when their milk yield was less than 2 kg/day.

A special form was arranged to be suitable to record the information for each farm which include location, cow number and breed, sire number and breed, date of mating, date of calving, calve number, sex of calve, birth weight of calve, age of cow, body weight of cow, total milk production, as well milk composition. Milk samples were collected during the peak in their milk production in order to determine fat, protein, lactose, SNF% by apparatus EKO TOTAL MILK. Samples taken from the evening were kept in the fridge at 4°C and mixed with the samples taken from the morning for each cow to obtain a homogeneous mixture of milk and then transferred to the laboratory for chemical analysis.

General Linear Model (GLM) within the statistical

*Corresponding address e-mail: hani.hermiz @su.edu.krd

programme SAS (2005) was used to analyze the collected data for diagnosing the significance effects of the available factors affecting the studied traits. The model for TMP includes the effects of breed, herd, parity, year and season of calving, sex of calf, the regressions on age at first calving, body weight of cow at calving, and on birth weight of calf. The same model was used to analyze the data of milk compositions as in the model of TMP after excluding all the regressions. The repeatability of TMP, fat, protein, lactose and SNF% were estimated using Restricted Maximum Likelihood (REML) method within SAS (2005). Correlation coefficients among TMP with milk composition (fat, protein, lactose and SNF %) were also estimated.

RESULTS AND DISCUSSION

Total Milk Production: The overall mean of TMP for the three breeds in all herds was 3,752.3±69.92 kg (Table 1)

Table 1. Least square means ± S.E. and mean square for the effects on total milk production (kg) of cows

Factor	d.f. or No.	Total milk production (kg) Mean square or means ± S.E
Overall mean	323	3752.3 ± 69.92
<i>Breed</i>	2	16530240.02 **
Bokane	72	2919.21 ± 112.68 c
Friesian	188	4056.78 ± 126.59 a
Simmental	63	3355.61 ± 147.69 b
<i>Herd</i>	2	8066420.27 **
MurtkayGawra	89	2754.10 ± 155.10 b
Murtka	194	3628.90 ± 129.71 a
Koya	40	3948.60 ± 153.47 a
<i>Parity</i>	3	4669484.85 **
1	68	4272.29 ± 199.75 a
2	138	3621.39 ± 91.45 b
3	82	3031.16 ± 133.62 c
≥4	35	2850.63 ± 211.73 c
<i>Year of calving</i>	1	4081806.67 *
2016–2017	164	3276.81 ± 96.03 b
2017–2018	159	3610.92 ± 95.37 a
<i>Season of calving</i>	3	1131630.80
Winter	137	3404.95 ± 90.42 a
Spring	73	3633.59 ± 108.01 a
Summer	48	3358.84 ± 129.98 a
Autumn	65	3378.09 ± 113.92 a
<i>Sex of calf</i>	1	2370909.67
Male	127	3335.42 ± 97.10 a
Female	196	3552.31 ± 78.99 a
<i>Regression on</i>		
Age at first calving	1	205450.85
	323	-19.597 ± 3.63
Body weight of cow	1	27960501.19 **
	323	12.567 ± 1.99
Birth weight of calf	1	16376433.19 **
	323	157.63 ± 32.71
<i>Residual</i>	307	705294.4

Means having different letters within each factor/column differ significantly (P<0.05) according to Scheffe’s test. **, P<0.01; *, P<0.05.

and within the range reported earlier by several investigators in different breeds (Alkass *et al.* 2002, Hermiz *et al.* 2005, Ríos-Utrera *et al.* 2013, Verma *et al.* 2015, Rahbar *et al.* 2016, Jonas *et al.* 2016).

The breed were found to have a highly significant effect on TMP, where Friesian cattle surpassed Simmental and Bokane in their TMP and were 4056.78, 3355.61 and 2919.21 kg respectively (Table 1). The significant differences may be due to the genotype as well the variations between individuals within a certain dairy breed (Thaller *et al.* (2003). Similar results were noticed by Ríos-Utrera *et al.* (2013).

The differences in TMP due to the herd were significant (Table 1). It is therefore expected for different herds to exhibit different levels of production because of variations in the level of management. Petroviæ *et al.* (2015) claimed that the herd affects TMP significantly.

The results shows that TMP significantly (P<0.01) declined with the progress of parity (Table 1). While others revealed that an increase in parity resulted in a significant increase in TMP up to parity 4 and started declining in parity 5 (Alkass *et al.* 2002, Badri *et al.* 2011, Petroviæ *et al.* 2015, Jonas *et al.* 2016).

Year of calving affects TMP significantly (Table 1). Cows calved during the second year (2017–2018) produced higher milk (3610.92 kg) comparing with those calved in the first year (2016–2017) which produced 3,276.81 kg. This could be due to differences in environment, availability of pastures, different management systems and different herd size as well to the changes in age of the animals (Tavirimirwa *et al.* 2012). Similarly, many investigators found that the year of calving had a significant effect on TMP (Alkass *et al.* 2002, Al-Khazragi 2005, Badri *et al.* 2011).

Although cows calved in spring produced higher milk compared with those calved in other seasons, but the differences were not significant (Table 1). Earlier investigators noticed no significant effects of season of calving on TMP (Badri *et al.* 2011, Verma *et al.* 2015). While others revealed a significant effect of season on TMP (Alkass *et al.* 2002, Petroviæ *et al.* 2015, Jonas *et al.* 2016).

The differences between cows calved, males or females in their TMP were not significant (Table 1), it appears that cows calved females had higher TMP (3552.31 kg) rather than male calf (3335.42 kg). The mentioned results were confirmed by Atashi *et al.* (2012).

Regression coefficient of TMP on age at first calving (AFC) was not significant and negative (-19.597 kg/mo.) (Table 1). Al-Khazragi WJM (2005) found that the regression of TMP on AFC was negative but significant. On the other hand, Petroviæ *et al.* (2015) mentioned that AFC in dairy cattle is considered as one of the important factors which affects TMP significantly.

The regression coefficient of cow’s milk production on their body weight at calving was positive (12.567 kg/kg) (P<0.01) (Table 1). Previously, Petrovska S and Jonkus D (2014) also reported a positive significant correlation

between the two traits, which could be due to the fact that cows with greater live weight can intake more feed.

Effect of calf birth weight on TMP was studied as a regression [157.63 kg/kg] ($P < 0.01$) (Table 1). Ghoraihy S H and Rokouei M (2013) obtained linear and positive relationship between both traits. Also, Rahbar *et al.* (2016) found a trend for milk305 based on calf birth weight, and was significantly dependent.

Milk Composition: The overall means of fat, protein, lactose, and SNF were 3.129 ± 0.02 , 3.065 ± 0.01 , 4.507 ± 0.01 , and $7.688 \pm 0.01\%$, respectively (Table 2).

The effects of breed on fat and protein % were significant while the effects on lactose and SNF% were not significant (Table 2). Such differences could be due to different milk produced by breeds used in this study (Table 1). The highest fat % (3.514) and protein (3.088) was recorded for Simmental, Bokane, respectively, while the highest lactose % (4.531) and SNF (7.712) were recorded for Friesian. Sarkar *et al.* (2006) claimed that milk composition is not constant in dairy cows and was influenced significantly by breed. Variation in milk composition due to heredity was 55%, while it was 45% due to environmental factors such as feeding and management (Schroeder 2012). Effect of breed on milk composition was reported to be significant for all the traits except lactose % (Sarkar *et al.* 2006). Ivanov *et al.* (2017) reported no statistically significant difference

established between the milk fat, protein and total solids contents of Holstein and Simmental milk samples. Unlike these two breeds, the milk of the Jersey breed is characterized by significant higher values ($P < 0.05$) of the milk fat, protein and total solids contents. On the other hand, Sudhakar *et al.* (2013) found that the differences in all of milk contents between Holstein Friesian and Jersey crossbred breeds were statistically not significant.

The differences between the herds in fat, lactose and SNF% were significant, while the differences in protein % were not significant (Table 2). Nyamushamba *et al.* (2013) noticed a significant effect of herd-year-season on milk composition. Sudhakar *et al.* (2013) used Jersey and Holstein Friesian crossbred bred at 6 farms, revealed that the differences were significant on fat %, while the differences in protein, lactose and SNF% were not significant.

Fat % in milk of cows with the 1st and 2nd parity were significantly ($P < 0.01$) higher than that in milk of cows with the 3rd and 4th parity. The differences in milk of cows with different parity were significant ($P < 0.01$) in protein and ($P < 0.05$) in SNF %, while the differences in their lactose % found in this study were not significant (Table 2). In addition, Al-JaafSh SA (2004), Jonas *et al.* (2016) revealed to a significant effect of parity on fat and protein %. Also Suman (2009) observed significant effect of parity on SNF

Table 2. Least square means \pm S.E. and mean square for the effects on Fat, Protein, Lactose and SNF (%) in milk of cows

Factor	d.f. or No.	Mean square or Means \pm S.E			
		Fat %	Protein %	Lactose %	SNF %
Overall mean	323	3.129 \pm 0.02	3.065 \pm 0.01	4.507 \pm 0.01	7.688 \pm 0.01
<i>Breed</i>	2	2.8543**	0.0376**	0.0159	0.0469
Bokane	72	3.253 \pm 0.02 ^b	3.088 \pm 0.01 ^a	4.508 \pm 0.01 ^a	7.704 \pm 0.02 ^a
Friesian	188	2.927 \pm 0.03 ^c	3.071 \pm 0.01 ^{ab}	4.531 \pm 0.01 ^a	7.712 \pm 0.02 ^a
Simmental	63	3.514 \pm 0.03 ^a	3.037 \pm 0.01 ^b	4.487 \pm 0.02 ^a	7.649 \pm 0.02 ^b
<i>Herd</i>	2	1.6610**	0.0135	0.0631**	0.0930**
MurtkayGawra	89	2.994 \pm 0.03 ^c	3.064 \pm 0.01 ^{ab}	4.484 \pm 0.01 ^b	7.665 \pm 0.02 ^b
Murtka	194	3.290 \pm 0.03 ^b	3.047 \pm 0.01 ^b	4.487 \pm 0.01 ^b	7.656 \pm 0.02 ^b
Koya	40	3.410 \pm 0.03 ^a	3.084 \pm 0.01 ^a	4.555 \pm 0.02 ^a	7.744 \pm 0.02 ^a
<i>Parity</i>	3	0.3932**	0.0418**	0.0021	0.0493*
1	68	3.334 \pm 0.03 ^a	3.107 \pm 0.01 ^a	4.511 \pm 0.02 ^a	7.728 \pm 0.02 ^a
2	138	3.300 \pm 0.02 ^a	3.074 \pm 0.01 ^b	4.515 \pm 0.01 ^a	7.703 \pm 0.01 ^a
3	82	3.172 \pm 0.03 ^b	3.032 \pm 0.01 ^c	4.509 \pm 0.01 ^a	7.652 \pm 0.02 ^b
≥ 4	35	3.118 \pm 0.03 ^b	3.048 \pm 0.01 ^{bc}	4.499 \pm 0.02 ^a	7.669 \pm 0.02 ^{ab}
<i>Year of Calving</i>	1	1.9521**	0.0482**	0.0660**	0.2067**
2016–2017	164	3.131 \pm 0.02 ^b	3.049 \pm 0.01 ^b	4.490 \pm 0.01 ^b	7.656 \pm 0.01 ^b
2017–2018	159	3.332 \pm 0.02 ^a	3.081 \pm 0.01 ^a	4.527 \pm 0.01 ^a	7.721 \pm 0.01 ^a
<i>Season of Calving</i>	3	0.0455	0.0046	0.0207	0.0124
Winter	137	3.217 \pm 0.02 ^a	3.072 \pm 0.01 ^a	4.507 \pm 0.01 ^{ab}	7.695 \pm 0.01 ^a
Spring	73	3.243 \pm 0.02 ^a	3.071 \pm 0.01 ^a	4.496 \pm 0.01 ^b	7.683 \pm 0.02 ^a
Summer	48	3.203 \pm 0.03 ^a	3.063 \pm 0.01 ^a	4.497 \pm 0.01 ^b	7.670 \pm 0.02 ^a
Autumn	65	3.263 \pm 0.03 ^a	3.055 \pm 0.01 ^a	4.535 \pm 0.01 ^a	7.705 \pm 0.02 ^a
<i>Sex of Calf</i>	1	0.0355	0.0143	0.0202	0.0739*
Male	127	3.220 \pm 0.02 ^a	3.058 \pm 0.01 ^a	4.500 \pm 0.01 ^a	7.672 \pm 0.01 ^b
Female	196	3.242 \pm 0.02 ^a	3.072 \pm 0.01 ^a	4.517 \pm 0.01 ^a	7.704 \pm 0.01 ^a
<i>Residual</i>	310	0.0393	0.0056	0.0099	0.0158

Means having different letters within each factor/column differ significantly ($P < 0.05$) according to Scheffe's test. **, $P < 0.01$; *, $P < 0.05$.

and protein content. According to a survey of Holstein Dairy Herd Improvement Association (DHIA) lactation records, milk protein content typically decreases 0.10 to 0.15 units over a period of five or more lactations or approximately 0.02 to 0.05 units per lactation (Looper 2012). He reported that parity can influence fresh milk components, whilst milk fat content remains relatively constant; milk protein content gradually decreases with advancing parity/age. Other studies found that the effect of parities was not significant for the milk composition traits of different breeds (Sudhakar *et al.* 2013, Sarkar *et al.* 2006).

It appears from Table 2 that year of calving affect all milk composition % significantly ($P < 0.01$) and the differences were 0.201, 0.032, 0.037 and 0.065 for fat, protein, lactose and SNF %, respectively. This significant effect was in accordance with that reported by Nyamushamba *et al.* (2013).

Table 2 shows that the effects of season of calving on all studied % were not significant and the differences between cows calved in different seasons were not significant except that of lactose % where higher lactose % was recorded for cows calved in autumn. Similar results were found by Verma *et al.* (2015). While Ivanov *et al.* (2017) found that the effect of season of calving on all or some of milk composition % was significant. As temperatures increase, component levels are gradually decreased which could be indicative of feed intake patterns (Petroviæ *et al.* 2015, Jonas *et al.* 2016). This variation is related to changes in both the types of feed available and climatic conditions. Al-JaafSh S A (2004) noticed that the effect of months on fat % was not significant, while the effect on protein % was significant. Some of the changes in milk fat % with temperature could be related to changes in blood plasma lipids, but these observations are also confounded by dietary changes.

Although, fat, protein, lactose, and SNF% in milk produced from cows reared females (3.242, 3.072, 4.517, and 7.704% respectively) were higher than those in milk produced from cows reared males (3.220, 3.058, 4.500, and 7.672% in the same order), but the differences were not significant except those of SNF (Table 2). According to the study conducted by Taher *et al.* (2011), the differences in milk composition of cows with male or female calf were not significant. While Atashi *et al.* (2012) observed that fat% in milk produced by cows with female calf was higher.

Correlations between milk yield and its compositions: The highest estimate of correlation (0.73) ($P < 0.01$) was between lactose % and SNF % while the lowest estimate (-0.57) ($P < 0.01$) was between TMP and fat % (Table 3). Results obtained in this study confirm earlier studies, which claimed of negative correlation between TMP with fat %, protein % and total solids % in milk of several breeds (Al-Jaaf Sh 2004, Jonas *et al.* 2016). Taher *et al.* (2011) calculated the correlations among milk composition traits (fat, protein, lactose and SNF %) and found that all correlations were highly significant except that between protein and SNF. The correlations between fat with protein

Table 3. Correlations between total milk production (TMP) and milk compositions in cows

Trait	Fat %	Protein %	Lactose%	SNF%
TMP	-0.57**	-0.14*	0.10	-0.01
Fat %		0.14*	0.09	0.16**
Protein%			-0.04	0.58**
Lactose%				0.73**

*, $P < 0.05$; **, $P < 0.01$.

and lactose were 0.452 and -0.089 and between protein and lactose was -0.122 (Jonas *et al.* 2016).

Repeatability: The estimated values of repeatability for TMP, fat %, protein %, lactose % and SNF % were 0.67, 0.48, 0.26, 0.33, and 0.30 respectively, and these estimates were closed to that found by Badri *et al.* (2011).

The present study concluded that exotic breeds of dairy cattle could be improved to be promising dairy animals in Kurdistan Region-Iraq. Most of the phenotypic correlations among the studied traits were significant which mean that improving one trait will improve the others. The productive traits were repeatable which mean that the traits can be improved with improving the environmental effects.

REFERENCES

- Al-Jaaf Sh S A. 2004. 'The influence of some factors on milk contents of somatic cells, fat and protein in Holstein cows'. MSc Thesis, College of Agriculture, University of Baghdad (Abstract in English).
- Alkass J E, Al-Mulsi A M and Hermiz H N. 2002. Some Productive and Reproductive Traits of Friesian Cattle in Yemen. *The Iraqi Journal of Agricultural Science* **33**(4): 191–98.
- Al-Khazragi W J M. 2005. 'Adjustment factors for some permanent effects on milk productions in Holstein cattle'. MSc Thesis, College of Agriculture, University of Baghdad. (Abstract in English).
- Atashi H, Zamiri M J and Sayyadnejad M B. 2012. Effect of twinning and still birth on the shape of lactation curve in Holstein dairy cows of Iran. *Archives Animal Breeding* **55**(3): 226–33.
- Badri T M, Atta M, Ibrabim M T and Gubartalla K A. 2011. Genetic and non-genetic factors affecting production potential of Butana dairy cows at Atbara Research Station, Sudan. *Research Opinions in Animal and Veterinary Sciences (roavs)* **1**(7): 429–33.
- Boro P, Naha B C, Prakash C, Madkar A, Kumar N, Kumari A and Channa G P. 2016. Genetic and non-genetic factors affecting milk composition in dairy cows. *International Journal of Advanced Biological Research* **6**(2): 170–74.
- Ghoraishy S H and Rokouei M. 2013. Impact of birth weight of Iranian Holstein calves on their future milk production and reproductive traits. *Journal of Livestock Science and Technologies* **1**: 39–44.
- Hermiz H N, Juma K H, Khalaf S S and Aldoori T Sh. 2005. Genetic parameters of production, reproduction and growth traits of Holstein cows. *Dirasat, Agricultural Sciences* **32**(2): 157–62.
- Ivanov G Y, Bilgucu E, Balabanova T B, Ivanova I V and Uzatici A. 2017. Effect of animal breed, season, and milk production scale on somatic cell count and composition of cow milk.

- Bulgarian Journal of Agricultural Science* **23** (6): 1047–52.
- Jonas M, Atasever S, Graff M and Erdem H. 2016. Non-genetic factors affecting milk yield, composition and somatic cell count in Hungarian Holstein cows. Kafkas University, Veterinary Faculty. *Derg. Journal* **22**(3): 361–66.
- Looper M. 2012. *Factors affecting milk composition of lactating cows*. Agriculture and Natural Resources. Division of Agriculture Research and Extension, University of Arkansas, USA, pp. 6.
- Nyamushamba G B, Halimani T E, Imayarwo-chikosi V E, Tavirimirwa B and Zishiri O T. 2013. Effect of within herd environmental factors on milk, fat and protein yields in red dane cattle in zimbabwe. *Online Journal of Animal Feed Research* **3**(5): 202–04.
- Petroviæ D M, Bogdanoviæ V, Petroviæ M M, Bogosavljeviæ-Boškoviæ S, Ðokoviæ R and Rakonjac S. 2015. Effect of non-genetic factors on standard lactation milk performance traits in Simmental cows. *Annual Animal Science* **15**(1): 211–20.
- Petrovska S and Jonkus D. 2014. Relationship between body condition score, milk productivity and live weight of dairy cows. *Research for Rural Development* **1**: 100–106.
- Rahbar R, Abdollahpour R and Sefidmazgi A S. 2016. Effect of calf birth weight on milk production of Holstein dairy cattle in desert climate. *Journal of Animal Behaviour Biometeorol* **4**(3): 65–70.
- Ríos-Utrera Á, Calderón-Robles R C and Galaviz-Rodríguez J R. 2013. Effects of breed, calving season and parity on milk yield, body weight and efficiency of dairy cows under subtropical conditions. *International Journal Animal and Veterinary Advances* **5**(6): 226–32.
- Sarkar U, Gupta A K, Sarkar V, Mohanty T K, Raina V S and Prasad S. 2006. Factors affecting test day milk yield and milk composition in dairy animals. *Journal of Dairying, Foods and Home Science* **25**: 129–32.
- SAS. 2005. SAS/STAT® User's Guide for Personal Computers. Release 8.2. SAS Institute Inc., Cary, NC, USA.
- Schroeder J W. 2012. *Dairy cow nutrition affects milk composition*. NDSU Extension Service July 2012. Retrieved February 11, 2014, from <http://www.ag.ndsu.edu/pubs/ansci/dairy/as1118.pdf>.
- Simões M G, Portal R E, Rabelo J G and Ferreira C L L F. 2014. Seasonal variations affect the physicochemical composition of Bufallo milk and artisanal cheeses produced in Marajó Island (Pa, Brazil). *Advance Journal of Food Science and Technology* **6**(1): 81–91.
- Sudhakar K, Panneerselvam S, Thiruvankadan A K, John Abraham and Vinodkumar G. 2013. Factors effecting milk composition of crossbred dairy cattle in Southern India. *International Journal of Food, Agriculture and Veterinary Sciences* **3**(1): 229–33.
- Suman C L. 2009. Lactation trend of milk solid-not-fat in two-breed crosses of cattle at an organized farm. *Indian Journal of Animal Research* **43**: 12–16.
- Taher K N, Hassan H J and Mohammad B J. 2011. A study effect of age of dam and sex of birth on chemical and physical composition of milk in some farm animals. *Kufa Journal for Veterinary Medical Science* **2**(2): 8–17.
- Tavirimirwa B, Manzungu E and Ncube S. 2012. The evaluation of dry season nutritive value of dominant and improved grasses in fallows in Chivi district, Zimbabwe. *Online Journal of Animal Feed Research* **2**(6): 470–74.
- Thaller G, Krämer W, Winter A, Kaupe B, Erhardt G and Fries R. 2003. Effects of DGAT1 variants on milk production traits in German cattle breeds. *Journal of Animal Science* **81**: 1911–18.
- Verma M K, Sachdeva G K, Gautam S, Ali M M, Kumar R and Bindal S. 2015. Effect of genetic and non-genetic factors on milk yield and milk constituents of Sahiwal cattle. *Research Journal of Animal Husbandry and Dairy Science* **6**(1): 44–47.