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GENETIC AND NONGENETIC FACTORS AFFECTING BODY WEIGHT IN NILI RAVI BUFFALOES

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ABSTRACT

Live body weight of *Nili Ravi* buffaloes was studied to investigate the effect of certain environmental sources of variation such as herd, lactation number, lactation stage, season of recording and age of buffaloes at the time of recording along with appraisal of genetic parameters of body weight including heritabilities, genetic correlation and phenotypic correlation of body weight with milk yield. Five milking herds belonging to *Nili Ravi* buffaloes breed in Punjab were utilized in this study. Data recorded during 2010 to 2012 included 839 observations. Estimation of genetic parameters were carried out by Best Linear Unbiased Prediction (BLUP) procedure through ASREML set of computer program. Least square mean for body weight was found as 523.13±81.63 with a coefficient of variation of 15.60%. Herd, stage of lactation, lactation number, recording season and buffalo's age at the time of recording significantly affected live body weight. Univariate analysis of body weight indicated that heritability estimate for body weight was 0.33±0.07. Phenotypic correlations of body weight with milk yield in 305 days and milk yield on day of recording were found as 0.071±0.034 and 0.090±0.053 while genetic correlations were found as 0.16±0.00 and 0.20±0.00, respectively. High heritability and positive genetic correlation of body weight with milk yield suggested that body weight should be included in selection program for improved milk yield in *Nili Ravi* buffaloes.

Keywords: *Bubalus bubalis*, buffaloes, heritability, genetic correlation, body weight, *Nili Ravi* buffaloes

INTRODUCTION

Second highest buffalo populated country in the world is Pakistan (Perisic *et al*., 2015) and Nili Ravi breed is one of the most important buffalo breeds in Pakistan which is an important animal genetic resource (Khan *et al*., 2007). Body weight is belived to be very important for milk production standpoint. Various research reports indicate that correlation exists between

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body weight and milk yield. Dhillod *et al.* (2017) have mentioned phenotypic correlation in Murrah buffaloes as positive but not very high. Similarly, a positive genetic correlation of body weight with milk yield in 305 days has been reported by Khan (2009). Consdering live body weight as one of the most important parameters, the present study was planned. Main objectives of the study were documentation of body weight in Nili Ravi breed of buffaloes, to evaluate the consequence of certain genetic and nongenetic factors affecting body weight like herd, parity, lactation stage, season of recording and buffalo's age at the time of recording on body weight. The second main objective was estimation of genetic parameters including heritability, genetic correlation, and phenotypic correlation of body weight with milk yield in this breed of buffalo.

MATERIALS AND METHODS

Five herds of Nili Ravi breed of buffaloes maintained at government livestock farms and experimental stations in Punjab at different locations including Pattoki, Bhakkar, Hasil pur, Khushab and some private buffalo farmers were used in current study.

At all the stations, feeding and management practices were almost uniform. Animals were being kept in open yards with pipe fencing throughout the year. Proper covered space was provided to save animals from harsh weather conditions. Grazing was provided to all milking buffalo herd for about 4 to 6 h per day on available fodders in the morning after completion of milking process keeping in view seasonal conditions.

Concentrate feeding was practiced daily and 1 kg of concentrate mix was offered to each milking buffalo for every 3 kg milk mproduced. Rock salt (Sodium Chloride) was provided in feeding mangers free of choice for licking at all the farms. Twice a day miking of buffaloes was carried out early in the morning and evening with almost equal interval. In order to facilitate proper milk, let down, calves were not weaned and were offered direct suckling from their dams as per their daily allowance. Concentrate feeding was done to stimulate milk let down if death of the calf occurred during lactation period.

Data collection

Body weight was recorded for 3 years on monthly basis from 2010 to 1012 using weighing scale. Data regarding buffaloes and their pedigree records up to all available generations, birth dates, calving dates, parity, fertility status on recording date, milk production on recording day as well as 305 days milk yield, length of lactation, preceding dry period and age and weight at recording were also collected for use during analysis.

Evaluation model

Heritabilities and correlations (Phenotypic and genetic) were worked out by the use of best linear unbiased prediction procedures. Environmental sources of variation loike age of buffaloes at recording, lactation stage, parity, season of recording and effect of herd were added in the model for evaluation. Patterson and Thompson (1971) procedure of individual animal model was applied under Restricted Maximum Likelihood (REML) Procedure. Each year was devided in to 5 seasons as reported by Mirza *et al.* (2015). Fixed effects added in the model were as under;

- Herd: 1 to 5
- Recording season: 1 to 5
- Lactation No. 1 to 4 (first, second, third,

fourth and onward)

- Lactation stage 1 to 4 (early stage, mid, late stage and dry)

Age of each buffalo on the day of recording following general methametical model was used

$$Y_{bcdef} = \mu + S_b + H_c + P_d + T_e + b_1 (a_{bcdef}) + b_2 (a_{bcdef})^2 + e_{bcdef}$$

(Model 1)

Where:

Y_{bcdef}: The record of f^{th} buffalo at e^{th} stage of lactation during d^{th} parity of c^{th} herd in b^{th} season

μ: The overall population mean

S_b: The effect of b^{th} season

H_c: The effect due to c^{th} herd

P_d: The effect due to d^{th} parity

T_e: The effect due to e^{th} stage of lactation

a_{bcdef}: The age of buffalo at recordind time

b_1 and b_2: The linear and quadratic regression coefficient of age at recording time

e_{bcdef}: The random error pertaining to observation on f^{th} buffalo at e^{th} lactation stage in d^{th} lactation number of c^{th} herd in b^{th} season

Statistical Analysis System (SAS, 2011) program was used applying mixed model procedure for data analysis. Various fixed effects which were found as significant source of variation from preliminary analysis were only incorporated in 2^{nd} model to estimate variance components instead of using all fixed effects and then genetic parameters were estimated accordingly.

Genetic parameters stimation

ASREML set of computer program was used for estimation of genetic parameters applying Individual Animal Mode procedure. Heritability estimate for body weight was computed using following statistical model:

$$Y_{bcd} = \mu + F_b + A_c + P_d + e_{bcd}$$ (Second Model)

Where,

Y_{bcd}: Body weight of each buffalo

μ: Population mean

F_b: Fixed effects which were found significant from early analyses

A_c: Random additive effect of c^{th} animal with mean zero and variance σ^2_A

P_d: Random permanent effect of c^{th} animal with mean zero and variance σ^2_A

e_{bcd}: Random error with mean zero and variance σ^2_A

Following formula was used to calculate heritability:

$$\text{Heritability } (h^2) = \sigma^2_A / \sigma^2_P$$

Bivariate analysis was carried out for the estimation of genetic and phenotypic correlation of body weight with performance traits. Fixed effects used for bivariate analysis were the same as incorprated in univariate analysis (Model 1). ASREML (Gilmour, 2009) software was used for all these analyses.

RESULTS AND DISCUSSIONS

Herds of Nili Ravi breed buffaloes maintaind at government Livestock farms located at Pattoki, Hasil pur, Khushab, Bhakkar and some private farms were used in the present study. Data structure pertaining to various environmental factors is presented in Table 1 as given below.

Effect of environmental factors on body weight

Table 2 represents level of significance and F-value for body weight. It was seen that herd,

lactation stage, lactation number and season of recording were significant source of variation for body weight. Effect of age on body weight (both linear and quadratic) revealed that age at recording day was found as a significant source of variation for live body weight.

Body weight was significantly affected by all the factors included in the present investigation. Lin *et al.* (1983); Khan (2009) have documented significant herd effect on body weight in dairy breeds. Shankar and Mandal (2010) have reported significant effect of parity on body weight in Murrah, Diara and non-descript buffaloes. Karacaoren and Kadarmideen (2008); Blottner *et al.* (2011) have also reported this effect as significant in Swiss dairy cows and Holstein cows, respectively. Significant effect of lactation stage on body weight was described in Sahiwal cows (Khan, 2009). Effect of season on body weight was reported significant by Karacaoren and Kadarmideen (2008); Blottner *et al.* (2011). Lin *et al.* (1983); Islam *et al.* (2010) have reported significant effect of age on body weight in Holstein and Aayrshire line and in Swamp buffaloes, respectively. All these reports match with the results of this study. Contrary to these findings, Shankar and Mandal (2010) in Murrah, Diara and non-descript buffaloes and Khan (2009) in Sahiwal cows reported non-significant herd, stage of lactation and age effect body weight.

Least squares mean for body weight was found as 523.13±81.63 with a coefficient of variation of 15.60 (%). Body weight of Nili Ravi buffaloes in different herds, stages of lactation, parities and seasons have been presented in Tables 3, 4, 5, and Table 6, respectively.

The findings of current study are higher than the values reported by Cockrill (1974); Khan (2009a) in Nili Ravi buffaloes as 450 kg and 454 kg, respectively. Tariq *et al.* (2013) has reported body weight in 2 groups of Nili Ravi buffaloes as 448.4±100.6 kg and 529.5±67.5 kg for buffaloes with age ranging from 3 to 8 years and more than 8 years respectively. Other important reports included as 446.05±45.06 kg (Djaja, 2011) and 403.35±59.06 kg (Harun- Or-Rashid *et al.* 2019) in Murrah buffaloes, as 508.972+3.36 and 461.789±3.32 kg in graded Murrah and Diara buffaloes (Shankar and Mandal, 2010) and as 295.4±4.7 kg in Iranian buffaloes (Dezfuli *et al*., 2010).

Some of the workers have reported higher values than the findings of current study in different other breeds. These reports included 550 kg by Cockrill (1974) in Surti buffaloes, 573.68 kg by Al Jamass (1999) in Iraqi buffaloes, 725.08±104.5 kg by Negretti *et al.* (2008) in Mediterranean buffaloes and 550 kg by Hysen *et al.* (2019) in Mediterranean buffaloes and 556.11±4.91 kg by Dhillod *et al.* (2017) in Murrah buffaloes. All of the above lower and higher values differ from the results of current study. This might be due to herd, breed, year, age and other environmental and managemental differences.

Heritability estimates of body weight

Number of records generated in 3 years on 380 milking Nili Ravi buffaloes were 839. Data files in exel sheets for body weight and pedigree records were arranged and data were analysed using ASREML computer program (Gilmour, 2009). Five available generations of pedigrees showed that there were 281 buffaloes which were found the daughters of 78 sires and 281 dams. Quantity of base animals without pedigree records were 99. Results from univariate analysis of body weight indicated that heritability estimate for body weight was 0.33±0.07. Almost similar findings by Brum and Ludwick (1969) as 0.38±0.07 and Abreu Silva *et al.* (2018) as 0.34±0.01 have been

reported. Contrary to these findings, Khan (2009) and Vallimont *et al.* (2010) have reported very high heritability estimates for body weight as 0.60±0.08 and 0.82±0.02, respectively. Manoj *et al.* (2014) reported heritability estimate in Sahiwal cows as 0.19 ±0.10, Akhtar *et al.* (2012) reported heritability estimate of body weight as 0.23±0.17 in Nili Ravi breed buffaloe heifers of age 3 years. Abu El-Naser (2019) reported heritability estimate of body weight in Egyptian buffaloes at the age of first calving as 0.27. Pandya *et al.* (2015) reported heritability estimate of body weight in Surti buffaloes as 0.144±0.096.

Phenotypic and genetic correlation of body weight to milk yield

Analysis (bivariate) was carried out to estimate phenotypic and genetic correlations of body weight to milk yield by the use of ASREML computer program (Gilmour, 2009). Fixed factors in this analysis were the same as accounted for in the univariate analysis. These correlations of body weight with milk yield in Nili Ravi buffaloes have been presented in Table 7. Phenotypic correlations of 305 days milk yield and milk yield on recording day with body weight were positive but low in magnitude.

Phenotypic correlation of recording day milk yield with body weight as 0.09±0.05 and 305 days milk yield with body weight as 0.07±0.03 has been found in current study. Parke *et al.* (1999) has described phenotypic correlation between body weight and milk yield as 0.04. Khan (2009) reported relatively stronger phenotypic correlation between body weight and milk yield in 305 days as 0.13±0.06 in cows of Sahiwal breed. Dhillod *et al.* (2017) have mentioned phenotypic correlation in Murrah buffaloes as 0.26.

Positive genetic correlation of body weight with milk yield in 305 days and recording day milk yield was found as 0.16±0.01 and 0.20±0.00, respectively. Genetic correlation of body weight with recording day milk yield and milk yield in 305 days was detected as 0.20±0.00 and 0.16±0.007, respectively. Parke *et al.* (1999) has presented genetic correlation between body weight and milk yield as 0.10 in Holstein cows. Khan (2009) has estimated slightly higher genetic correlation between body weight and 305-days milk production as 0.26±0.00. A moderate genetic correlation between body weight and milk yield suggested that this relationship is important and body weight can be included in selection program for improved milk yield in Nili Ravi buffaloes.

CONCLUSIONS

Relatively higher body weight was observed in the current study as compared to other available reports for Nili Ravi buffaloes. This higher body weight might be due to relatively better supply of feed and fodder during current study period. There were more buffaloes pertaining to 3rd and latter parities in number than younger buffaloes. All the factors studied in the current investigation affected body weight. A reasonable high heritability suggested that this trait can be improved through selection and breeding. Positive genetic correlation between body weight and milk yield indicated that body weght should be used for indirect selection of Nili Ravi buffaloes for improved milk yield.

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Table 1. Data structure and distribution of records for live weight in Nili Ravi buffaloes.

Effect	Levels	Description	Number of records
Herd	1	Bhunikey	200
	2	Chack Katora	281
	3	Khushab	157
	4	Rakh Ghulaman	154
	5	Private	46
Stage of lactation	1	Up to 90 days	203
	2	91-180 days	313
	3	181 and above	237
	4	Dry	74
Parity	1	First parity	119
	2	Second parity	118
	3	Third parity	172
	4	Forth and later parities	414
Season of scoring	1	July to September (humid hot)	115
	2	October and November (Autumn)	169
	3	December and January (Winter)	186
	4	February to April (spring)	235
	5	May and June (hot dry)	134

Table 2 Level of significance and F-value for body weight in Nili Ravi buffaloes.

Effect	Num DF	F-Value	Pr>F
Herd	4	97.45	<0.0001
Stage	3	4.22	0.0057
Parity	3	11.27	<0.0001
Season of recording	4	6.37	<0.0001

Highly significant = P<0.0001, Significant = P<0.005

Table 3. Live weight of Nili Ravi buffaloes in different herds.

Herd	N	Mean	Std	Min	Max	StdErr	CV	Range
1	200	606.80[a]	68.80	285.00	750.00	4.86	11.34	465.00
2	281	490.34[b]	58.98	370.00	700.00	3.52	12.03	330.00
3	157	516.4[b]	66.11	380.00	720.00	5.28	12.80	340.00
4	154	464.14[c]	48.99	350.00	575.00	3.95	10.56	225.00
5	46	582.93[a]	65.46	448.00	770.00	9.65	11.23	322.00
All	839	523.13	81.63	285.00	770.00	2.82	15.60	485.00

Means with different superscripts differed significantly (P<0.05).

Table 4. Live weight of Nili Ravi buffaloes in different stages of lactation.

Stage	N	Mean	Std	Min	Max	StdErr	CV	Range
1	203	520.06[a]	82.66	365.00	770.00	5.80	15.89	405.00
2	313	520.21[a]	83.75	285.00	735.00	4.73	16.10	450.00
3	237	527.93[b]	78.88	367.00	750.00	5.12	14.94	383.00
4	74	516.85[a]	73.88	358.00	720.00	8.59	14.29	362.00
Overall	827	522.08	81.21	285.00	770.00	2.82	15.56	485.00

Means with different superscripts differed significantly (P<0.05).

Table 5. Live weight of Nili Ravi buffaloes in different parities.

Parity	N	Mean	Std	Min	Max	StdErr	CV	Range
1	119	468.55[a]	69.81	350.00	655.00	6.40	14.90	305.00
2	118	464.09[a]	49.76	380.00	630.00	4.58	10.72	250.00
3	172	521.95[b]	69.88	370.00	770.00	5.33	13.39	400.00
4	414	555.15[c]	77.60	285.00	750.00	3.81	13.98	465.00
Overall	823	522.64	80.88	285.00	770.00	2.82	15.48	485.00

Means with different superscripts differed significantly (P<0.05).

Table 6. Live weight of Nili Ravi buffaloes in different seasons.

Season	N	Mean	Std	Min	Max	StdErr	CV	Range
1	115	561.70 [a]	84.67	400.00	735.00	7.90	15.07	335.00
2	169	534.33[b]	88.01	285.00	750.00	6.77	16.47	465.00
3	186	505.17 [c]	84.45	350.00	715.00	6.19	16.72	365.00
4	235	521.25[b]	74.44	365.00	770.00	4.86	14.28	405.00
5	134	504.16 [c]	64.20	358.00	690.00	5.55	12.73	332.00
Overall	839	523.13	81.63	285.00	770.00	2.82	15.60	485.00

Means with different superscripts differed significantly (P<0.05).

Table 7. Genetic and phenotypic correlations of body weight with milk yield in Nili Ravi buffaloes.

Trait	Phenotypic correlations	Genetic correlations
305 days milk yield	0.071±0.034	0.16±0.007
Recording day milk yield	0.090±0.053	0.20±0.000

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