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Breeding efficiency and related traits in buffalo cows under the conditions of Nature Park "Rusenski Lom"

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Abstract

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A study was initiated with the objective to evaluate the efficiency of reproduction of Bulgarian Murrah buffaloes from two farms under the conditions of a Nature Park in Bulgaria, practicing tie-stall pasture system with natural mating. From farm 1 (Fm-1) it assigned 266 calvings (postpartum periods) of 65 buffalo cows and 37 heifers and from farm 2 (Fm-2) – respectively 240, 61 and 22. The studied traits were age of first calving (AFC), period from calving to first estrus/mating (CFE), number of matings per conception (NMC), calving interval (CI) and breeding efficiency (BE) by Wilcox et al. (1957) (BE_W) and by Tomar (1965) (BE_T). The analysis of variance (LSMLMW and MIXMDL by Harvey, 1990) of BE_W and CI established significant individual effect ($P = 0.0077$ и $P = 0.0086$). Also significant was the co-effect age × season of calving ($P = 0.0039$ and $P = 0.0003$), the conventional statistics showing that BE_W, CI ($P > 0.05$) and CFE ($P < 0.05$; $P < 0.01$) improve with the advance in age, while conception rates worsens ($P < 0.05$; $P < 0.001$); and that after calving in winter the values are most unfavourable ($P < 0.05$; $P < 0.01$). BE_W was not influenced by year of calving and month of conception. The buffaloes from the two farms demonstrate good BE, with non-significantly higher value on Fm-1 (95.5 versus 93.7%). The non-significantly shorter calving interval on Fm-1 (392.7 versus 402.6 days) compensates the difference of 3 months in AFC (1112.4 versus 1026.9 days) within BE_T, thus rendering the values of the two farms also close (93.2 versus 92.7%). This leads to the assumption that the method of Tomar is inappropriate for the conditions of Bulgaria, not taking into account the greater economic weight of AFC within the selection index developed previously by Peeva (2000); while the Wilcox coefficient is not suitable for buffaloes at all as it neglects this trait.

Keywords: buffaloes; breeding efficiency; Wilcox; Tomar; factors

Introduction

In the process of its breeding formation, the Bulgarian Murrah has been developed to a breed of high milk productivity, and as such it has become notorious and well-established in many countries worldwide. However, Bulgarian experience in buffalo farming and research results have shown that for the profitability of a farm milk yield is not the most important trait. Analyzing the essential components within the selection index for the buffalo population and the market conditions in Bulgaria, Peeva (2000) found that age of first calving had highest economic weight, followed by calving interval. Except to gross financial losses, low breeding capacity – due to delayed conception, missed estrus, low pregnancy rates – leads to great genetic losses.

This renders management of reproduction in a buffalo herd essential for the economy of the farm in both short- and long-term perspective. In a material sense, not only does fertility rate affect the annual profits from milk production, animals sale or farm enlargement, but also the quality and quantity of replacement, intensity of selection, generation interval and hence genetic gain. In fact, it is a sheer economic indicator, while coefficient of reproductive efficiency, as constructed by Wilcox et al. (1957), represents the biological capacity of animals for efficient breeding. For buffaloes their formula was further developed by Tomar (1965) using the same basis of 365-day calving interval but giving weight also to the other economic trait – age of first calving.

The present study was initiated with the objective to evaluate the traits defining breeding efficiency as well as some effects on them in buffalo cows from two farms under the conditions of *Rusenski Lom* Nature Park.

Material and Methods

The study comprises two farms for the period from 2007 to 2016, assigning only calvings (postpartum periods) with proved pregnancy afterwards: 266 on Farm 1 (Fm-1) and 244 on Farm 2 (Fm-2) from respectively 63 and 56 buffalo cows. Both farms are situated in one and the same region – the territory of *Rusenski Lom* Nature Park.

Both farms practice pasture (semi-intensive) system with barn for tie-stall keeping and exercise yard, which is typical for the buffalo farming in Bulgaria. The milking is twice a day and the newborn is separated from the dam immediately after birth. After the colostrum period, the calves are fed twice daily 6 L cow milk per head per day on Fm-1 and 4 L buffalo milk on Fm-2. The grower heifers are admitted to pasture for 8 hours a day in summer and for 7 hours in winter from 8 months of age on Fm-1 and from 12 months on Fm-2.

Natural service bull is used – on Fm-1 full time, on Fm-2 only by day (on pasture). Two herdsmen stay full day with the herd on the pasture on each farm – with good practical experience to register matings and other signs of estrus behavior independently.

Fertility rate was computed for each farm for each year separately as a percentage of all born calves within the year out of all buffaloes in the main herd, excluding the primiparous animals. Only complete calendar years were taken into consideration – from 2010 to 2015.

Coefficient of breeding efficiency was computed for animals with at least two parities under the formula of Wilcox et al. (1957):

$$BE_W = 365/CI$$

The method, as designed to cover all calvings of an animal, here is adapted separately for each postpartum period, using the length of calving interval (CI) from the respective calving to the next one, with the purpose to provide more data for linear analysis.

For the analysis of the different effects, using the software products LSMLMW and MIXMDL (Harvey, 1990), to processing were subjected the traits providing multiple values per animal – CI, BE_W, period from calving to first mating/estrus (CFE), and number of matings per conception (NMC).

The general model for CI and BE_W is as follows:

$$Y_{fi} = \mu + TN_f + YR_k + MO_l + AC_i/MC_j + e_{fi},$$

where μ is the mean value of the trait;

TN_f – the random effect of individual, or tag number (f = 1…119);

YR_k – the fixed effect of year of calving (k = 1…10), each level of the factor corresponding to each year from 2007 to 2016;

MO_l – the fixed effect of month of conception (l = 1…12), each level of the factor corresponding to each calendar month;

$AC_i/$ – the co-effect of the fixed factors age of calving and month of calving (i = 1…5, j = 1…12), the levels of age (AC_i) being up to 1200 days, 1201-2000, 2001-2800, 2801-3600, and over 3600 days, and those of MC_j – as for MO_l;

and e_{fi} – the residual effect.

From the models for the traits CFE and NMC was excluded the factor month of conception (MO_l). For a regression upon CI and BE_W was included the calving-to-first-mating period, and upon NMC – days open.

For the animals with available information about age of first calving (AFC) and with at least two more parities (n = 37 on Fm-1 and n = 22 on Fm-2) was computed coefficient of breeding efficiency by Tomar (1965) for all subsequent calving intervals (N; i.e. N+1 is the number of parities), using a standard of 1040 days for AFC:

$$BE_T = (365 \times N + 1040)/ (AFC + \sum CI).$$

The two formulae are not applied as proposed for lifetime because of the limited information about the herds.

The data of all traits were processed by the conventional statistical procedure.

Results and Discussion

The results of the analysis of variance of the studied traits are presented in Table 1. They reveal the pronounced effect of the genetic factor individual on CFE ($P \leq 0.001$) and CI ($P < 0.01$). Unlike it, the environmental factor year of calving was found not to influence these traits but to have effect on NMC ($P < 0.05$). The co-effect AC*MC was established to be a significant source of variation for all analyzed traits – most prominently expressed for CI ($P < 0.001$). The effect of month of conception is not statistically proved ($P > 0.05$).

On the indicator representing the individual capacity of a buffalo to rebreed after calving – the coefficient of breeding

Table 1. Analysis of variance of Wilcox coefficient of breeding efficiency (BE_W) and related traits

Sources of variance	df	CFE		NMC		CI		BE_W	
		F	P	F	P	F	P	F	P
Factors:									
Individual (tag #)	118	1.57	0.0010	1.01	0.4619	1.42	0.0086	1.43	0.0077
Year of calving	9	2.04	0.0341	2.28	0.0175	1.49	0.1504	1.49	0.1492
Month of conception	11	–	–	–	–	1.34	0.2000	1.20	0.2892
Co-effect:									
AC*MC	58	1.73	0.0017	1.51	0.0141	1.90	0.0003	1.65	0.0039
Regression:				$r^2 = 0.389$		$r^2 = 0.685$		$r^2 = -0.673$	
Days open		–	–	45.98	0.0000	–	–	–	–
CFE		–	–	–	–	250.45	0.0000	221.52	0.0000

CFE – period from calving to first mating/estrus; NMC – number of matings needed for conception; CI – calving interval; AC – age of calving; MC – month of calving

efficiency by Wilcox (BE_W) – was established significant effect of tag number and AC*MC interaction ($P<0.01$). It was established to be in strongly expressed regression with CFE ($P<0.001$), the correlation between them being $r^2 = -0.673$.

The results of the conventional statistical procedure (Table 2) indicate that the buffaloes from Fm-1 have by 12 days shorter CFE ($P\leq0.05$) than Fm-2 and lower NMC, which is non-significant ($P>0.05$). The phenotypic values for both herds are close to the recommended calving-to-estrus period of 60 days. The differences in CI and BE_W between the two farms are small and non-significant, in favour of Fm-1 where the efficiency is 95.5%.

Endocrine ovarian activity in buffaloes is dependable on lineage, level of feeding, presence of naturally suckling calf, milk productivity, uterine involution, and season of calving (Barile, 2005; El-Wishy, 2007). On global scale, of these factors greatest variation of calving interval is caused by the pronounced seasonality of breeding (Farooq et al., 2001; Sule et al., 2001; Zicarelli, 2007). Table 2 shows that fewest buffaloes have calved in winter (9.1%), and greatest number – in summer (44.1%), which is in confirmation of the established seasonality of reproduction of the buffaloes in Bulgaria (Penchev, 1999; Peeva et al., 2011; Penchev et al., 2014). After calving in winter the animals had worst performance

Table 2. Reproductive traits and Wilcox coefficient of breeding efficiency (BE_W) by farm, season, and age

Factor	n	CFE			NMC			CI			BE_W		
		$\bar{x}$	$\bar{x} \pm S$	CV	$\bar{x}$	$\bar{x} \pm S$	CV	$\bar{x}$	$\bar{x} \pm S$	CV	$\bar{x}$	$\bar{x} \pm S$	CV
Farm													
1. Fm-1	266	55.8	±3.33	97.2	1.395	±0.0439	51.3	392.7	±4.54	18.9	0.955	±0.0085	14.5
2. Fm-2	240	67.8	±4.69	107.3	1.512	±0.0584	59.9	402.6	±5.46	21.0	0.937	±0.0098	16.3
t-test		1-2*			n.s.			n.s.			n.s.		
Season of calving													
3. Spring	126	61.9	±3.93	71.2	1.357	± 0.0632	52.3	389.7	±5.14	14.8	0.953	±0.0103	12.2
4.Summer	223	57.3	±3.94	102.6	1.426	±0.0521	54.6	385.8	±4.36	16.9	0.966	±0.0082	12.7
5.Autumn	111	57.4	±7.14	131.1	1.604	±0.0916	60.2	413.5	±9.92	25.3	0.928	±0.0174	19.7
6.Winter	46	90.6	±13.6	102.0	1.457	±0.1192	55.5	435.8	±15.3	23.8	0.880	±0.0276	21.3
t-test		6-[3, 4, 5]*			3-5*			5-[3, 4]*; 6-[3, 4]**			3-6*; 4-5*; 4-6**		
Age of calving, days													
7. up to 1200	62	89.4	±11.7	102.8	1.258	±0.0606	37.9	413.2	±12.3	23.4	0.921	±0.0212	18.1
8.1201–2000	135	62.5	±6.05	112.5	1.415	±0.0643	52.8	396.0	±7.01	20.6	0.951	±0.0128	15.6
9. 2001–2800	129	54.4	±4.98	104.0	1.403	±0.0628	50.8	396.1	±7.10	20.4	0.950	±0.0129	15.4
10. 2801–3600	91	58.8	±5.31	86.2	1.495	±0.1152	73.6	391.9	±7.08	17.2	0.953	±0.0136	13.6
11. over 3600	89	53.6	±4.84	85.1	1.663	±0.0903	51.2	395.9	±7.63	18.2	0.946	±0.0147	14.6
t-test		7-[8, 10]*; 7-[9, 11]**			11-7***; 11-[8, 10]*			n.s.			n.s.	±0.0060	
Mean	506	61.5	±2.80	103.9	1.451	±0.0360	56.0	397.4	±3.53	20.0	0.946		15.3

CFE – period from calving to first mating/estrus; NMC – number of matings per conception; CI – calving interval

Table 3. Age of first calving (AFC) and Tomar coefficient of breeding efficiency (BE_T) by farm (P > 0.05)

Farm	AFC				BE_T			
	n	$\bar{x}$	$\bar{x} \pm S$	CV	n	$\bar{x}$	$\bar{x} \pm S$	CV
Fm-1	37	1112.4	±30.73	16.8	30	0.9320	±0.017	9.8
Fm-2	22	1026.9	±44.06	20.1	19	0.9270	±0.024	11.5
Mean	59	1080.5	±25.67	18.3	49	0.9300	±0.014	10.4

concerning CFE, CI and BE_W ($P < 0.05$; $P < 0.01$). Conception rates (NMC) is worst after calving in autumn, which, in spite of the relatively early estrus, resulted in relatively late conception – more than three months postpartum (judging by CI value). The cases of calving in the main season (summer) show best CI of 385.8 days and breeding efficiency of 96.6%, although they do not differ much in CFE and NMC from the cases of calving in spring and autumn respectively. Spring calvings are also associated with good performance, comparatively high BE_W in particular.

Reproductive capacity of buffaloes can be improved through advanced preparatory measures for the breeding season by adequate level of nutrition, which is essential for the economy of the farm because of the imminent risk an animal with missed estrus in the main breeding season to enter a prolonged anestrus (El-Wishy, 2007).

It is also seen (Table 2) that with age NMC increases, unlike the other traits. After calving at earliest age (first parity) the first mating is observed to occur by one to one and a half months later in comparison to the other age classes ($P<0.05$; $P<0.01$) and hence, in spite of the good conception rates, CI and BE_W are most unfavourable.

From Table 3 it is clear that between the two farms there is a difference of more than three months in AFC, which is not statistically significant. However, despite earlier calving heifers, the BE_T value of Fm-2 is yet lower because of the longer CI mentioned above (Table 2). The Tomar coefficient does not differ substantially from the Wilcox value, as was also observed in comparative studies in the Indian Murrah (Singh V. et al., 2016; Raina et al., 2016), but not in the Egyptian buffalo (Eman et al., 2012) where it was lower.

For earlier stage of breed formation of the Bulgarian Murrah, Danev (1993) established lower values of Wilcox and Tomar coefficients – respectively 79% and 84% – which is based on the later age of first calving and longer calving interval.

Table 4 presents the annual fertility rates of the two herds. The data show that, alike breeding efficiency, again better is the performance of Fm-1 – averagely 87.6 calves from 100 buffalo cows, Fm-2 having 84.0.

To summarize, the buffaloes of the two studied farms manifest very good breeding efficiency, higher than the coefficients established for the Bulgarian Murrah (Danev, 1993), Indian Murrah (Raina et al., 2007; Singh V. et al., 2016), Nili-Ravi (Baghdasar & Juma, 1998), and Iraqi buffalo (Bashir et al., 2007). This is confirmed by the estimated high annual fertility rate, and is presumably associated with the very good management and the natural technology of the two farms – the presence of active bull for natural mating in the herd throughout the day and the utilization of natural pasture resources, which, according to Abdalla et al. (2003), have favourable influence on the resumption of ovarian activity postpartum and hence on pregnancy rates. As Zicarelli (2007) points out, good farming and management practices could make a buffalo cow reproduce with a similar rate as a bovine cow. But still age of first calving will always be essential for profitability and genetic progress in the buffalo. In this context the Wilcox coefficient is not suitable for buffaloes, its formula not including that important trait. As for the

Table 4. Annual fertility rate (FR) by farm

Year	Fm-1			Fm-2		
	Heads in main herd*	Calves born	FR, %	Heads in main herd*	Calves born	FR, %
2010	28	24	85.7	23	20	87.0
2011	35	31	88.6	42	36	85.7
2012	45	40	88.9	49	39	79.6
2013	45	39	86.7	51	45	88.2
2014	46	37	80.4	52	47	90.4
2015	46	37	80.4	48	35	72.9
Total	245	208		265	222	
Average			84.9			83.8

*excluding primiparous buffaloes

method of Tomar (1965), it can be assumed from the present results that it is not quite suitable for the conditions of Bulgaria in particular since the great difference in age of first calving between the two farms is compensated by calving interval. This is inadequate with respect to the different economic weights of these two traits within the selection index developed by Peeva (2000) for the Bulgarian Murrah population which calls for further development of this approach on national scale.

Conclusions

On the Wilcox breeding efficiency coefficient (BE_W) of the studied buffaloes was established significant individual effect ($P = 0.0077$ and $P = 0.0086$). The analysis of variance showed also significant effect of the co-effect between age and season of calving ($P = 0.0039$ and $P = 0.0003$); the conventional statistics indicating that BE_W, calving interval ($P > 0.05$) and calving-to-first-mating period ($P < 0.05$; $P < 0.01$) improve with the advance in age, while conception rates deteriorates ($P < 0.05$; $P < 0.001$); and that after calving in winter the values are most unfavourable ($P < 0.05$; $P < 0.01$).

The buffaloes from the two farms perform very well reproductively – with non-significantly higher annual fertility rate and Wilcox breeding efficiency on Fm-1 (87.6% and 93.7%, respectively). The non-significantly shorter calving interval on Fm-1 (392.7 versus 402.6 days) compensates the difference of 3 months in age of first calving within the Tomar breeding efficiency coefficient.

References

Abdalla, E. B. (2003). Improving the reproductive performance of Egyptian buffalo cows by changing the management system. *Animal Reproduction Science*, *75*(1-2), 1-8.

Baghdasar, G. A., & Juma, K. H. (1998). Some aspects of life performance of Iraqi buffalo. In *Proc. 6th World Cong. Genet. Appl. Livest. Prod.,* Jan 11-16, Armidale NSW. Australia.

Barile, V. L. (2005). Improving reproductive efficiency in female buffaloes. *Livestock Production Science*, *92*(3), 183-194.

Bashir, M. K., Khan, M. S., Bhatti, S. A., & Iqbal, A. (2007). Lifetime performance of Nili-Ravi buffaloes in Pakistan. *Asian-Australasian Journal of Animal Sciences*, *20*(5), 661-668.

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Danev, A. (1993). Study on the reproductive capacity of the buffaloes in Bulgaria. PhD Thesis, Sofia.

El-Wishy, A. B. (2007). The postpartum buffalo: II. Acyclicity and anestrus. *Animal Reproduction Science*, *97*(3-4), 216-236.

Eman, A. S., Sosa, G. A., & El-Bayomi, K. M. (2012). Influence of some factors affecting the breeding efficiency in the Egyptian buffalo. *Benha Veterinary Medical Journal*, *23*(1), 72-80.

Farooq, M., Syed, M., Alkaraki, N. I., Durrani, F. R., Muqarrab, A. K., & Amjed, M. (2001). Reproductive performance of Nili-Ravi buffaloes. *Sarhad Journal of Agriculture (Pakistan)*, 17: 295-299.

Harvey, W. R. (1990). Users' Guide for LSMLMW and MIXMDL, Mixed model least squares and maximum likelihood computer program. PC-2 version, Ohio State University, Columbus, USA.

Peeva, Tz. (2000). Optimized methods of selection in buffaloes. Doc. Agric. Sci. Thesis, Sofia, pp. 320.

Peeva, Tz., Penchev, P. Ilieva, & Boichev, M. (2011). Factors affecting days open in Bulgarian Murrah buffalo cows. In *Fifth International Conference, BALNIMALCON, October 19-20, Bucharest*, Animal Science, ser. D, vol. 54, pp. 205-212.

Penchev, P. (1999). Study on the phenotypic and genetic parameters of selection traits in the newly created buffalo population in Bulgaria. PhD Thesis, pp. 154.

Penchev, P., Ilieva, Y., & Dimov, K. (2014). Effect of season of birth on season of calving and age at first calving in buffalo heifers. *Bulgarian Journal of Agricultural Science*, *20*(2), 447-451.

Raina, V., Narang, R., Malhotra, P., Kaur, S., Dubey, P. P., Tekam, S., & Dash, S. K. (2016). Breeding efficiency of crossbred cattle and Murrah buffaloes at organized dairy farm. *Indian J. Anim. Res*, *50*(6), 867-871.

Singh, V., Narang, R., Singh, S. G., & Kaur, A. (2016). Comparison of two methods of calculating breeding efficiency of crossbred cattle and Murrah buffaloes. *J. Anim. Res.*, *6*(5), 885-889.

Sule, S. R., Taparia, A. L., & Tailor, S. S. (2001). Reproductive status of Surti buffaloes maintained under sub-humid conditions of Rajasthan. *Indian Vet. J.*, *78*, 1049-1051.

Tomar, N. S. (1965). A note on the method of working out breeding efficiency in Zebu cows and buffaloes. *Indian Dairyman*, *17*, 380-390.

Wilcox, C. J., Pfau, K. O., & Bartlett, J. W. (1957). An investigation of the inheritance of female reproductive performance and longevity, and their interrelationships within a Holstein-Friesian herd. *Journal of Dairy Science*, *40*(8), 942-947.

Zicarelli, L. (2007). Can we consider buffalo a non precocious and hypofertile species? *Italian Journal of Animal Science*, *6*(Suppl. 2), 143-154.