FEEDING REGIMES AND SOME PRODUCTION PARAMETERS OF ANATOLIAN BUFFALOES IN THE KIZILIRMAK DELTA OF SAMSUN PROVINCE IN TURKEY

Habip Muruz* and Zehra Selçuk

ABASTRACT

This study was conducted to determine feeding regimes and some production parameters of Anatolia buffaloes in the Azikheli Delta which one of the Turkey's biggest and most important wetland ecosystem. A total of 59 dairy farms, whose owners were members of the Samsun Provincial Buffalo Breeders Union, were selected for the survey. According to results of the survey, 55.9% of the buffalo breeders had above 20 buffaloes. The majority of the farmers produced their own roughage. Most respondents reported that calves were weaned at 5 months of age or older. The investigation revealed that the buffalo feeding system depended on grazing from April to November (summer feeding). During winter feeding, dry forage+silage were used together on the majority of the farms (96.6%). All respondents didn't feed concentrates to their heifers and pregnant buffaloes in the last trimester were fed a special regime by some farmers (16.9%). The buffaloes in early lactation were provided a supplementary concentrate mixture by 78% of farmers. None of the producers used balanced rations for their animals. Daily milk yield, 69.5% of farms, were 3 to 5 L. Mean age at first calving were 31 to 36 months. The survey results showed that the feeding regimes for Anatolian buffaloes adopted by the farmers are deficient and this is probably causing reduced milk yields and reproductive performance. Consequently, in order to improvement milk yield and reproduction potential, it is suggested that buffalo feeding regime should be matched to nutrient requirements and giving information to farmers about feeding techniques.

Keywords: *Bubalus bubalis*, buaffaloes, Anatolia buffalo, Kızılırmak delta, feeding regime

INTRODUCTION

Water buffalo milk and meat products constitute an important source of protein for low-income farmers, and also serve as a significant source of income for rural economies (Borghese and Mazzi, 2005). There are two general types of water buffalo, namely the swamp and the river water buffalo. The river water buffalo is more suitable for milk production. Buffaloes in Turkey are classified as Anatolian buffaloes as they originated from Mediterranean buffaloes, a subgroup of river buffaloes (Soysal *et al*., 2007). In 2016, the number of Anatolian water buffaloes in Turkey was 142,073,591 and 63,085 tonnes of

Department of Animal Nutrition and Nutritional Diseases, Faculty of Veterinary Medicine, Ondokuz Mayıs University, Samsun, Turkey, *E-mail: habip.muruz@omu.edu.tr

milk and 351 tonnes of red meat was produced from them (TUIK, 2017). Samsun Province, with 17,944 buffaloes, has the most of any province in Turkey, and 57.9% of them are in the Kızılırmak Delta (TUIK, 2017).

The delta contains one of the most important wetlands in Turkey, including approximately 12,000 ha of wetlands of a total area of 56,000 ha, and comprises different ecological features that include rivers, lakes, reed beds, marshes, meadows, pastures, woods and agricultural land. Buffalo production is one of the most important agricultural industry in the Kızılırmak Delta. The majority of buffalo are traditionally released into open areas for grazing between April and November for the summer season. During this period, they graze on communal pasture and in wetland areas. In winter, the buffaloes are housed indoors in barns (Selçuk, 2012).

It has been previously reported that digestive capacity, nitrogen utilization and rumen fermentation in buffaloes are more efficient than in cattle. The superiority is particularly noticeable in situations where feed supply is of low quantity and/or quality (Wanapat *et al*., 2000). Traditionally, most buffaloes are fed on low-quality roughage, namely agricultural crop-residues and industrial by-products which contain high levels of lingo-cellulosic materials, low levels of fermentable carbohydrate, and low levels of good-quality protein (Wanapat and Rowlinson, 2007). Improper and inadequate nutrient availability has resulted in low milk production, poor growth rates, high mortality rates and poor reproductive performance (Sarwar *et al*., 2009; Khan *et al*., 2009). Recent research on locally available feed sources such as cereal straws and corncobs; ensiled fodders; industrial and agricultural by-products; dietary addition of fermentation modifiers, vitamins and minerals; and the use of ruminally-protected dietary protein and fat sources has shown significant potential to improve both growth rate and milk yield in buffaloes (Sarwar *et al*., 2009). In Italy, milk production is sustained by diets with a high energy content (from 0.85 to 0.95 MFU/kg dry matter-DM) and a high protein concentration (14 to 16 % crude protein in DM), based on maize and other silages, cereal grains, soya, alfalfa and "graminaceae" hay and by-products, and the mean milk production is over 2,200 kg for each lactation period (Borghese, 2013).

The Turkish government has taken steps to improve political and necessary financial support to buffalo producers, as has been provided to cattle producers since 2008. In addition, with the aim of maintaining the numbers of buffaloes and improving their milk production and fertility, the Anatolian Water Buffalo Breeding Project was initiated in Turkey in 2011. However, few studies of buffalo feeding in Turkey were found in a literature review and there have been no studies of buffalo feeding practices in the Kızılırmak Delta. Therefore, the aim of this study was to collate baseline information on current buffalo feeding practices and productivity criteria so as to contribute to policy development and improved support for farmers.

MATERIALS AND METHODS

The study was carried out in the Kızılırmak Delta in Samsun Province in the Black Sea Region of Turkey. The centre of the Kızılırmak Delta is located at approximately 410° 30' north latitude and 360° 05' east longitude. The primary data was obtained from the members of the Samsun Provincial Buffalo Breeders Union

in the Kızılırmak Delta through a questionnaire via a face to face interview. The main body of the research constituted a survey of the 421 members of the union. The sample number of farmers (n=59) to be interviewed was determined through the random method with the following formula from the total 421 farmers (Güneş and Tarık, 1998), with data collected from April to May, 2016:

$$n = (N. \sigma^2)/((N-1).D^2+ \sigma^2))$$

where, n = sample number,

N = number of enterprises of population

σ^2 = population variance

$D^2 = (d/t)^2$, d = margin of error,

t = corresponding values 90% confidence limits.

According to the equation, the sample size was calculated to be 59 farmers from 421 farmers, the total number of farmers, with 10% error acceptable and 90% confidence limits.

The variables selected for investigation in this study were the education status of the farmers, and feeding practices and some reproductive and productivity parameters of buffaloes. Data were analysed with the Statistical Package for Social Sciences SPSS-PC (version 21.0) (2007).

RESULTS

The education level of farmers, land holding, planting area for roughage and herd size of farms are given in Table 1. The buffalo producers were generally primary school graduates (74.6%). 55.9% of farms were land holding more than 5 ha. The majority of the farmers produced their own roughage, but 6.8% of farmers grew no roughage. As for buffalo holding size, 59.3%, 27.1% and 13.6 % of the farmers had over 20, 10 to 20 and 1 to 9 animals, respectively.

All new born calves were fed colostrum within two hours of parturation. On all farms, calves were allowed to suckle their mothers for colostrum. Most farmers (96.6%) used mother's milk for calf nutrition for more than five months (96.6%) and none of the farmers used concentrate mixture for heifer nutrition (Table 2).

Nutrition regimes in summer and winter are provided in Table 3. The buffalo feeding system in the Kızılırmak Delta was dependent on open grazing from April to November (summer feeding). No farmers were found to supply balanced ration for their buffaloes. During summer feeding, more than half of the farmers supplied concentrate (>2 kg/buffalo/day) to lactating buffaloes. During winter feeding (between October and March), straw, dry vetch hay and straw+dry vetch hay were used as the roughage source at 6.8%, 3.4% and 89.8%, respectively. Dry forage+silage were used together on the majority of farms (96.6%). Some of the farmers (32.2%) used from 1 to 10 kg of dry roughage/animal/day, while the majority (67.8 %) used more than 10 kg of dry roughage/animal/day. Concentrate mixture, grain and concentrate mixture+grain were used as the concentrate feed source by 33.9%, 10.2% and 55.9% of farmers, respectively. During winter feeding, the majority of the farmers (52.5%) used more than 2 kg of concentrated feed/animal/day, while 39% of the farmers used up to 2 kg of concentrated feed/animal/day. In this period, concentrated feed wasn't provided on 8.5% of farms. Vitamin and mineral supplements weren't added to the rations for both summer and winter feeding of lactating buffaloes. However, pregnant buffaloes in the last trimester were fed a special regime by some

Table 1. Farmers education level, farm size and farming practices.

Parameters	Category	Frequency	Percentage
Education	Illiterate	1	1.7
	Primary	44	74.6
	Middle school	5	8.5
	High school	5	8.5
	Degree	4	6.8
Land holding (ha)	0.1-1.0	6	10.2
	1.1-3.0	13	22
	3.1-5.0	7	11.9
	>5.0	33	55.9
Roughage planting area (ha)	No fodder crops	4	6.8
	0.1-2.0	16	27.1
	2.0-5.0	22	37.3
	>5.0	17	28.3
Herd size (head)	1-9	8	13.6
	10-20	16	27.1
	>20	35	59.3

Table 2. Calf and heifer nutrition.

Parameters	Category	Frequency	Percentage
Colostrum consumption for the first time after birth	Within 1 h	59	100
	Within 4-6 h	0	0
	Within 7-10 h	0	0
Feeding method for milk	Natural	59	100
	Feeding bottle	0	0
Weaning age (month)	1-3	1	1.7
	3-5	1	1.7
	>5	57	96.6
Concentrate consumption by heifers	Yes	0	0
	No	59	100

Table 3. Summer and winter feeding of lactating buffaloes.

Parameters	Category	Frequency	Percentage
Grazing period (month)	April-May to October-November	59	100
Balanced rations	Yes	0	0
	No	59	100
Source of dry roughage	Straw	4	6.8
	Vetch hay	2	3.4
	Straw and vetch hay	53	89.8
Silage consumption	Yes	57	96.6
	No	2	3.4
Source of concentrate	Commerical feed	20	33.9
	Grain	6	10.2
	commerical feed+ grain	33	55.9
Additional concentrate mixture per day (in summer)	0	5	8.5
	Up to 1 kg	4	6.8
	1-2 kg	19	32.2
	>2kg	31	52.5
Amount of concentrate mixture per day (in winter)	No	5	8.5
	Up to 2 kg	23	39
	>2 kg	31	52.5
Concentrate consumption by pregnant buffaloes in the last trimester	Yes	10	16.9
	No	49	83.1
Concentrate consumption during early lactation period	Yes	46	78
	No	13	22
Mineral and vitamin supplementation	Yes	0	0
	No	59	100

farmers (16.9%). In addition, most farmers (78%) provided concentrated feed in the early lactation period.

Mean milk yield/buffalo was reported as 1 to 3 L, 3 to 5 L and 5 to 7 L by 23.7%, 69.5% and 6.8% of farmers, respectively. Age at first calving, calving interval and lactation period were from 31 to 36 months (84.7% of farms), 11 to 15 months (88.1% of farms) and 210 to 270 days (93.2% of farms), respectively (Table 4).

DISCUSSION

The majority of buffalo producers in this study graduated from primary school and their education level was rather low. The result was consistent with those of Günlü *et al.* (2010) and Işık and Gül (2016) who reported that the educational status of the buffalo producers in Afyonkarahisar and Muş Provinces of Turkey, respectively, was generally low. This can be generally attributed to the socio-economic circumstances of the producers. The majority of buffalo farmers in the Kızılırmak Delta had land that can be cultivated. It was determined that a little farmers don't produce own forage in this study. Although there are suitable agro-climatic conditions and substantial, countrywide financial support available from the government for forage cultivation, the production of forage was still inadequate in the Kızılırmak Delta. In study area, more than half of the buffalo breeders in the Kızılırmak Delta had above 20 buffaloes, which is higher than the number reported by Günlü *et al.* (2010) who studied the buffalo industry in Afyonkarahisar Province of Turkey. According to statistical data from the TUIK (2007), the number of buffaloes in the Kızılırmak Delta constituted 57.9% of the total number of water buffaloes in Samsun Province. Apart from milk production, buffaloes are an important contributor to ecological processes and a notable part of the

Table 4. Some production and reproductive parameters of buffaloes.

Parameters	Category	Frequency	Percentage
Milk yield per day (L)	1-3	14	23.7
	3-5	41	69.5
	>5	4	6.8
Lactation length (days)	90-150	2	3.4
	150-210	2	3.4
	210-270	55	93.2
Age at the first calving (months)	24-30	4	6.8
	31-36	50	84.7
	37-43	5	8.5
Calving interval (months)	11-15	52	88.1
	16-20	4	6.8
	21-25	3	5.1

livestock heritage of the Kızılırmak Delta.

In the present study, all newborn calves were fed colostrum within the first hour of their life and then, almost all calves were fed with their mother's milk until they were more than five months of age. In contrast to our study, Pasha (2013) reported that only 8% of farmers fed calves within three hours from birth in Pakistan. Tiwari *et al.* (2007) reported that generally the main goal of commercially oriented dairy buffalo farms was to achieve maximum milk production and thus calves were allowed to suckle their mothers in order to stimulate the secretion of milk. In the current study, all heifers were not provided any concentrate. In contrast to our study, Yılmaz (2013) reported that 30% of the farmers in Afyonkarahisar Province provided concentrate mixture for heifer nutrition. Many farmers, who considered heifers to be in an unproductive period of their life, supplied mostly low quality forage which is less expensive than concentrate. Moore *et al.* (2000) reported that heifer rearing is the most expensive part of buffalo production, with feed costs contributing 63% to 84% of the total costs and therefore representing a large proportion of expenses of the overall farm operation. However, one of the major causes of the delayed puberty of buffalo heifers has been the use of low cost feed resources of poor nutritional quality (Bhatti *et al*., 2007). In the present study, it could be inferred that the buffalo farmers did not rear their buffaloe heifers with optimum management, rather following traditional practices.

In the study area, the buffalo feeding system depended on grazing from April to November. In this period, more than half of the farmers supplied concentrate (>2 kg/buffalo/day) to lactating buffaloes, but that amount of concentrate was not supplied after determination of the nutrient composition of pastures. Therefore, it was not clear how much concentrate was needed to supply daily nutritional requirements. In winter, straw+dry vetch hay and corn silage are the most important roughage sources in the Kızılırmak Delta. Commerical feed and/or grain were the main feed concentrates in the diets of all lactating buffaloes which were fed diets' that included forage and concentrate, regardless of the buffaloes' daily requirements for production. Indeed, all of the producers reported that they did not supply balanced rations to their animals. In addition, no farmers used vitamin and mineral supplements for buffalo nutrition. In Italy, which is recognized as having the world's best dairy buffalo management practices, buffaloes are grazed in paddocks all year long, utilizing the same modern systems used for dairy cows; the buffalo cows normally have a high daily energy consumption (0.85 to 0.95 MFU/kg dry matter-DM) and a high daily protein diet (14 to 16% crude protein on DM), based on maize and other silages, cereal grains, soya, alfalfa and "graminaceae" hay and by-products (Khan *et al*., 2009).

In the present study, 16.9 % of the respondents fed a concentrate mixture, in addition to forage, to pregnant buffaloes in the last trimester. This percentage is much lower than that reported by Yılmaz (2013) who reported that 30% of farmers provided concentrated feed in Afyonkarahisar Province. An inadequate or unbalanced diet was most likely the cause of the lower production and fertility of buffaloes in the Kızılırmak Delta when compared to Italy. In our study, the buffaloes in early lactation were provided a supplementary concentrate mixture by the majority of farmers (78%). In the Kızılırmak Delta, farmers are aware of the nutritional requirements in the early period of lactation of buffaloes but do not provide sufficient and balanced diets to pregnant and lactating

buffaloes in order to prevent metabolic disorders, infertility problems and low milk production. Therefore, the determination of what constitutes a balanced, economical, optimum diet for proper buffalo management should be studied in the Kızılırmak Delta and in the different production areas of Turkey.

In the present study, daily milk yield and lactation period were reported as 3 to 5 L and 210 to 270 days by 69.5 and 93.2% of the farmers, respectively. Salari *et al.* (2013) reported that Mediterranean buffalo cows produced 8.47 kg of milk/head/day and Khan *et al.* (2014) reported that Azikheli buffaloes in Pakistan produced 7.19±0.18 L of milk per day. In the present study, milk yield was similar to the findings for Turkey of a large number of authors (Günlü *et al*., 2010; Han *et al*., 2015; Soysal, 2015; Soysal *et. al*., 2015). Low milk yield in the research area may be explained by the indigenous type of buffalo and the inadequate, traditional feeding system. In addition, buffalo farming may not be an important contributor to total income. If farmers can be convinced that the financial returns would justify increased inputs, a comprehensive programme for increasing the milk production of Anatolian buffaloes in Kızılırmak Delta may be successful.

In the present study, the age of first calving was from 31 to 36 months (84.7% of the farms). The age at the first calving is very important indicator for the whole of life production of dairy animals. It could be inferred that the buffalo farmers did not rear their heifers with optimum management, rather following traditional practices. Şekerden *at al.* (1999) reported a similar age at the first calving in Anatolian buffaloes raised at the Afyon Kocatepe Agricultural Research Institute. Pasha (2013) reported that the mean age of first calving of buffalo in Pakistan was 48 months. In contrast, heifers are fed intensively in order to achieve puberty before 20 months in Italy where the objective of the heifer rearing system is to provide heifers that can reach maximum lactation productivity as early as possible (Khan *et al*., 2014). The age of first calving can be reduced through the proper management of the nutrition of growing heifers (Zicarelli, 2010). Furthermore, Qureshi *et al.* (2002) reported that the age of first calving can be reduced significantly if heifers are fed properly to achieve higher daily gains. Borghese *et al.* (1994) documented an average daily gain (ADG) of 562 g/day and 465 g/day in heifers fed higher and lower energy diets, respectively, of 5.56 MFU/d and 4.42 MFU/d, respectively.

Calving interval were 210 to 270 days (93.2% of farms) (Table 4). In buffalo dairy production, it is most profitable to have at least one calf every 15 months. If the calving interval is longer, the total number of calvings and total life production of milk both decrease (Qureshi *et al*., 2002). The calving interval in the present study was from 11 to 15 months. These findings are in conformity with the findings of Şekerden (1999) and Sachan *et al.* (2015) for Anatolian buffaloes raised at Afyon Kocatepe Agricultural Research Institute and in the Unnao district of Uttar Pradesh, respectively.

In conclusion, in the Kızılırmak Delta, when intensive production dairy cow farms are used as the basis of comparison, there were no intensive dairy production buffalo farms in the current study. Buffaloes at the Kizilirmak Delta are fed diets containing insufficient nutrients, and this is probably one of the most important factors contributing to both reduced milk yield and poor reproductive performance. The reason for this situation is probably that it is not economical to provide better feed and/or that farmers are not

willing to change their current feeding practices. Therefore, to achieve productivity gains, farmers have to be convinced that it will be to their financial benefit if they match feeding regimes to the specific nutritional requirements of Anatolian buffaloes at different life stages.

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REFERENCES

Bhatti, S.A., M, Sarwar, M.S. Khan and M. Hussain. 2007. Reducıng the age at fırst calvıng through nutrıtıonal manıpulatıons ın dairy buffaloes and cows: A revıew. *Pak. Vet. J.*, **7**: 42-47.

Borghese, A. 2013. Buffalo livestock and products in Europe. *Buffalo Bull.*, **32**: 50-74.

Borghese, A., G. Terzano, V. Barile and A. Parmeggiani. 1994. Season and feeding level effects on onset of puberty in buffalo heifers. p. 525-527. *In Procceeding of the 4th World Buffalo Congress*, Sao Paulo, Brazil.

Borghese and M. Mazzi. 2005. Buffalo population and strategies in the world, p. 1-41. *In* Borghese, A. (ed.) *Buffalo Productıon And Research*. Food and Agriculture Organization, Rome, Italy.

Güneş, T. and R. Arıkan. 1998. *Tarım Ekonomisi İstatistiği.* Ankara University Agriculture Faculty Publication, Ankara, Turkey.

Günlü, A., H. Çiçek and M. Tandoğan. 2010. Socio-economic analysis of dairy buffalo enterprises in Afyonkarahisar province in Turkey. *J. Food. Agric. Environ.*, **8**: 689-869.

Han, Y., Ş. Tez, P. İpek, M.E. Vural, A. Karataş, B. Keskin and G. Bakır. 2015. Some yield features of Anatolian water buffaloes grown people's hand in Diyarbakir province. p. 129. *In Proceedings of the 7th Balkan Conference on Animal Science*, Sarajevo, Bosnia and Herzegovina.

Işık, M. and M. Gül. 2016. Economic and social structures of water buffalo farming in Muş province of Turkey. *Rev. Bras. Zootecn.*, **45**: 400-408.

Khan, M.J., K.J. Peters and M.M. Uddin. 2009. Feeding strategy for improving dairy cattle productivity in small holder farm in Bangladesh. *Bangladesh Journal of Animal Science*, **38**: 67-85.

Khan, M., M. Saleem, I. Rahim, H. Khan, A. Gohar, S. Ahmad, M. Salim, Q. Ali and. F. Farmanullah. 2014. Assessment of morphometric, productive and reproductive characteristics of Azikheli buffalo in Swat valley in northern. *Life Sci. J.*, **11**: 1-8.

Moore, R., J. Beiler and G. Schnitkey. 2000. The Economics of heifer contracting. https:// sdda.sd.gov. Accessed November 20, 2017.

Pasha, T.N. 2013. Prospect of nutrition and feeding for sustainable buffalo production. *Buffalo Bull.*, **32**: 91-110.

Qureshi, M.S., G. Habib, H.A. Samad, M.M. Siddiqui, N. Ahmad and M. Syed. 2002. Reproduction-nutrition relationship in dairy buffaloes. I. Effect of intake of protein, energy and blood metabolites levels. *Asian Austral. J. Anim.*, **15**: 330-339.

Sachan, R., G. Sankhala and J. Manjusha. 2015. Productive and reproductive performance of buffalo. *Asian J. Anim. Sci*., **10**: 29-36.

Salari, F., I, Altomonte and M. Martini. 2013. Buffalo milk: A case study of some parameters related to milk production. *Large Anim. Rev.*, **19**: 17-20.

Sarwar, M., M. Khan, M. Nisa, S.A. Bhatti and M.A. Shahzad. 2009. Nutritional management for buffalo production. *Asian Austral. J. Anim*., **22**: 1060-1068.

Şekerden, Ö. and M. Küçükkebapçı. 1999. Afyon Kocatepe Tarımsal Araştırma Enstitüsü Anadolu mandalarında süt verim ve bileşiminin laktasyon dönemlerine göre değişimi, süt ve bazı döl verim özellikleri. *Atatürk Üniversitesi Ziraat Fakültesi Dergisi*, **30**: 151-159.

Selçuk, Z. 2012. The Kızılırmak delta: The natural habitat of Anatolian water buffaloes. *Kafkas Univ. Vet. Fak*., **18**: 167-168.

Soysal, İ., E. Özkan, S. Kök, M. Occidente, Y.T. Tuna, E.K. Gurcan and D. Matassino. 2007. Genetic characterization of indigenous anatolian water water buffalo breed using microsatellite DNA markers. *Ital. J. Anim. Sci*., **6**(Suppl. 2): 409-412.

Soysal, M.I. 2015. Anatolian Water buffalo husbandry in Turkey. *In Proceedings of the 8th Asian Buffalo Congress*, Istanbul, Turkey

Soysal, M.İ., E.K. Gürcan and M. Aksel. 2015. The comparison of lactation curve with different models in Anatolian water buffalo. p. 90. *In Proceedings of the 7th Balkan Conference on Animal Science*, Sarajevo, Bosnia and Herzegovina.

SPSS. 2007. *Statistical Packages for Social Science*. Version 21, SPSS Illionsa, USA.

Tiwari, R., M.C. Sharma and B.P. Singh. 2007. Buffalo calf health care in commercial dairy farms: a field study in Uttar Pradesh (India). *Livestock Research for Rural Development*, **19**: 38.

Turkish Statistical Institute, (TUIK). 2017. Livestock Statistics. https://biruni.tuik.gov.tr. Accessed May 20, 2017.

Wanapat, M., A. Ngarmsang, S. Korkhuntot, N. Nontaso, C. Wachirapakorn, G. Beakes and P. Rowlinson. 2000. A comparative study on the rumen microbial population of cattle and swamp buffalo raised under traditional village conditions in the northeast of Thailand. *Asian Austral. J. Anim*., **13**: 918-921.

Wanapat, M. and P. Rowlinson. 2007. Nutrition and feeding of swamp buffalo: Feed resources and rumen approach. *Ital. J. Anim. Sci*., **6**: 67-73.

Yılmaz, S. 2013. *Afyonkarahisar yöresinde manda yetiştiricliği: Küçükçobanlı* örneği. M.Sc. Thesis, Adnan Menderes Üniversitesi, Aydın, Turkey.

Zicarelli, L. 2010. Can we consider buffalo a non precocious and hypofertile species? *Ital. J. Anim. Sci*., **6**: 143-154.