International Journal of Bio-resource and Stress Management https://pphouse.org/ijbsm.php

Crossref

IJBSM January 2022, 13(1):99-105 Print ISSN 0976-3988 Online ISSN 0976-4038 **Article** AR2615

Research Article *Natural Resource Management*

DOI: HTTPS://DOI.ORG/10.23910/1.2022.2615

Production Performance of Murrah Buffaloes under Weaning and Suckling System of Calf Management

C. P. S. Solanki[1], G. P. Lakhani[2], B. Roy[2], A. Mishra[3], S. K. Joshi[4], B. Aharwal[2]

[1]Krishi Vigyan Kendra Raigarh, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh (49 6001)
[2]Dept. of Livestock Production Management, Nanaji Deshmukh Veterinary Science University, Jabalpur, M. P. (482 001), India
[3]Dept. of Veterinary Physiology and Biochemistry, Nanaji Deshmukh Veterinary Science University, Jabalpur, M. P. (482 001), India
[4]Dept. of Animal Genetics and breeding, Nanaji Deshmukh Veterinary Science University, Jabalpur, Madhya Pradesh (482 001), India

Open Access

Corresponding drcpssolanki1@gmail.com

0000-0001-7524-6441

ABSTRACT

Sixteen Murrah buffalo's dams and their calves were evaluated at Livestock Farm, Adhartal, Department of Livestock Production and Management, College of Veterinary Science & A.H., N.D.V.S.U., Jabalpur Madhya Pradesh, India during 12 months period (from 1st June, 2020 to 30th May, 2021). The objective was to study the production performance in weaning and suckling system of management and randomly assigned into two different groups as suckling (control) and weaning (experimental) based on their lactation yield and parities. The average daily milk let down time was significantly (p<0.05) lower in suckling group of buffaloes than weaning group of buffaloes (1.62±0.04 vs. 3.08±0.09 min). The mean value of daily colostrum yield for 5 days after calving was 3.95±0.23 and 4.7±0.15 kg for weaning and suckling buffalo groups respectively. Daily colostrum yield for suckling group of buffaloes was significantly (p<0.05) higher than weaning group of buffaloes. The average daily milk yield was higher in suckling group than the weaning group and its mean value was 4.83±0.23 kg for weaning and 6.14±0.21 kg for suckling group respectively. The average milking time and total milking time was significantly (p<0.05) lower in suckling group than weaning group of buffaloes (4.38±0.09 vs. 5.39±0.11 min and 6.01±0.11 vs. 8.42±0.12 min respectively). The average daily milk flow rate was significantly (p<0.05) higher in suckling group (0.84±0.01 kg min^{-1}) than the weaning group (0.59±0.01 kg min^{-1}). It is concluded that suckling have positive effect on production performance of Murrah buffalo.

KEYWORDS: Colostrum-yield, Murrah buffalo, milk-yield, milk flow-rate, suckling, weaning

***Citation* (VANCOUVER):** Solanki et al., Production Performance of Murrah Buffaloes under Weaning and Suckling System of Calf Management. *International Journal of Bio-resource and Stress Management,* 2022; 13(1), 99-105. HTTPS://DOI.ORG/10.23910/1.2022.2615.

Data Availability Statement: Legal restrictions are imposed on the public sharing of raw data. However, authors have full right to transfer or share the data in raw form upon request subject to either meeting the conditions of the original consents and the original research study. Further, access of data needs to meet whether the user complies with the ethical and legal obligations as data controllers to allow for secondary use of the data outside of the original study.

Conflict of interests: The authors have declared that no conflict of interest exists.

RECEIVED on 11th September 2021 RECEIVED in revised form on 29th December 2021 ACCEPTED in final form on 24th January 2022 PUBLISHED on 31st January 2022

1. INTRODUCTION

The Success of a dairy farm enterprise depends upon successful calf rearing because these young calves will be the future replacement stock of a dairy farm. In most mammals, care for the young depends primarily on the mother (Zilkha et al., 2016). Rearing of calf after birth may have a significant impact on the subsequent performance and behaviour of animals and keeping the calf together with the mother in buffalo production systems could have a good outcome on calf growth without compromising milk production (Singh et al., 2019). Proper rearing of a healthy and viable calf is another prerequisite for making the best use of its genetic potential for dairy animals (Frelich et al., 2008 and Rehak et al., 2009). The practice of weaning is more beneficial in terms of scientific feeding; recording actual milk production of the dam, help in mechanization and automation of farm operations such as machine milking, reduce labour cost and ensuring clean milk production etc. (Rashid et al., 2013). But early mother-calf relationship disruption, which cause the emotional and physiological stress (Mota–Rojas et al., 2019).

In the market oriented dairy farming, calves are mostly separated from their dams and reared separately (Khan et al., 2020 and De Rosa et al., 2017) and the priority of selling more milk, instead of feeding to calves is in practice (Iqbal et al., 2014 and Cantor et al., 2019). Previous research reported that the nutritional component of the dam and calf bond is essential for better growth and production (Mandel and Nicol, 2017).

Buffalo has strong maternal instinct consequently mother and young relationships are closely bonded and the bonded offspring express affiliative behaviour toward the mother and show marked distress when separated from her (Sirovnik et al., 2020). Buffalo calves are slow learners as compared to the crossbred cattle calves and require more time to learn drinking of milk from the pail/bucket under artificial feeding (Smijisha, 2007). Therefore, the separation between buffalo dam and their calves becomes more stressful for both calf and dam in comparison to *taurus* cattle's calves (Foulkes, 2005). There are several adverse consequences of the weaning of calves on the dams. Experience has shown that buffaloes do not adapt to weaning as they do not let-down milk without being suckled and there is a greater amount of residual milk as the let-down of milk is partial. Average daily milk yield reduces in the weaned dam (Upadhyay et al., 2015 and Saini, 2012).

In the suckling, after milking, the young calf is set free to suckle the dam for a specific amount of time (Derkho et al., 2019). There are several positive effects of the suckling on cow performance; suckling has been reported to increase milk production in both zebu crosses and pure Holstein cows (Mendoza et al., 2010). Significant increases in milk yield in the suckled group may have been resulted either due to better let down and efficient removal of milk from udder and udder health (Upadhyay et al., 2015). When the calf is suckled the residual milk after milking, it increased degree of udder emptying and enhances production (Sandoval-Castro et al., 2000). The natural nursing of calves depends on the development of social bonds with the dam and it is necessary for the survival and welfare of newborn calf (Enriquez et al., 2010 and Khan et al., 2020).

Weaning system of calves rearing is recognized as scientific, hygienic and economic however; its results are not always satisfactory especially in case of buffalo. Therefore, present study was designed to examine the effect of weaning and suckling on production performance of Murrah buffalo dam.

2. MATERIALS AND METHODS

The study was conducted on the Murrah buffalo's dams and their calves, herd maintained at Livestock Farm, Adhartal, Department of Livestock Production and Management, College of Veterinary Science & A.H., N.D.V.S.U., Jabalpur (M.P.). A total of sixteen recently calved Murrah buffaloes and their calves were randomly assigned into two different groups as suckling (control) and weaning (experimental) based on their lactation yield and parities. Diet was formulated and fed as a total mixed ratio according to the nutrient requirement of lactating Murrah buffaloes (Anonymous, 2013).

2.1. Experimental Design

Group 1 (Suckling or control)- In this group the calves were allowed for the natural suckling of colostrum and milk at the start of milking and at the end of milking they were allowed again to suckle the required amount of milk throughout the experimental period.

Group 2 (Weaning at birth)- In this group the calves were weaned immediately after birth and trained manually to drink colostrum as well as milk and the milk let-down of buffaloes was done by teat massage before milking and provision of concentrate mixture.

The animals selected were free from any anatomical, physiological and infectious disorders and maintained under a semi-intensive management system. The basal diet was formulated with following ingredients as per Anonymous (2013) - Yellow maize (38%), Mustard cake (20%), Cotton seed cake (13%), Rice polish (8%), Wheat bran (9%), Arhar chuni (9%), Mineral mixture (2%) and Common salt (1%). The study was conducted for a period of one year (from 1stJune, 2020 to 30th May, 2021) at Livestock Farm, Adhartal, Jabalpur, Madhya Pradesh, India. Prior to experimentation, the animals were allowed 10 days adjustment period to reduce the effect of stress possibly

experienced by the animals due to separation from the main stock of the farm. The significance of the differences between the mean values of various parameters studies was tested by employing Z test using SYSTAT 12.0 (SPSS Inc. Chicago, IL, USA).

2.2. Observation taken

The milk let-down time (min) was recorded as the time interval between the provision of milking stimulus (initiation of suckling by calf) in the suckling group and the start of udder massage in the weaning group to let down of milk by using stop-watch in morning and evening daily and was estimated at weekly intervals up to 90 days.

Milking time was recorded as the total time required for the actual milking from the start of milking to the end of milking daily and was estimated at weekly intervals up to 90 days.

The daily yield of colostrum (kg) was recorded from the day of calving and up to 5 days.

Individual milk yields (kg) were recorded at each milking after the 5th days of calving to 9 months of lactation.

The milk flow rate was calculated by the formula given below.

MFR= Yield per milking (kg) / Total milking time

3. RESULTS AND DISCUSSION

3.1. Milk let-down time (min)

The average daily milk let down time (min) in the weaning group of buffaloes was 3.08±0.09 min with a range of 2.64 to 3.36 min whereas, in the suckling group of buffaloes was 1.62±0.04 min with a range of 1.49 to 1.79 min. Statistical analysis revealed that average daily milk let down time was significantly (p<0.05) lower in the suckling group as compared to the weaning group (Table 1).

During 1st few weeks average let–down time was lower in the suckling group then there was an increasing trend. A similar trend of milk let -down time in Murrah buffaloes was observed by Ramasamy and Singh (2004) and Kumar et al. (2006).

More than 80 % of milk is stored in udder alveoli (Combellas and Tesorero, 2003) and is transferred to the cistern by a neuro-hormonal reflex initiated by the contact of the calf's mouth with the udder that culminates in the contraction of the myoepithelial cells, surrounding the alveoli by the action of oxytocin liberated from the pituitary gland and this leads to an efficient milk ejection from the udder (Soloff et al., 1980). Suckling elicits a higher level of oxytocin than milking (Bar–Peled et al., 1995; Samuelsson and Svennersten, 1996 and Lupoli et al., 2001).

3.2. Daily colostrum yield (kg)

The average daily colostrum yield for the weaning and suckling group of buffaloes was 3.95±0.23 and 4.70±0.15 kg, respectively. Statistical analysis revealed that the average daily colostrum yield in the suckling group of buffaloes was significantly (p<0.05) higher than the weaning group of buffaloes (Table 2).

Table 1: Average daily milk let- down time (min) in weaning and suckling group of Murrah buffaloes

Weeks	Weaning	Suckling
1	3.27±0.36	1.66±0.24
2	3.23±0.40	1.67±0.21
3	2.83±0.28	1.68±0.22
4	3.00±0.33	1.79±0.23
5	3.36±0.38	1.77±0.18
6	2.83±0.24	1.67±0.19
7	2.81±0.29	1.56±0.09
8	2.64±0.18	1.50±0.10
9	3.20±0.34	1.50±0.09
10	3.26±0.33	1.49±0.11
11	3.15±0.25	1.52±0.10
12	3.12±0.32	1.59±0.07
13	3.25 ±0.41	1.58±0.08
Overall	3.08a±0.09	1.62b±0.04

These findings are in agreement with Mondal and Verma (2000) who reported that daily colostrum yield for 1st 5 days post-partum was significantly (p<0.01) higher in the suckling group as compared to the weaning group in buffaloes. However, Ramasamy and Singh (2004) and Robinson et al. (2009) observed higher average daily colostrum yield for the 1st 5 days post-partum than the present investigation.

Table 2: Average daily colostrum yield (kg) in weaning and suckling group of Murrah buffaloes

Days	Weaning	Suckling
1	3.31±0.27	4.33±0.26
2	3.06±0.38	4.00±0.23
3	4.06±0.36	5.30±0.29
4	4.63±0.60	4.78±0.31
5	4.88±0.67	5.21±0.33
Overall	3.95a±0.23	4.70b±0.15

3.3. Milking time (min)

The average milking time in the weaning and suckling group of buffaloes was 5.39±0.11 and 4.38±0.09 min, respectively. Statistical analysis revealed that average milking time was significantly (p<0.05) lower for the suckling group

of buffaloes as compared to the weaning group (Table 3).

Table 3: Average daily milking time (min) in weaning and suckling group of Murrah buffaloes

Weeks	Weaning	Suckling
1	4.42±0.29	3.86±0.37
2	5.35±0.33	4.39±0.45
3	5.28±0.30	4.62±0.40
4	5.82±0.29	4.76±0.38
5	5.92±0.28	4.60±0.36
6	6.02±0.31	4.56±0.37
7	5.59±0.44	4.47±0.38
8	5.55±0.48	4.43±0.28
9	5.56±0.51	4.27±0.30
10	5.39±0.52	4.28±0.37
11	5.15±0.48	4.28±0.33
12	4.96±0.46	4.31±0.29
13	5.21±0.44	4.23±0.21
Overall	5.39a±0.11	4.38b±0.09

Higher milking time in the weaning group of buffaloes than suckling group may be due to the poor milk temperament and poor let-down in weaned buffaloes therefore they caused a lot of inconvenience to the milkers during milking that resulted in longer time spent on milking although the mean daily yield was significantly lower in these buffaloes.

Similar findings were reported by Kumar et al. (2004), Kumar et al. (2006) and Saini (2012) when studied the factors affecting milking time in buffaloes and reported lower milking time in buffaloes suckling by their calves than those buffaloes milking without the presence of calves.

3.4. Daily total milking time (min)

The average daily total milking time in the weaning and suckling group of buffaloes was 8.42±0.12 and 6.01±0.11min, respectively. Statistical analysis revealed that the average daily total milking time was significantly (p<0.05) lower in the suckling group of buffaloes as compared to the weaning group of buffaloes (Table 4).

3.5. Daily milk yield (kg)

The average daily milk yield in the weaning and suckling group of buffaloes was 4.83±0.23 kg and 6.14±0.21 kg, respectively. Statistical analysis revealed that the average daily milk yield in the suckling group was significantly (p<0.05) higher than in the weaning group (Table 5).

Higher daily milk yield in the suckling group of buffaloes might be due to the better milk let-down, efficient removal of milk from the udder and stimulation of posterior pituitary

Table 4: Average daily total milking time (let-down time+milking time) in weaning and suckling group of Murrah buffaloes (min)

Weeks	Weaning	Suckling
1	7.68±0.24	5.52±0.52
2	8.57±0.44	6.07±0.50
3	8.12±0.31	6.30±0.49
4	8.84±0.34	6.55±0.48
5	9.27±0.38	6.36±0.41
6	8.82±0.40	6.24±0.43
7	8.40±0.66	6.02±0.31
8	8.19±0.52	5.94±0.34
9	8.76±0.49	5.76±0.32
10	8.64±0.52	5.76±0.41
11	8.30±0.41	5.80±0.36
12	8.07±0.38	5.91±0.28
13	8.45±0.50	5.81±0.16
Overall	8.42a±0.12	6.01^{b}±0.11

Table 5: Average daily milk yield (kg) in weaning and suckling group of Murrah buffaloes

Fortnights	Weaning	Suckling
1	5.97±0.34	6.91±0.64
2	6.88±0.33	8.39±0.63
3	7.31±0.45	8.35±0.50
4	7.00±0.55	7.84±0.42
5	6.57±0.53	7.68±0.46
6	6.24±0.51	7.65±0.41
7	6.48±0.52	7.52±0.31
8	6.46±0.55	7.45±0.18
9	6.43±0.69	7.29±0.28
10	5.56±0.61	6.50±0.33
11	4.92±0.58	6.33±0.42
12	4.31±0.85	5.82±0.76
13	3.52±0.93	5.26±0.89
14	3.12±0.90	4.65±0.93
15	2.21±0.87	4.29±1.07
16	1.52±0.83	3.96±1.0
17	1.31±0.79	2.83±0.95
18	1.11±0.77	1.70±0.85
Overall	4.83^{a}±0.23	6.14b±0.21

for release of oxytocin for milk ejection (Wellnitz et al., 1999). Suckling also stimulates the release of prolactin, adrenocorticotropin and somatotropin which is thought to maintain galactopoiesis (Tucker, 1985).

Without pre-milking stimulation, myoepithelial cells are sensitive to mechanical stimulation and the tap reflex, induced by the butting calf, may augment the action of oxytocin on these cells, milk flow is depressed or totally interrupted after removal of the cisternal milk until oxytocin-induced milk ejection occurs (Bruckmaier and Blum, 1996), milk ejection probably is most efficacious when mechanical stimuli and oxytocin combine to affect the myoepithelial cells of udder (Gimpl and Fahrenholz, 2001).).

In the agreement of present finding Krohn, (2001), Combellas et al. (2003), Yilma et al. (2006), Tesorero et al. (2006), Kaskous et al. (2006), Froberg et al. (2007), Mendoza et al. (2010) and Upadhyay et al. (2015) reported higher value of daily milk yield in suckling cows as compared to weaning cows.

This higher milk production in suckling cows was probably due to the effect of frequent udder emptying because when the calf is suckled the residual milk after milking; an increased degree of udder emptying enhances production (Sandoval-Castro et al., 2000).

3.6. Daily milk flow rate (kg min^{-1})

The average daily milk flow rate was significantly (p<0.05) higher in suckling group (0.84±0.01 kg min^{-1}) than the weaning group (0.59±0.01 kg min^{-1}) (Table 6).

Table 6: Average daily milk flow rate (kg min^{-1}) in weaning and suckling group of Murrah buffaloes

Weeks	Weaning	Suckling
1	0.60±0.01	0.81±0.01
2	0.61±0.01	0.85±0.01
3	0.61±0.01	0.84±0.02
4	0.58±0.02	0.85±0.02
5	0.61±0.01	0.87±0.01
6	0.61±0.01	0.88±0.01
7	0.61±0.02	0.86±0.01
8	0.62±0.01	0.84±0.01
9	0.60±0.01	0.83±0.02
10	0.56±0.04	0.81±0.03
11	0.56±0.03	0.83±0.02
12	0.56±0.04	0.82±0.03
13	0.56±0.04	0.81±0.02
Overall	0.59^{a}±0.01	0.84b±0.01

The higher daily milk flow rate in the suckling group of buffaloes may be due to complete let-down of milk by suckling calves, as the milk ejection reflex is a neuro-humoral reflex and occurs in response to tactile stimulation of the mammary gland. (Tancin et al., 1994).

Samuelsson and Svennersten (1996) reported a stronger effect of the suckling stimulus on oxytocin release. Similar findings were reported by Kumar et al. (2006), Mendoza et al. (2010), Saini (2012), and Upadhyay et al. (2015)

Saini (2012) and Upadhyay et al. (2015) reported a lower value of average daily milk flow rate in the weaning group of buffaloes than the suckling group of buffaloes.

4. CONCLUSION

With the same level of concentrate allowance, buffaloes reared under restricted suckling management had increased colostrum yield, daily milk yield, milk flow rate and decreased milk letdown time, milking time than those artificially reared. Restricted suckling may be a more beneficial and viable alternative for the management of the buffalo's herd.

5. REFERENCES

Anonymous, 2013. Nutrient requirements of cattle and buffalo. Indian Council of Agricultural Research, New Delhi, India.

Bar-Peled, U., Maltz, E., Bruckental, I., Folman, Y., Kali, Y., Gacitua, H., Lehrer, A.R., Knight, C.H., Robinzon, B., Voet, H., Tagari, H., 1995. Relationship between frequent milking or suckling in early lactation and milk production of high producing dairy cows. Journal of Dairy Science 78, 2726–2736.

Bruckmaier, R.M., Blum, J.W., 1996. Simultaneous recording of oxytocin release, milk ejection and milk flow during milking of dairy cows with and without pre-stimulation. Journal of Dairy Research 63, 201–208.

Cantor, M.C., Costa, J.H.C., Neave, H.W., 2019. Current perspectives on the short and long-term effects of conventional dairy calf raising systems: a comparison with the natural environment. Translational Animal Science 3, 549–563.

Combellas, J., Tesorero, M., 2003. Cow-calf relationship during milking and its effects on milk yield and calf live weight gain. Livestock Research for Rural Development 15(3), 12–21.

Combellas, J., Tesorero, M., Gabaldon, L., 2003. Effect of calf stimulation during milking on milk yield and fat content of *Bos indicus* x *Bos taurus* cows. Livestock Production Science 79, 227–232.

De Rosa, G., Grasso, F., Pisani, M., Salese, M., Serrapica,

M., Napolitano, F., 2017. Cross–sucking and inter-suckling in dairy buffaloes. Proceedings of the 7th International Workshop on Assessment of Animal Welfare at Farm and Group Level. 5-8 September, Ede, The Netherlands, 247.

Derkho, M., Mukhamedyarova, L., Rubjanova, G., Burkov, P., Schnyakina, T., Shcherbakov, P., Shcherbakova, T., Stepanova, K., Kazhibayeva, G., 2019. Erythrocytes and their transformations in the organism of cows. International Journal of Veterinary Sciences Research 8, 61–66.

Enriquez, D., Ungerfeld, R., Quintans, G., Guidoni, A., Hotzel, M., 2010. The effects of alternative weaning methods on behaviour in beef calves. Livestock Science 128, 20–27.

Foulkes, D., 2005. Management of orphaned or weaned buffalo calves. www.nt.gov.au/dpifm

Frelich, J., Slachta, M., Szarek, J., Weglarz, A., Zapletal, P., 2008. Seasonality in milk performance and reproduction of dairy cows in low-input farms depending on feeding system. Journal of Animal and Feed Sciences 18, 197–208.

Froberg, S., Aspegren-Guldorff, A., Olsson, I., Marin, B., Berg, C., Hernandez, C., Galina, C.S., Lidfors, L., Svennersten-Sjaunja, K., 2007. Effect of restricted suckling on milk yield, milk composition and udder health in cows and behaviour and weight gain in calves, in dual-purpose cattle in the tropics. Tropical Animal Health and Production 39, 71–81.

Gimpl, G., Fahrenholz, F., 2001. The oxytocin receptor system: structure, function, and regulation. Physiological Reviews 81, 629–683.

Iqbal, Z., Hayat, Z., Abdullah, M., Javed, K., Ahamd, N., 2014. Milk and milk replacer performance in dairy calves. Journal of Animal and Plant Sciences 24, 52–54.

Kaskous, S.H., Weiss, D., Massri, Y., Al-Daker, A.M.B., Nouh, A.D., Bruckmaier, R.M., 2006. Oxytocin release and lactation performance, in Syrian Shami cattle milked with and without suckling. Journal of Dairy Research 73, 28–32.

Khan, U.D., Khan, A., Gul, S.T., Saleemi, M.K., Du, X.X., 2020. Seroprevalence of brucellosis in cattle (Bos taurus) kept in peri urban areas of Pakistan. Agrobiological Records 1, 6–10.

Krohn, C.C., 2001. Effects of different suckling systems on milk production, udder health, reproduction, calf growth and some behavioural aspects in high producing dairy cows- A review. Applied Animal Behaviour Science 72, 271–280.

Kumar, A., Singh, R., Kumar, Y., 2004. Study on the factors affecting milking time in buffaloes under farming conditions. Indian Journal of Animal Research 38(2), 133–136.

Kumar, A., Singh, R., Kant, N., Kumar, Y., 2006. Studies on factors affecting milk flow rate in buffaloes under farmer's conditions. Journal of Dairying, Foods and Home Science 25(1), 59–62.

Lupoli, B., Johansson, B., Uvnas-Moberg, K., Svennersten-Sjaunja, K., 2001. Effect of suckling on the release of oxytocin, prolactin, cortisol, gastrin, cholecystokinin, somatostatin and insulin in dairy cows and their calves. Journal of Dairy Research 68, 175–18

Mandel, R., Nicol, C.J., 2017. Re-direction of maternal behaviour in dairy cows. Applied Animal Behavior Science 195, 24–31.

Mendoza, A., Cavestany, D., Roig, G., Ariztia, J., Pereira, C., La Manna, A., Contreras, D.A., Galina, C.S., 2010. Effect of restricted suckling on milk yield, composition and flow, udder health and postpartum anestrus in grazing Holstein cows. Livestock Science 127, 60–66.

Mondal, S.K., Verma, G.S., 2000. Colostrum yield, its relation with economic traits and prediction of part lactation yields in Murrah buffaloes. Italian Journal of Animal science 70(5), 533–534.

Mota-Rojas, D., De Rosa, G.de, Mora-Medina, P., Braghieri, A., Guerrero-Legarreta, I., Napolitano, F., 2019. Dairy buffalo behaviour and welfare from calving to milking. CAB Review 14(35), 1–9.

Ramasamy, M., Singh, M., 2004. Post-partum milking behaviour and its effect on milk production in Murrah buffaloes (*Bubalus bubalis*). Indian Journal of Animal Sciences 3(4), 188–192.

Rashid, M.A., Pasha, T.N., Jabbar, M.A., Ijaz, A., Rehman, H., Yousaf, M.S., 2013. Influence of weaning regimen on intake, growth characteristics and plasma blood metabolites in male buffalo calves. Animal 7(9), 1472–1478.

Rehak, D., Rajmon, R., Kubesova, M., Stipkova, M., Volek, J., Jilek, F., 2009. Relationships between milk urea and production and fertility traits in Holstein dairy herds in the Czech Republic. Czech Journal of Animal Science 54, 193–200.

Robinson, P.H., Moorby, J.M., Gisia, D.D., 2009. Colostrum production by primiparous and multiparous Holstein dairy cows and its usefulness as an estimator of full lactation milk yield. Livestock Science 125(3), 323–325.

Saini, M., 2012. Effect of using dummy calf for milk let-down on the performance and behaviour of Murrah buffaloes. M.V.Sc. Thesis. NDRI, Karnal, India.

Samuelsson, B., Svennersten, K., 1996. Effect of suckling on the release of oxytocin in dairy cows and their calves. In: Proceedings of the symposium on milk synthesis,

secretion and removal in Ruminants, Bern, 26–27 April 1996, p75.

Sandoval-Castro, C.A., Anderson, S., Leave, J.D., 2000. Production responses of tropical crossbred cattle to supplementary feeding and to different milking and restricted suckling regimes. Livestock Science 66(1), 13–23.

Singh, P.K., Kamboj, M.L., Chandra, S., Kumar, A., Kumar, N., 2019. Influence of weaning on growth, health and behaviour of buffalo (*Bubalus bubalis*) calves. Indian Journal of Animal Research 53(5), 680–684.

Sirovnik, J., Barth, K., Oliveira De, D., Ferneborg, S., Haskell, M.J., Hillmann, E., Jensen, M.B., Mejdell, C.M., Napolitano, F., Vaarst, M., Verwer, C.M., Waiblinger, S., Zipp, K.A., Johnsen, J.F., 2020. Methodological terminology and definitions for research and discussion of cow-calf contact systems Journal of Dairy Research 87, 108–114.

Smijisha, A.S., 2007. Effect of methods of feeding and individual housing on growth and health status of buffalo calves. M.V.Sc. Thesis, NDRI Deemed University, Karnal, India.

Soloff, M.S., Chakarborty, J., Sadhukhan, P., Senitzer, D., Wieder, M., Frenstrom, M.J., Sweet, P., 1980. Purification and characterization of mammary myoepithelia and secretary cells from the lactating rat. Endocrinology 106, 887–899.

Tancin, V., Broucek, J., Harcek, L., Uhrincat, M., Mihina, S. and Cupka, P., 1994. Suckling and machine milking-influenced secretion of oxytocin, cortisol and milk characteristic in primiparous dairy cows. In: Proceedings of the 3rd International Housing Conference on Dairy System for the 21st Century, ASAE, Orlando, FL, 2–5 February 1994, pp 426–433.

Tesorero, M., Gabaldon, L., Combellas, J., 2006. Influence of calf presence loose in a pen alongside the milking parlor on yield and fat content of milk from Brahman x Holstein cows. Livestock Research for Rural Development 18, 4. http://www.lrrd.org/lrrd18/4/teso18056.htm

Tucker, H.A., 1985. Endocrine and neural control of mammary gland. In: Larson, B.L. (Ed.), Lactation, Firsted–Ition, Iowa State University Press, Ames, Iowa, pp 39–79.

Upadhyay, V.K., Tomar, A.K.S., Patel, B.H.M., Golher, D.M., Sahu, S., Bharti, P.K., 2015. Effect of early weaning on milking behaviour, production and reproduction of Tharparkar cows. Indian Journal of Dairy Science 68(5), 477–482.

Wellnitz, O., Bruckmaier, R.M., Albrecht, C., Blum, J.W., 1999. Atosiban, an oxytocin receptor blocking agent: pharmacokinetics and inhibition of milk ejection in dairy cows. Journal of Dairy Research 66, 1–8.

Yilma, Z., Gojjam, Y., Shumye, M., 2006. Milk production level and calf rearing system affecting Boran, Ethiopian zebu cattle breed, cow-calf performance. Livestock Research for Rural Development 18(5), 11.

Zilkha, N., Sofer, Y., Beny, Y., Kimchi, T., 2016. From classic ethology to modern neuroethology: Overcoming the three biases in social behavior research. Current Opinion in Neurobiology 38, 96–108.