Nutrition management and reproductive performances in buffalo species

Gianluca Neglia[1]*, DVM, PhD; Roberta Cimmino[2] DAS, PhD, Anna Balestrieri[2] DVM, Giuseppe Campanile[1], DVM, PhD

[1]*Department of Veterinary Medicine and Animal Production, Federico II University, Naples, Italy.*
[2]*Istituto Zooprofilattico Sperimentale del Mezzogiorno – sez. Portici. Via Salute, 2 – 80055 Portici (Naples), Italy*

***Corresponding author**: neglia@unina.it

Abstract

Nutrition plays a fundamental role in the management of buffalo herd. The satisfaction of nutritional requirements, particularly in some countries, like Italy, where the breeding season has been modified for commercial purposes, represents the key point to guarantee high reproductive efficiency. In fact, the optimization of production in livestock depends on the quick resumption of ovarian activity immediately after calving and/or on the anticipation of puberty in subjects destined to the culling. In lactating buffaloes, the period just after calving is particular important, because of the decrease in dry matter (DM) intake which determines a condition of physiologic hyponutrition. This is responsible for some metabolic changes which in turn leads to a low body condition score, slowing down of the follicular turn-over and reduced oocyte quality. However, increasing the energy density of the diet by high amount of starch may increase the endometritis rate: therefore, high quality forage are fundamental in buffalo nutrition. Dietary protein may also influence reproductive performance, because of the higher levels of blood urea following diets with high protein content or the decrease ruminal microbial activity following low protein content counterparts. Finally, mineral and vitamins supplementation have to be considered, particularly when pasture or fresh forages are not available.

Keywords: Nutritional requirements; Negative energy balance; Protein; Puberty.

Introduction

The optimization of production in livestock depends on the quick resumption of ovarian activity immediately after calving and/or on the anticipation of puberty in subjects destined to the culling. These conditions help to reduce the herd's unproductive period. Moreover, the decrease of the puberty age reduces the generation interval and favours genetic improvement. Several factors influence reproductive activity, such as pathologies, farm management, climatic conditions, space availability and nutrition. They may play a direct or an indirect role but in any case affect the reproductive performance. Among these, the nutrition

Overview

The start of lactation in buffalo is characterized by a decrease in dry matter (DM) intake which determines a condition of physiologic hyponutrition (Campanile, 1997) and leads to the utilization of fat deposits and muscle proteins (negative energy balance – NEB). The high productive level and the lower DM intake causes a body weight loss of 1.6% and

3.8% in primiparous in pluriparous buffaloes, respectively (Campanile *et al.*, 2001), affecting the intercalving period (Table 1).

Table 1. Body weight loss (%) during the first 60 days of lactation, variability coefficient (CV %), energy (expressed as milk forage unit – MFU) utilized for Kg of energy corrected milk (ECM), in relation with the category (pluriparous and primiparous buffaloes), the productive level (kg) and the intercalving period (days).

		Body weight loss (%)	**CV**	**MFU/kg ECM**	**Intercalving period (days)**
Pluriparous	n.	x ± ds	%		
> 5,000 kg	13	5.6 ± 5.1	91	0.447	479
< 5,000 kg	18	2.0 ± 4.0	200	0.445	436
Total	31	3.8 ± 5.2	137	0.446	452
Primiparous					
> 5,000 kg	12	4.2 ± 4.6	110	0.436	520
< 5,000 kg	9	+3.06 ± 7.6	245	0.436	476
Total	21	0.51 ± 7.4	1187	0.436	502

The NEB is responsible for a slowing down of the follicular turn-over, as demonstrated by the reduction of large follicles in buffaloes undergone ovum pick twice weekly and fed 40% productive requirements deficit (Campanile et al., 1999). Furthermore, a reduction of good quality oocytes can be observed 80 days after feeding restriction, because of the influence of hyponutrition on primordial follicles, that need around 90-110 days in order to mature from the preantral to the preovulatory stage (Lussier *et al.*, 1987). In a trial carried out on Murrah buffalo heifers fed high (5.8 MFU/day) or low (3.6 MFU/day) energy diets for 19 weeks, no differences were observed in terms of follicular turnover, but a decreased oocyte quality was recorded in animals fed low energy diet, together with lower IGF-1 concentration in follicular fluid (Campanile et al., 2010). It is known that IGF-I is the main factor involved in in vitro oocyte maturation in buffalo (Pawshe et al., 1998): therefore it can be speculated that NEB may lead to seasonal anoestrus via IGF-1 and gonadotrophins reduction. Interestingly, these animals did not show a decrease in live weight throughout the trial, suggesting that buffalo heifers are able to modulate their metabolism in response to a sub-optimal energy diet (Campanile et al., 2010).

The negative influence of NEB on reproductive performance has been largely demonstrated also in other trials. Sastry (1988) reported that the body weight loss during the first 4-5 months of lactation was inversely correlated to the mating period and to the number of services/conception. Similarly, Kaur and Arora (1982) reported a great reduction in the conception rate (66.6% vs 16.6 %) in underfed Murrah buffaloes compared to those whose diet met requirements and Baruselli (1993) recorded a decreased number of deliveries, following an increased number of head /hectare. Negative correlations between daily milk yield and mating period length were also reported by Zafar (1985), whereas weight gain during the insemination period improves fertility. The body condition score (BCS) is a good indicator that reflects the nutritional status and underfed or overfed buffaloes show lower or higher BCS values, respectively, compared to those with satisfied requirements. An optimal BCS at calving time (>3.5 points; 1 to 5 scale) improves reproductive efficiency (Hegazy et al., 1994; Baruselli et al., 2001), while negative performance have been reported in buffaloes with BCS higher than 4 (Baruselli et al., 2001) or lower than 2.5 points (Qureshi, 2009). This is due mainly to delayed postpartum

estrus interval, higher incidence of anoestrus, retarded conception and increase of the number of services for conception.
In order to face the NEB, the diet energy density has to be increased at the beginning of lactation, changing the forage:concentrate ratio. However, if high starch concentration is reached (>22%), a sub clinic metabolic acidosis condition occurs in buffalo cows, increasing the endometritis rate, the calving-conception interval and the number of not pregnant subjects (Campanile *et al.*, 1991a). Therefore it is necessary to increase the diet energy density with high quality forage (grazing stage of ryegrass hay silage) and/or rumen protected fats: some studies demonstrated that the increase of diet energy density using protected fats, reduced the calving-conception interval from 48 to 38 days (Zicarelli, 1997), probably via linolenic acid increase, that favours $PGF_{2\alpha}$ activity, and consequently, follicular growth, P4 and LH haematic levels and cyclicity. In this regard, in a recent trial (Nazir et al., 2013) it was demonstrated the beneficial effects of post-partum dietary supplementation with flaxseed (a source of omega 3 fatty acids) on progesterone levels and conception rate on Murrah buffaloes.

Dietary protein intake may also affect reproductive performance. Protein and/or energetic underfeeding cause a decrease of ruminal microbial activity and, consequently, of the whole volatile fat acid content. This condition leads to GH increase and insulin decrease, allowing the mobilization of the muscular proteins used for glucose synthesis. Similarly, an excess of protein intake, may have negative impact on reproduction: a positive correlation has been found between crude protein intake and urea blood levels in both Mediterranean (Campanile et al., 2003) and Nili Ravi (Qureshi et al., 2002) buffaloes. Higher urea serum levels may be responsible for altered uterine pH and ovarian function (Qureshi et al., 2002). Furthermore, the elevation of ureic nitrogen in the local (reproductive) or systemic apparatus reduces the ovarian receptors LH linkage and, therefore, it would be responsible for low progesterone levels in the post ovulation days and low conception rate. However, overfeeding proteins has been associated with a decline in fertility in most (Elrod and Butler, 1993), but not all (Howard et al., 1987) studies. Qureshi et al., (2002) report negative relationships between urea levels and duration of placenta expulsion, first postpartum ovulation interval and pregnancy rate. On the contrary, no influence of high urea levels in blood and vaginal mucus is reported in other studies (Campanile et al., 2003). A diet with a 50% protein content higher than required, led in Mediterranean buffaloes to an increase of heats followed by an appropriate luteinic phase and a prolongation of the inter-oestrus interval (Campanile et al., 1991). Furthermore, protein digestibility in the rumen did not seem to influence reproductive activity in buffalo cows (Campanile et al., 2003). This is probably due to a lower diffusion of ammonia in the uterus, reducing the detrimental effect on reproductive efficiency. In fact, buffalo uses nitrogen better than cattle, also with NSC deficiency (Langer et al., 1969), since the intraruminal environment is more favourable for NPN-using bacteria.

Minerals and vitamins have also to be considered for their influence on reproduction. Ca and P amounts for buffalo maintenance requirements are those recommended for dairy cows, while production requirements are higher (6 - 6.5 g of calcium and 2.2 - 2.5 g of phosphorus for litre of milk), due to the higher quantity of these elements in milk (Zicarelli, 1990). Ca and P requirements during the dry period need to be maintained in a ratio close to the unit, to avoid vaginal and/or uterine prolapse (Campanile *et al.*, 1989). In particular, a high Ca:P ratio in the diet induces an alteration of the normal Ca:Mg ratio at the haematic level, followed by an alteration of the uterine-vaginal muscular fiber excitability, atony of the organ and prolapse (Campanile *et al.*, 1989). However, according to Pathak et al., (1989) Ca supplementation in the last gestation phase reduces the time necessary for

placenta expulsion, probably because the low milk yield recorded in these subjects. Selenium and vitamin E supplementation (4.2 mg of Se + 4200 mg of vit. E) during the dry perio, reduces placenta retentions and allows a ready recovery of the reproductive activity immediately after calving, because of the uterine phlogosis reduction. Similarly, the supplementation with 400,000 IU of A vitamin some months before mating, increasing the conception rate.
Finally, it has to be considered the nutritional management of growing buffaloes. Nutritional deficiencies in these phases may cause low live weight and, consequently, delayed puberty (Afidi et al., 1979; Campanile, 1997). The growth pattern experienced by buffalo heifers from the time of weaning has a major influence on age and LW at puberty and first conception. Heifers that experience a nutritional deficiency after weaning and during the pre-pubertal period conceive at an older age and heavier LW (Campanile, 1997).

Final remarks and recommendations

The nutrition effects on reproductive performances are particularly evident in those countries where buffalo mating period coincides with a period characterized by a decreasing of light hours and where, thanks to the climate, forage availability changes throughout the year. In Italy, where the breeding season is modified for commercial purposes, other factors have to be considered, such as number of light hours, climate, etc. However, nutritional mistakes worsen this situation, further influencing reproductive performance. Therefore, hygiene and food quality represent a key point to improve buffalo breeding.

References

Afidi Y, El Ashry M, El Fouly M, Kirralla K, Abu Selim I, 1979. The effect of different planes of nutrition on growth and reproductive performances of buffalo heifers. Agric Res Rev, 56: 39-49.
Baruselli PS, 1993. Manejo reprodutivo de bubalinos. Inst. Zoot. Estacao Esperimental de Zootecniq do Vale do Ribeira, Registro SP., Brazil.
Baruselli PS, Barnabe VH, Barnabe RC, Visintin JA, Molero-Filho JR, Porto Filho R, 2001. Effect of body condition score at calving on pospartum reproductive performances in buffalo. Buf J, 1: 53-65.
Campanile G, 1997. Relationship between nutrition and reproduction. 3th course on biotechnology of reproduction in buffaloes.. Bubalus bubalis, Suppl II/98: 217-235.
Campanile G, Baruselli PS, Vecchio D, Prandi A, Neglia G, Carvalho NAT, Sales JNSJ, Gasparrini B, D'Occhio MJ, 2010. Growth, metabolic status and ovarian function in buffalo heifers fed a low energy or high energy diet. Anim Reprod Sci, 122: 74–81.
Campanile G, Bonavoglia C, Perrucci GF, Di Palo R, 1991. Caratteristiche ematochimiche in bufale appartenenti ad aziende con differente fertilità. Proc Fe.Me.S.P.Rum, 1: 93-97.
Campanile G, Di Palo R, Di Meo C, Boni R, 1989. Effetti dell'integrazione con P durante l'asciutta sui livelli ematici di Ca P e Mg nella bufala. Proc XLII Congr. SISVet, Ottobre 1, 261-265 pp.
Campanile G, Di Palo R, Gasparrini B, Spadetta M, Neglia G, Zicarelli L, 1999. Follicle and oocytes characteristics in buffaloes fed different diets. Proc ASPA XIII Congress, Piacenza, Italy, June 21–24, 241–243 pp.

Campanile G, Di Palo R, Infascelli F, Gasparrini B, Neglia G, Zicarelli F, D'Occhio MJ, 2003. Influence of rumen protein degradability on productive and reproductive performance in buffalo cows. Repr. Nutr. Dev 43: 557-566.
Campanile G, Di Palo R, Zicarelli L, 2001. Bilancio energetico e attività riproduttiva nella specie bufalina. Proc. I Congresso Nazionale sull'All. Del Bufalo, Eboli (SA) 3-5 Ottobre, 114-127 pp.
Elrod CC, Butler WR, 1993. Reduction of fertility and alteration of uterine pH in heifers fed excess ruminally degradable protein. J Anim Sci, 71: 694-701.
Hegazy MA, Essawy SA, Teleb HM, El-Wishy AA, Youssef AH, 1994. Effect of body condition score on reproductive performance of buffaloes. Proc IV World Buffalo Congress, São Paulo, Brazil, June 3, 630-631 pp.
Howard HJ, Aalseth AP, Adams GD, Bush LG, McNew RW, Dawson LJ, 1987. Influence of dietary protein on reproductive performance of dairy cows. J Dairy Sci, 70: 1563-1571.
Kaur H, Arora SP, 1982. Influence of the level of nutrition and season on the oestrus cycle rythm and on the fertility in buffaloes. Trop Agricult, 59: 274-278.
Langer PN, Sidhu GS, Bathia JS, 1969. A study of the microbial population in the rumen of buffalo (Bos bubalis) and zebu (Bos indicus) on a feeding regimen deficient in carbohydrates. Indian J Vet Sci, 38: 333-336.
Lussier JG, Matton P, Dufour JJ, 1987. Growth rate of follicles in the ovary of the cow. J Reprod Fertil, 81: 301-315.
Nazir G, Ghuman SPS, Singh J, Honparkhe M, Ahuja CS, Dhaliwal GS, Sangha MK, Saijpaul S, Agarwal SK, 2013. Improvement of conception rate in postpartum flaxseed supplemented buffalo with Ovsynch+CIDR protocol. Anim Reprod Sci, 137: 15-22.
Pathak MM, Patel AV, Meta VM, 1989. Role of serum calcium in association with phosphorus in placental expulsion of Surti buffalo. Proc II World Buffalo Congress, New Delhi, India, December 1: 73 p.
Pawshe CH, Appa Rao KBC, Totey SM, 1998. Effect of insulin-like growth factor I and its interaction with gonadotropins on in vitro maturation and embryonic development, cell proliferation and biosynthetic activity of cumulus cells and granulosa cells in buffalo. Mol Reprod Dev 49: 277-285.
Qureshi MS, 2009. Nutritional and management support to reproduction in dairy buffaloes under tropical conditions. Pak J Zool Suppl Ser, 9: 895-909.
Qureshi MS, Habib G, Samad AH, Siddiqui MM, Ahmad N, Syed M, 2002. Reproduction-nutrition relationship in dairy buffaloes. I. Effect of intake of protein, energy and blood metabolites levels. Asian Australs J Anim Sci, 15: 330-339.
Sastry NSR, 1988. Modern management for optimizing buffalo production. Proc II World Buffalo Congress, New Delhi, December 2, 556-573 pp.
Zafar AH, 1985. Economics of rural dairy animals in the canal irrigated area of Punjab 1982-83. Livestock Production Research Institute, Okara Pakistan.
Zicarelli L, 1990. Considerazioni sull'allevamento bufalino. Ed. ERSAC
Zicarelli L, 1997. Note comparative di fisiopatologia della riproduzione tra le specie bovina e bufalina. Proc Giornate Buiatriche 1996-1997, 84-104 pp.