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Nutritional aspects of buffalo production

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Abstract
Nutrition of animals and milk production is closely related. Every aspect of animal production performance is directly affected by the feeding and nutrition of the animal. India has witnessed an average annual growth rate of milk production of 4.51% during the 2007-2012, reaching 127.9 million tonnes in 2011-12, taking per capita milk availability for Indian citizens to the WHO recommended standard of 290 grams per head per day. This is mainly due to significant numbers of the buffalo population. Additional contribution of the buffaloes as the top exported agricultural commodity i.e. carabeef sourced from spent and unwanted buffaloes, truly makes this species the 'Black Gold' of the country. India have diverse germplasm of buffaloes some of them are non-descript and low producing. Furthermore, milk productivity is marred by suboptimal reproductive efficiency and lack of quality feed resources. Better utilization of feeds and fodders hold the promise for overall improvement in buffalo productivity. This needs to be addressed. Therefore, in this review the nutritional management of lactating and non-lactating buffalo is thoroughly discussed.

Keywords: Black Gold, nutrition, buffalo production, milk production, nutritional management

Introduction

Buffalo plays crucial role in rural livelihood, food security and agricultural economy. Apart from milk and meat, buffaloes contribute significantly to draught power for agricultural operations as well as through dung for fuel and soil improvement. Farmers preferred buffaloes is over cattle in many parts of the country owing to its more quantity of milk yield, disease resistance, longer productive life and higher milk productivity. Nutrition plays a vital role in livestock rearing. Optimum nutrition is of paramount importance to exploit full production potential from buffaloes. Therefore, nutritional aspect of buffalo production and management should be considered scientifically and proper attention should be given to the feeding management to achieve maximum output from this species. India possess largest population of buffaloes i.e. 108.7 million buffaloes (18th Livestock Census, 2007) with an annual growth rate of 1.84% and shares 57% of world buffalo population and thus first in buffaloes and milk production (19th Livestock Census, 2012, DAHD & F, Govt. of India). Buffaloes are reared for milk and meat production. India, with over 53% of the world's buffalo meat productivity, produces 39% of global buffalo meat and contribute 55% of total milk production, highlighting the untapped potential for increased production (Kondaiah, 2025) [31].

Apart from this, buffaloes termed as *Black Gold*, and contribute various byproducts such as leather, dung, blood, bones etc. apart from milk and meat which helps to improve the economic status of the farmers. The drought power from buffalo bullocks in field operations which have added advantage goes unnoticed. However, production performance in terms of milk, reproduction and growth rate (meat) is lower as compared to their western counterpart (Singh and Mehra, 1990; Qureshi *et al*., 2002; Sahoo *et al*., 2004; Wynn *et al*., 2009) [47, 43, 45, 56] which is mainly attributed to the poor state of nutrition that accounts for the major share in cost of production. There is net deficit of 40, 57 and 36% of dry forages, concentrates and green forages, respectively in India (NABCONS, 2007). This area hence needs proper attention of researchers across the globe to enhance the production potential of buffaloes.

Use of unconventional or agro-industrial byproducts in buffaloes is promising but restricts its use due to presence of one or more anti-nutritional factors which warrants proper processing before feeding. In past, several attempts have been made to process and improve the nutritive value of feed resources by various process and treatments (Katole *et al*., 2011) [26]. However, there are certain constraints in adopting the methods of processing, cost being a major constraint. Improving nutritional status of buffalo is still a grey area of research to improve the productivity from buffaloes.

The buffalo species is originated in India and are descendants of arni breed in wild found in north-eastern parts of India. Buffalo in Asia are also known as Water buffalo are classified under the genus *Bubalus*, species *bubalis*. Asian buffalo are classified in two subspecies i.e. River and Swamp. Buffaloes are commonly known as Asian animal and India is considered as the home tract for best buffalo breeds of the world. India stands first country in Asia for scientific and technological development in buffalo nutrition, production, reproduction, biotechnologies and genetic improvement (Borghese, and Mazzi, 2005) [10]. Moreover India has implemented the "*Red Revolution*" to increase meat production and strengthen the meat industry, particularly with regard to buffalo. In India, out of 10 recognized buffalo breeds, best River milk breeds are Murrah, Nili-Ravi, Surti and Jaffarabadi, which are originated from the north-western states (Table 1 & 2). These breeds have high potential for milk and fat production (Sethi, 2003) [46]. Apart from this, buffaloes are used for drought power and meat production. In some Asian countries, buffaloes are used in social and cultural events. India is endowed with rich biodiversity of buffalo germplasm in the form of different recognized breeds and several local distinct types.

Table 1: Buffalo breeds of India with production traits (ICAR, 1997) [23]

Name of Breed	Average Lactation length (days)	Average Lactation yield (kg)	Milk composition (Fat%)
Badhawari	272	780	8.60
Jaffarabadi	319	2151	7.86
Mehsana	305	1893	7
Murrah	305	1675	7.3
Nagpuri	286	1055	7.7
Pandharpuri	305	1142	7
Surti	305	1289	7.9
Toda	200	500	-
Nilli Ravi			

Table 2: Group wise buffalo breeds of India (Banerjee, 2009) [5]

Murrah Group	Gujarat Group	Uttar Pradesh Group	Central India Group	South India Group
Murrah	Surti	Bhadawari	Nagpuri	Toda
Nili-Ravi	Jaffarabadi	Tarai	Pandharpuri	South Kanara
Kundi	Mehsana		Manda	
Godavari			Jarangi	
			Kalhandi	
			Sambalpur	

In countries like Australia and Bulgaria, the meat industry is developed on the basis of meat production from buffaloes on large scale. Dressing percentage of buffaloes is 55-65% on moderate diets. Buffaloes are the good source of quality meat. Buffalo meat is leaner and less fat as compared to cattle thus there is market demand for such meat among health conscious consumers.

Buffaloes are well adapted to the hot and hot humid climate. Byproducts from buffalo production include milk, meat, skin (hide), blood, bone etc. Thus buffalo rearing may be helpful to uplift the socio-economic status of marginal or landless farmers. Apart from this, buffaloes are the financial asset and acts as an insurance against the risk of crop failure due to natural calamities (Dhanda, 2004) [15]. Indian swamp buffaloes reared for milk production, males are used for work in fields and for other agricultural operations (Faruque, 2003) [18]. On an average buffaloes are almost 3-4 times more productive than indigenous cattle. The research findings on the comparative functional rumen developments and feremental activities suggest that the buffaloes in general are more efficiently utilizes the poor quality roughages and have better feed conversion ratio (Bartocci *et al*., 1997; Agarwal *et al*., 2009) [7, 3]. Other reason might be that buffaloes are not discriminate during foraging and consume larger amount of coarse forages which are generally rejected by other animals. Thus are better at converting poor-quality roughage into high quality milk and meat. The other significant point which gives buffalo rearing upper hand is that their low cost of milk production per litre and gives better economic returns.

They have almost 5% higher fibre digestibility than cattle and 4-5% higher efficiency of utilization of metabolic energy for milk production (Mudgal, 1988; Terramoccia *et al*., 2000) [48, 33, 52]. In buffaloes dry matter intake per unit body weight is also lesser than cattle.

Protein and energy

Buffaloes, from birth to death, passes through various physiological stages, thus require different nutritional allowances through different stages of life, otherwise they may be prone to various metabolic and transition disorders which limits its productivity (Katole *et al*., 2013b) [25]. Dry matter intake of buffaloes depends on body weight, production level, physiological stage, roughages and concentrates ratio, quality and quantity of the feeds used in ration formulation. Most important physiological stage is lactating period which need utmost nutritional attention. Buffaloes require protein and energy to produce quality milk during lactation period. Energy and protein requirements of ruminants can be met from fermentation of feedstuffs in rumen which produces fermentation end-products such as volatile fatty acids (to fulfill energy requirement) and microbial protein (to fulfill protein demand). This depends on the amount and quality of feedstuffs offered to the animals.

The maintenance requirements of the indigenous buffaloes are somewhat lower than their western counterparts. Growth is important parameter and generally indicated by weight gain per unit time. Thus, growth phase require additional allowances as it is influenced by feeding and environmental conditions. As cost of concentrates is escalating, it is not feasible to feed buffaloes at higher level. The average growth rate in indigenous buffaloes is 400-700g/day and in crossbred buffaloes it may be even higher. Faster growing buffaloes require more energy and protein along with minerals such as calcium and phosphorus. For such animals bypass protein is recommended.

Lactation period is preceded by dry period which is of 280-310 days. During this period, reduction in nutritional allowances results in low lactation yield and poor health (Zicarelli, 2000) [58]. Nutritional requirement of foetus also increases as the dry period advances and buffaloes should be fed maintenance plus gestation rations. Therefore, provision of additional allowance is essential to maintain the reproductive performance of the animal. It is suggested that non-lactating buffaloes should be given 0.63-0.65 Milk Feed Unit (FU)/kg DM and 10-11% of crude protein (Proto, 1993; Bertoni *et al*., 1994) [41, 8]. Bertoni *et al*. (1994) [8] also recommended that crude protein level in dry buffaloes should be more than 10%, otherwise lower quantity of crude protein may compromise the rumen activity and production will be lower. Energy requirements for maintenance are 97.8-188.8 kcal/kgW$^{0.75}$ in dry and lactating buffalo. For 4% fat corrected milk (FCM) energy required is 1171 to 1863 kcal/kgW$^{0.75}$. Protein requirements for maintenance are 1.28 to 3.48 g/kgW$^{0.75}$ in dry and lactating animals. For milk production protein requirements is 126.6 to 166.34 g/100g protein secreted in milk (Banerjee, 2009) [5].

It is reported that good quality *ad libitum* diet should be provided to non-lactating buffaloes that provide energy content not less than 0.65 Milk FU/kg DM and crude protein content not lower than 9% (Di Lella, 2000) [16]. Diet of buffaloes should comprised of fresh green forages or good quality hay and 25-30% of dry matter form concentrates to re-establish reserves of fat soluble vitamins and minerals to normalize the rumen fermentation and hepatic functions (Terramoccia *et al*., 2005) [51]. The diet mentioned above causes low rumen fermentation rate, which condition the production of volatile fatty acids and favors the proliferation of cellulolytic bacteria. The nutritional requirements of the buffalo are increases after parturition, accordingly supplemental feeding should be started before parturition to avoid sudden shift in dietary regimen. Energy and protein level should be increased by about 50% and 25%, respectively (Di Lella, 2000) [16]. Low protein 7-8% in diet could be justified by the nitrogen metabolism in buffaloes that differs from cattle (Abdullah *et al*., 1990; Kennedy *et al*., 1990) [2, 29] but protein should not be less than 10% of diet. More digestibility of protein is reported in buffaloes than cattle due higher carbohydrates in ration (Puppo *et al*., 2002) [42]. Thus carbohydrates should form the major portion of diet. This also might be due to higher protozoal population in buffaloes.

Protein level in diet of buffaloes should be in range of 9-14% on DM basis (Sivaiah and Mudgal, 1978; Verna *et al*., 1992; Verna *et al*., 1994; Rai and Aggarwal, 1991) [48, 54, 55, 44]. Quality protein if used should be bypass or rumen un-degradable, otherwise it will be extensively degraded in rumen causing increased concentration of ammonia and higher levels of blood urea. Reported reduced feed intake and conception rate in cattle due to increased levels of ammonia in rumen and blood urea. Similar results in buffaloes could also be expected if more rumen degradable protein is fed to buffaloes.

Protein concentrations used in lactating buffalo diets can be equal to or below 12% on DM basis, since these concentrations have little influence on the quantity and quality of milk produced (Verna *et al*., 1992; Verna *et al*., 1994). Sivaiah and Mudgal (1978) [48] suggested administration of 166 to 126 g of digestible CP/100 g of milk protein produced, while according to Rai and Aggarwal (1991) [44], the concentration of CP on DM should be between 11-14%.

Table 3: Nutrient requirements during gestation of the dry buffalo herd (multiparous: 600 kg; primiparous: 500 kg) in relation to the gestation months (Technical-Scientific Committee, 2002) [50]

Month of pregnancy		Milk FU/d	CP (g/d)	Ca (g/d)	P (g/d)
8	Multiparous	5-7	700	40	35
	Primiparous	6-7	830	40	35
9	Multiparous	6-7	700	40	35
	Primiparous	6-7.5	830	40	45
10	Multiparous	6-7	800	40	45
	Primiparous	7-8	900	40	45

Minerals particularly Ca and P needs due attentions as these minerals are associated with various metabolic diseases during transition period. Ratio of Ca: P should be 1:1.1 to avoid vaginal or uterine prolapse in buffaloes (Zicarelli *et al*., 1982) [59]. Higher Ca:P alteres Ca:Mg ratio in blood resulting in excitability of the uterine-vaginal muscle fibre causing atonicity of the organ leading to prolapse (Campanile *et al*., 1989) [11]. Excess calcium during dry phase which causes reduce parathyroid activity at calving should be avoided. More phosphorus rich feed ingredients need to be fed to the animals to stimulate parathyroid activity (Campanile *et al*., 1995) [12]. To avoid the alterations in mineral balance and maintain the balance of major minerals it is suggested to offer oat hay, wheat straw and maize silage not more than 5.0-7.0 kg/head/d (Technical-Scientific Committee, 2002) [50]. These roughages being poor in minerals do not cause any variations in diet of buffaloes.

In buffaloes, lactation phase is of 270 days and peak milk yield is observed during 4-6th week of gestation. As compared to cattle, quantity as well as quality of milk shows much variation during lactation period. Energy level in diet positively influences the percent fat in milk of buffaloes which varies from 6-12%. Similarly, protein content in milk which varies form 3.5-5.5% also depends on the protein content of the diet. According to the fat and protein percent, feed ingredients should be added to the diet of lactating buffaloes. Major minerals that should be considered during ration formulation are Ca, P and Mg.

As mentioned above milk yield increases gradually and peak is observed during 4-6th week of gestation, nutrients requirements of buffaloes during this period are also increases accordingly. For every increase in 1 kg of milk, dry matter intake of 500 g and 0.75 milk FU need to be increased. After 150 days of parturition buffaloes raise their feed intake and accumulate excessive body reserves. This is due to shift from the catabolism to the anabolism phase of the lactation curve. One should be careful to avoid excessive fat accumulation. This can be accomplished by using diets having low energy density, starch and more NDF. More fat tissue deposition observed in buffaloes with low yield and more lactation period (above 270 days) due to fertility problems (Terramoccia *et al*., 2005) [51]. Protein degradation in rumen of buffaloes is more than that in cow (Terramoccia *et al*.,

2000) [52] which might be attributed to more retention time in buffaloes (Bartocci *et al*. 1997) [7]. Production of protein in milk yield, growth and body weight gain and endocrine metabolic effect should be considered while formulating protein requirement for buffaloes.

It has been suggested that similar values of dairy cow of 2.5 g CP/g protein in milk are sufficient. Generally in early lactation feed intake is lower. The ration containing less than 13.5% CP is not adequate thus, CP should be increased by 10% (Campanile *et al*., 1995) [12]. Buffalo's milk contains 1.8-2.0 g Ca and 1.1-1.2 g P. Reported that Ca and P requirements for one kg of milk production are 5.2-5.8 and 2.1-2.3 g, respectively.

Energy and protein requirements for one kg of milk production for buffaloes are given in Table 4. Apart from energy and protein requirements, the mineral requirements and demands should also be considered, with special emphasis to the calcium, phosphorus and magnesium in ration of buffaloes. The production requirements are 6.7, 2.2 and 0.9 g for Ca, P, and Mg, respectively per kg of milk produced (Proto, 1993) [41].

Table 4: Energy and protein requirements for the production of one kg of buffalo milk relative to the fat and protein content (Proto, 1993) [41]

Energy requirements (milk FU/kg of milk)												
Milk Fat (%)	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0
NEL	061	0.64	0.64	0.70	0.73	0.76	0.79	0.82	0.85	0.87	0.90	0.93
Protein requirements (g/kg of milk)												
Milk Protein (%)		3.5	3.7	3.9	4.1	4.3	4.5	4.7	4.9	5.1	5.3	5.5
CP requried		99	105	111	116	122	128	134	139	145	151	157

Energy is the most important and neglected nutrient in livestock production system which have significant influence on reproduction. In countries like India where animals are reared on dry roughages provides poor plane of nutrition which results in a low ovulation rate due to inadequate hypothalamic GnRH secretion causing decrease LH pulse. Canfield and Butler (1990) observed a strong correlation between negative energy balance in early lactation and resumption of ovulation. Better nutrient to animals stimulates hypothalamic-pituitary-ovarian axis. Consequently it reduces negative energy balance thus, avoid stimulation of gonadotropin secretion, which could accompany severe nutrient depletion.

Processing of poor quality feed resources

Dry forages are low in nutrients and rich in fibre are the main roughage source used for feeding of buffaloes in India. Considering poor nutritional quality of dry roughages, it is necessary to process these dry roughages before feeding to improve their nutritive value. Such processing of available feed resources is helpful to exploit maximum production from buffaloes. Various methods have been tried in past to improve the nutritive value of the dry roughages (Katole *et al*., 2011; Katole *et al*., 2013a) [26, 25]. Out of various methods urea treatment seems to be promising as is economic and easy to adopt by farmers. Due to urea treatment nitrogen and in turn protein content is increased in processed forage.

Supplementation of chemically treated straw at 30-50% of DM of feed or 0.9 to 1.5% of live body weight may be sufficient as well as cheaper to sustain milk production and maintain optimum health status. Other supplementation such as supply of urea molasses with green fodder i.e. leguminous fodder, tree leaves of cassava, glyricidia, leucaena, water hyacinth and sweet potato etc. (Banerjee, 2009) [5] are low cost and beneficial.

Feed intake, palatability, digestibility, protein and energy of dry treated forages and milk yield are reported to increase by urea treatment (Nisa *et al*., 2004a; Sarwar *et al*., 2004a; Nisa *et al*., 2006) [36, 30]. During shortage or scarcity of forages, these dry forages are the only source available to feed buffaloes in tropical countries. These dry forages need to be properly supplemented or combined with molasses or mineral mixture to enhance the productivity during lean periods. In India, Urea Molasses Mineral Block (UMMB) has been developed and studies were conducted on the buffaloes which showed promising results in terms of increased growth rate and milk yield (Singh and Mehra, 1990; Sahoo *et al*., 2004) [47, 45]. Such type of feeding provides the source of easily fermentable carbohydrates and nitrogen to the microbes.

Buffaloes need to be fed green forages throughout the year to obtain milk in terms of quality as well as quantity. However, in India, as mentioned above there is always a scarcity of green forages. This necessitated the need to conserve the forages as silages or hay when sufficient green forages are available. Outlined the influence of berseem and lucerne silages on feed intake, nutrient digestibility and milk yield in buffaloes with encouraging results. Seasonal forages such as lucerne, berseem, sorghum, barley, oat, maize etc. could be conserved and to be used in lean periods. Lucerne and berseem are the fodders of choice as they are high in protein, minerals and are high yielding nutritious crops. Some studies indicated the positive influence of conserved forages on nutrient intake, digestibility and milk yield in buffaloes. Reported that high buffering and moisture of berseem and lucerne are detrimental to ensiling and causes heavy nutrient losses. Therefore moisture content should be reduced sufficiently to avoid nutrient losses or one can ensile these high moisture and protein forages with dry forages or by supplementing them with a fermentable carbohydrate source.

Nutrition and reproduction

Reproduction includes growth of foetus and birth of young ones. The proper nutrition is pre-requisite to maintain the reproductive health of the buffaloes and maintain the cyclicity of reproduction. Proper balance of protein, energy, mineral such as Ca, P, Mn, Cu, Zn and vitamins in ration of breedable buffaloes. During first half of the pregnancy, additional allowance rarely required. However, during last trimester of pregnancy, additional allowance required as foetus growth is very fast. As a thumb rule, additional allowance of 0.15 kg of DCP and 0.8 kg of TDN is suffice during last trimester of pregnancy, which can be met by providing good quality concentrate mixture.

More average daily gain and reduced age at puberty could be achieved with high level of feeding than low. Feed conversion efficiency at both the levels of feeding is similar in animals. This is also evident from various studies such as in Swamp heifers in Malaysia (Dollah *et al*., 1989) [17], Nili-Ravi in Pakistan (Chaudhary *et al*., 1983; Asghar *et al*., 1983) [14, 4] and Murrah in India (Kaur and Arora, 1989) [28]. However, lower fertility, seasonal estrous behavior and poor estrus, longer calving interval and delayed first calving age are reported in buffaloes (Qureshi *et al*., 2002) [43]. By nutritional intervention it is possible to improve all these reproductive disorder.

It is also reported that feeding calves at higher plane of nutrition i.e. more energy and protein in ration buffalo help to reach age at puberty earlier than those fed on poor plane of nutrition. Supplementation of green forages during reproductive phase of buffaloes is beneficial. Green forages contain carotenes which are precursor of vitamin A which have positive influence on reproductive status of animals. Similarly, supplementation of vitamin A, E and selenium and niacin is reported to be beneficial in dairy buffaloes.

Rumen fermentation

As mentioned above lower supply of proteins causes low reproductive and productive rates in buffaloes. This deteriorates the immunity thus making animals susceptible to various infectious and contagious diseases. In order to improve the productivity, research attention should be diverted to maximize the utilization of these fibrous feed materials by improving rumen fermentation and availability of digestible nutrients at duodenal level.

There is positive correlation between increased rumen fermentation and dry matter digestibility.

Feed utilization in buffaloes *vis-à-vis* cattle

- Require less DM as compared to cattle.
- Utilize DM and Fibre (NDF) better than cattle.
- Have more microbial population which extensively degrade feed materials.
- Have 10-25 times more *oscillospira* (protozoa) responsible for the more synthesis of microbial protein.
- Have higher number of iodophylic organisms and thus have better utilization of NPN for synthesis of microbial protein which is available to the host animal.
- Have higher proportion of butyric and propionic acid than acetic acid as end-product of carbohydrate metabolism.

All above mentioned benefits in buffaloes are due to larger ruminal volume than cattle, slower rate of passage of digesta results in higher recycling of sulphur and nitrogen, better pH stability, higher rate of salivation that maintain buffering capacity of rumen, retention time is more and slower rumen motility thus better mixing of digesta and more time for microbe to degrade feed materials and higher cellulolytic activity as compared to that in cattle rumen (Banerjee, 2009) [5].

Nutritional management of buffalo calves

After calving, buffalo calves should be fed fresh colostrums (first milk) as specialized cells in lower small intestine of calf are replaced by basal nuclei which are incapable of absorbing immunoglobulins by pinocytosis. This process is known as "gut closure" and it begins as rapidly as 12 hr. after birth if no colostrum is fed. Colostrum is low in fat, high in protein, carbohydrates, vitamin A, K, riboflavin, choline, thiamine and pantothenic acid and easy to digest. It also contains ample amount of copper, iron, magnesium and manganese. Colostrum contains proteins and peptides that have potent biological activity. Most importantly, colostrum contains high levels of immunoglobulins, which transfers passive immunity to the neonates and enables them to fight off infections by increasing immunity. At birth the serum gamma-globulin levels in calves is 0.97 mg/ml which increases to 16.55 mg/ml following first colostrums feeding at 12 hr. to 28.18 mg/ml on subsequent feeding. This level is maintained till the reticulo-endothelial system of the calf starts functioning to produce antibodies. Buffalo calf should be fed 2 to 2.5 liters of colostrums daily for the first 3 days of birth. As a thumb rule, colostrums should be fed at the rate of 10% body weight.

A practice of not feeding colostrums to buffalo calves within 12-24 h of birth results in poor nutrition and reduced immunity. This makes buffalo calves susceptible to various diseases and even mortality (Wynn *et al*., 2009) [56] causing heavy losses in the buffalo production and in turn to the economy of the farmer. Proper weaning time is not followed. Male and female buffalo calves are weaned at different periods. Effect of weaning age, energy level, protein level, supplementation of yeast culture on the performance of buffalo calves is reported. To reduce the mortality buffalo calves should be weaned at birth, feeding of colostrum soon after birth should be followed by milk feeding by hand.

After 3-4 days of colostrums feeding calf should be provided whole milk and that should be as far as possible from the calf's mother immediately after it is drawn. Milk feeding should be divided in 4-5 equal intervals of the day and should be continued to a week or more then reduce the frequency accordingly. After this milk feeding (app. 14-21 days) calf starter should be introduced slowly by rubbing small amount on mouth of calf. It is a mixture of ground grains, protein feeds and minerals, vitamins and antibiotics.

Calf mortality is a major husbandry problem and needs proper management particularly nutritional management after birth. Calves are born with almost sterile gastro-intestinal tract which is susceptible to infection by proliferation of *E. coli* results in scours. She buffaloes are not able to transfer the antibiotics to their foetus thus, newly born calves are more prone to infectious diseases during initial life. Other factors which are responsible are seasonal variations. Most of the deaths are seen during autumn and winter season. Probable reasons cited are pneumonia, enteritis, toxaemia, septicaemia, worm infestation, bloat, infectious diseases.

To control calf mortality it is recommended that calves should be fed colostrums as mentioned above. Some other management strategies include clean and hygienic housing, feeding of antibiotics, feeding of milk replacer, and optimum nutritional care etc.

Bypass nutrient technology

Buffaloes are major milk producing species. However, in India as stated earlier buffaloes are not as productive as their western counterparts. During lactation period requirements for energy and protein for maintenance as well as for milk production exceed the amount of nutrient obtained from diets. Lower density of energy and protein in feed resources for animals such as crop residues and alternate oil cakes are not able to provide optimum nutrition to productive animals resulting in considerable economic losses to the farmer community. Bypass nutrient technology is a tool to provide sufficient energy and protein to the buffalo at intestinal level (post ruminal) by avoiding extensive degradation in rumen. Bypass nutrient technology involves feed management through passive rumen manipulation. Bypass nutrients are not degraded in rumen but get digested and absorbed due to low pH in the lower tract (Yadav and Chaudhary, 2010) [57]. Fat has 2.25 times more energy than carbohydrates and will be available to the animals if it bypasses the rumen otherwise most part of fat will be degraded in rumen. Energy being limiting factor for production, bypass fat thus provides optimum energy availability which can be utilized for milk production in buffaloes. Calcium salt of long chain fatty acids (Ca-LCFA) can be used in ruminants ration as bypass fat to increase the energy density of the ration without adversely affecting the DM intake and digestibility (Naik *et al*., 2009) [34]. Various oils such as Palm oil, soybean oil etc. is hydrolyzed and reacted with Ca to form its salts that decreases their solubility in rumen (Sukhija and Palmquist, 1990) [49]. It is reported that feeding bypass fat is an alternative to increase energy density intake and digestibility of the diet in cattle (Palmquist and Jenkins, 1982; Hammon *et al*., 2008) [38, 22] resulting in higher milk yield. High acidity in the duodenum accompanied by detergent action of bile acids, lysolecithin and fatty acids causes saturated fatty acids to be more digestible in ruminants than in non-ruminants (Palmquist and Jenkins, 1980) [39]. Feeding of protected fat supplements increased fat, protein content and yield of milk in buffaloes (Gulati *et al*., 2003) [21]. It is reported that supplementation of bypass fat to buffaloes during early lactation increased milk yield and milk fat by correcting negative energy balance and increased serum triglyceride level (Barley and Baghel, 2009; Garg *et al*., 2012) [6, 19]. Supplementation of bypass fat in diet increases the proportion of unsaturated and long chain fatty acids of milk fat (Garg *et al*., 2008; Mahecha *et al*., 2008) [20, 32].

Buffaloes growing or lactating demands more protein (amino acids) for tissue synthesis and milk production. Ørskov (1982) [37] and Preston (1986) [40] suggested that bypass protein sustains this higher requirement for productive animals. Similarly, bypass protein serves as the quality source of protein and amino acids in small intestine. Positive effect of bypass protein on nutrients intake and reproduction, milk yield and its composition in buffaloes is reported (Bharadwaj *et al*., 2000; Chatterjee and Walli, 2003) [9, 13]. Recently, improvement in average daily weight gain, body length, height and heart girth and decreased the cost of feeding per kg live weight gain is in the buffalo heifers reported (Vahora *et al*., 2012) [53] by feeding combination of bypass protein and fat. Increased digestibility in buffaloes fed rumen bypass protein is attributed to the more availability of nitrogen in diverse form which facilitated the synchronization of carbon and nitrogen units in rumen fluid which positively influence the microbial proliferation that results in more enzyme production (Javaid *et al*., 2008; Nisa *et al*., 2008) [35, 24] leading to increase rumen fermentation activities producing more volatile fatty acid for productive purpose such as milk yield. Bypass protein increases the ammonia concentration in rumen which increases the rumen pH, as ammonia is alkaline in nature (Nisa *et al*., 2008) [24]. This pH changed causes the fermentation pattern shift in favour of acetate and butyrate which increased the *de novo* synthesis of fatty acids which accounts about 60-70% of bovine milk fat resulting in increased milk fat content.

Conclusion

In order to extract maximum production potential from buffaloes it is important to know the underlying cause to improve production, which lies in nutritional management. Thus, it is important to fed proper feeding during varying physiological stages of life of buffaloes. Lactation period and initial life of calves are critical periods in life of buffaloes and needs proper nutritional care.

Conflict of Interest

Not available

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Not available

Reference

1. Department of Animal Husbandry, Dairying & Fisheries. 19th Livestock Census (2012). New Delhi: Ministry of Agriculture, Government of India; 2012.
2. Abdullah N, Ho YW, Mahyuddin M, Jalaludin S. Comparative studies of fibre digestion between cattle and buffaloes. In: *Domestic Buffalo Production in Asia*. Vienna: International Atomic Energy Agency; 1990, p. 75-87.
3. Agarwal N, Kamra DN, Chatterjee PN, Kumar R, Chaudhary LC. *In vitro* methanogenesis, microbial profile and fermentation of green forages with buffalo rumen liquor as influenced by 2-bromoethanesulphonic acid. Asian-Australas J Anim Sci. 2008;21:818-823.
4. Asghar AA, Saghar MS, Rehman KU. Effect of intensive feeding of buffalo on age at maturity, conception rate and age of first calving. Fourth Annual Report, Directorate of LPRI. Bahadarnagar (Pakistan): Okara; 1983, p. 91-93.
5. Banerjee GC. *A Textbook of Animal Husbandry*. 9th Ed. New Delhi: Oxford & IBH Publishing Co. Pvt. Ltd.; 2009.
6. Barley GG, Baghel RPS. Effect of bypass fat supplementation on milk yield, fat content and serum triglyceride levels of Murrah buffaloes. Buffalo Bull. 2009;28(4):173-175.
7. Bartocci S, Amici A, Verna M, Terramoccia S, Martillotti F. Solid and fluid passage rate in buffalo, cattle and sheep fed diets with different forage to concentrate ratios. Livest Prod Sci. 1997;52:201-208.
8. Bertoni G, Di Lella T, Bartocci S. Nuove acquisizioni nel campo dell'alimentazione dei bufali. Agric Ricerca. 1994;153:159-172.
9. Bharadwaj A, Sengupta BP, Sethi RK. Effect of feeding protected and unprotected protein on nutrient intake and reproductive performance of lactating buffaloes. Indian J Anim Sci. 2000;70(4):428-430.
10. Borghese A, Mazzi M. Buffalo population and strategies in the world. In: Borghese A, editor. *Buffalo Production and Research*. FAO REU Technical Series No 67. Rome: Food and Agriculture Organization of the United Nations; 2005.
11. Campanile G, Palo DR, Meo DC, Boni R. Effetti dell'integrazione di P durante l'asciutta sui livelli ematici di Ca, P e Mg nella bufala. Atti SISVet. 1989;43:261-265.
12. Campanile G, Palo DR, Esposito L, Boni R, Meo DC. Variazioni di alcuni costanti ematiche in bufale in lattazione. Atti XI Congr ASPA. 1995;77-78.
13. Chatterjee A, Walli TK. Effect of feeding formaldehyde-treated mustard cake as bypass protein on milk yield and milk composition of Murrah buffaloes. Indian J Dairy Sci. 2003;56:299-306.
14. Chaudhary MA, Haider SI, Ahmed HI, Rasool G. Effect of concentrate feeding on growth and reproductive traits in cattle and buffalo heifers. Fourth Annual Report, Directorate of LPRI. Bahadarnagar (Pakistan): Okara; 1983, p. 88-90.

15. Dhanda OP. Developments in water buffalo in Asia and Oceania. Proc Seventh World Buffalo Congress. Manila (Philippines); 2004. p. 17-28.
16. Lella DT. Alimentazione della bufala in asciutta. Bubalus Bubalis. 2000;2:32-36.
17. Dollah MA, Ramakrishnan N, Nordin Y, Seni RA. Reproductive responses to climatic heat induced by management systems in swamp buffaloes. IDEA RC. 1989;3/13:155-166.
18. Faruque MO. Buffalo production system in Bangladesh. Proc Fourth Asian Buffalo Congress. New Delhi (India); 2003, p. 31-35.
19. Garg MR, Sherasia PL, Bhanderi BM. Effect of supplementing bypass fat with and without rumen-protected choline chloride on milk yield and serum lipid profile in Jaffarabadi buffaloes. Buffalo Bull. 2012;31(2):91-98.
20. Garg MR, Sherasia PL, Bhanderi BM, Gulati SK, Scott TW. Effect of feeding bypass fat supplement on milk production and characteristics of butter fat. Indian J Dairy Sci. 2008;61(1):13-23.
21. Gulati SK, Garg MR, Sherasia PL, Scott TW. Enhancing milk quality and yield in the dairy cow and buffalo by feeding protected nutrient supplements. Asia Pac J Clin Nutr. 2003;12(Suppl):S61.
22. Hammon HM, Metges CC, Junghans P, Becker F, Bellmann O, Schneider F, *et al*. Metabolic changes and net portal flux in dairy cows fed a ration containing rumen-protected fat compared with a control diet. J Dairy Sci. 2008;91:208-217.
23. Indian Council of Agricultural Research (ICAR). *Nutrient Requirements of Livestock and Poultry*. New Delhi: ICAR; 1997.
24. Javaid A, Nisa M, Sarwar M, Shahzad MA. Ruminal characteristics, blood pH, blood urea nitrogen and nitrogen balance in buffalo (*Bubalus bubalis*) bulls fed diets containing various levels of ruminally degradable protein. Asian-Australas J Anim Sci. 2008;21:51-58.
25. Katole S, Saha SK, Sastry VRB, Lade MH, Prakash B. Intake, blood metabolites and hormonal profile in goats fed processed *Jatropha curcas* meal. Trop Anim Health Prod; 2013.
26. Katole S, Saha SK, Sastry VRB, Lade MH, Prakash B. Intake, blood metabolites and hormonal profile in sheep fed processed *Jatropha curcas* meal. Anim Feed Sci Technol. 2011;170:21-26.
27. Katole SB, Sethy K, Pawar MM, Kumar S, Shankhpal SS, Saha SK. Nutritional management of transition cow. In: Saha SK, editor. *Animal Science Reviews*. Delhi: Satish Serial Publishing House; 2013.
28. Kaur H, Arora SP. Growth and puberty as influenced by the plan of nutrition in Murrah buffaloes. Buffalo J. 1989;1:57-64.
29. Kennedy PM. Digestion and passage of tropical forages in swamp buffalo and cattle. In: *Domestic Buffalo Production in Asia*. Rockhampton (Australia); 1990, p. 21-40.
30. Khan MA, Sarwar M, Nisa M, Khan MS, Bhatti SA, Iqbal Z, *et al*. Feeding value of urea-treated wheat straw ensiled with or without acidified molasses in Nili-Ravi buffaloes. Asian-Australas J Anim Sci. 2006;19:645-650.
31. Kondaiah N. Buffalo meat production and export. In: Chatli MK, Kumar H, Singh I, editors. *Buffalo (Bubalus bubalis) Meat*. Singapore: Springer; 2025.
32. Mahecha L, Angulo J, Salazar B, Ceron M, Gallo J, Molina CH, *et al*. Supplementation with bypass fat in silvopastoral systems diminishes the ratio of milk saturated to unsaturated fatty acids. Trop Anim Health Prod. 2008;40:209-216.
33. Mudgal VD. Proc Second World Buffalo Congress. New Delhi (India); 1988, p. 454.
34. Naik PK, Saijpaul S, Rani N. Effect of ruminally protected fat on *in vitro* fermentation and apparent nutrient digestibility in buffaloes. Anim Feed Sci Technol. 2009;153(1):68-76.
35. Nisa M, Javaid A, Shahzad MA, Sarwar M. Influence of varying ruminally degradable to undegradable protein ratio on nutrient intake, milk yield, nitrogen balance, conception rate and days open in early lactating Nili-Ravi buffaloes (*Bubalus bubalis*). Asian-Australas J Anim Sci. 2008;21:1303-1308.
36. Nisa M, Sarwar M, Khan MA. Influence of ad libitum feeding of urea-treated wheat straw with or without corn steep liquor on intake, in situ digestion kinetics, nitrogen metabolism and nutrient digestion in Nili-Ravi buffalo bulls. Aust J Agric Res. 2004;55:229-236.
37. Ørskov ER. *Protein Nutrition in Ruminants*. London, New York: Academic Press; 1982.
38. Palmquist DL, Jenkins TC. Calcium soaps as a fat supplement in dairy cattle feeding. In: *Proceedings of the XIIth World Congress on Diseases of Cattle*. Amsterdam: Dutch Section of the World Association for Buiatrics; Utrecht (The Netherlands); 1982, p. 477-481.
39. Palmquist DL, Jenkins TC. Fat in lactation rations: review. J Dairy Sci. 1980;63:1-14.
40. Preston TR. *Better utilization of crop residues and by-products in animal feeding: Research guidelines 2. A practical manual for research workers*. FAO Animal Production and Health Paper No 50/2. Rome: FAO; 1986.
41. Proto V. L'alimentazione della bufala. In: *Giornata di studio "Alimentazione zootecnica e qualità del latte bovino e bufalino"*. Eboli (SA); 1993 Oct 29, p. 1-42.
42. Puppo S, Bartocci S, Terramoccia S, Grandoni F, Amici A. Rumen microbial counts and *in vivo* digestibility in buffaloes and cattle given different diets. Anim Sci. 2002;72:323-329.
43. Qureshi MS, Habib G, Abdus Samad H, Siddiqui MM, Ahmad N, Syed M. Reproduction-nutrition relationship in dairy buffaloes: effect of intake of protein, energy and blood metabolite levels. Asian-Australas J Anim Sci. 2002;15:330-339.
44. Rai SN, Aggarwal SK. Effect of substitution of green fodder with ammoniated straw on nutrient utilization and milk production in Murrah buffaloes. Buffalo J. 1991;1:51-61.
45. Sahoo A, Elangovan AV, Mehra UR, Singh UB. Catalytic supplementation of urea-molasses on nutritional performance of male buffalo (*Bubalus bubalis*) calves. Asian-Australas J Anim Sci. 2004;17:621-628.
46. Sethi RK. Improving riverine and swamp buffaloes through breeding. In: *Proceedings of the Fourth Asian Buffalo Congress*. New Delhi, India; 2003 Feb 25-28, p. 51-60.
47. Singh UB, Mehra UR, Usha R. Utilization of ammoniated wheat straw given in feed blocks and supplemented with varying quantities of fish meal and oil-extracted rice bran. Anim Feed Sci Technol. 1990;29:129-134.

48. Sivaiah K, Mudgal VD. Effect of feeding different levels of protein and energy on feed utilization for growth and milk production in buffaloes (*Bos bubalis*). Annual Report, National Dairy Research Institute. Karnal (India); 1978, p. 145-146.
49. Sukhija PS, Palmquist DL. Dissociation of calcium soaps of long-chain fatty acids in rumen fluid. J Dairy Sci. 1990;73:1784-1787.
50. Technical-Scientific Committee of the Consortium for the Protection of Campania Buffalo Mozzarella Cheese. *Regolamento per la gestione igienica ed alimentare dell'allevamento bufalino in relazione alla produzione della Mozzarella di bufala campana DOP*. S. Nicola la Strada (CE), Italy: Consorzio Tutela Mozzarella di Bufala Campana; 2002.
51. Terramoccia S, Bartocci S, Borghese A. Nutritional requirements in buffalo cows and heifers. In: Borghese A, editor. *Buffalo Production and Research*. FAO REU Technical Series No 67. Rome: Food and Agriculture Organization of the United Nations; 2005.
52. Terramoccia S, Bartocci S, Amici A, Martillotti F. Protein and protein-free dry matter rumen degradability in buffalo, cattle and sheep fed diets with different forage to concentrate ratios. Livest Prod Sci. 2000;65:185-195.
53. Vahora SG, Parnerkar S, Kore KB. Effect of feeding bypass nutrients to growing buffalo heifers under field conditions. Livest Res Rural Dev. 2012;24:Article 24.
54. Verna M, Bartocci S, Amici A, Agostini M. Effect of diets with different energetic concentration on qualitative and quantitative yield in lactating buffaloes. In: *Proceedings of the International Symposium "Prospect of Buffalo Production in the Mediterranean and the Middle East"*. Cairo; 1992 Nov 9-12, p. 258-261.
55. Verna M, Bartocci S, Amici A, Agostini M. Effetto di diete diverse sulle prestazioni produttive di bufale in lattazione. Agric Ricerca. 1994;153:73-78.
56. Wynn PC, Warriach HM, Morgan A, McGill DM, Hanif S, Sarwar M, *et al*. Perinatal nutrition of the calf and its consequences for lifelong productivity. Asian-Australas J Anim Sci. 2009;22:756-764.
57. Yadav CM, Chaudhary JL. Effect of feeding protected protein on growth performance and physiological reaction in crossbred heifers. Indian J Anim Nutr. 2010;27(4):397-403.
58. Zicarelli L. Considerazioni sulla profilassi del prolasso vaginale e uterino nella bufala mediterranea italiana. Bubalus Bubalis. 2000;3:71-90.
59. Zicarelli L, Intrieri F, De Franciscis G, Squillacciotti A. Il profilo metabolico nella bufala gravida in relazione al regime alimentare adottato: indagine in allevamenti con diversa incidenza di prolasso vaginale. In: *Atti del II Convegno Internazionale sull'allevamento bufalino nel mondo*. Caserta; 1982 Sep 29-Oct 2, p. 262-288.

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