Nutrient requirements of buffaloes

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ABSTRACT - Present state of knowledge on nutrient requirements of buffaloes has been reviewed and best estimates suitable for use as safe guideline for feeding of buffaloes have been identified. Substantial data is available on dry matter intake, energy and protein requirement in river buffaloes but data are limited on swamp or Mediterranean buffaloes. There is huge variation in individual estimates of energy or protein requirements, which is primarily attributable to difference in the method used for assay of requirements. In most of earlier reports, requirements were assessed by short term nutrient deprivation trial or balance trials. Safety of such estimates for use in producing buffaloes is questionable. Recently most of the estimations were made in long term feeding trial and also by meta-analysis of large number of long term feeding trial data and hence these estimates have better safety margins. There is paucity of information on nutrient requirement of working, pregnant buffaloes and breeding bulls and also on mineral and vitamin requirements of all category of buffaloes. These areas need to be addressed in future research programmes on buffalo nutrition.

Key words: buffaloes, energy, nutrient requirement, protein

Exigências nutricionais de búfalos

RESUMO - O estado atual do conhecimento sobre exigências nutricionais de búfalos foi revisado, identificando-se os índices mais adequados para serem utilizados como parâmetro seguro para a alimentação de búfalas. Muitos dados estão disponíveis em relação ao consumo de matéria seca, energia e necessidades proteicas de búfalos de rio, mas os dados são limitados em búfalos de pântano e da raça Mediterrânea. Existe enorme variação nas estimativas individuais em relação às necessidades de energia ou proteína, que é atribuída principalmente à diferença de método utilizado para a análise destas necessidades. Na maioria dos trabalhos, os requisitos foram avaliados por teste de privação de nutriente a curto prazo ou teste de equilíbrio. A segurança de tais estimativas para uso na produção de búfalos é questionável. Recentemente, a maioria das estimativas foi feita pelo teste de alimentação a longo prazo e também por meta-análise de grande número de dados experimentais de alimentação de longo prazo e, portanto, essas estimativas têm melhores margens de segurança. Há escassez de informações sobre as exigências nutricionais em animais de trabalho, búfalas grávidas e touros reprodutores e também sobre as necessidades de minerais e vitaminas para todas as categorias de búfalos. Essas áreas devem ser abordadas em futuros programas de investigação sobre a nutrição de búfalos.

Palavras-chave: búfalos, energia, exigência nutricional, proteína

Introduction

Buffalo is increasingly becoming popular in several parts of the world because of its superior quality of milk, better ability to adapt to different climates especially hot and humid climate and to poor quality crop residue based fibrous diets and their high fertility rates (Paul & Lal, 2010). Most buffaloes are located in countries where cultivated forage crops and pastures are limited. The total buffalo population increased from about 135 million heads in 1991 to around 165 million heads in 2007, i.e., at annual growth rate of 3.3% buffalo population. However, the highest growth rate in buffalo population has been recorded in the American continent where its number is growing at a rhythm of 12.7% per year. Although mainly three types of domesticated buffaloes (river, swamp and Mediterranean) are reared across the world, the river buffalo constitute the major population of buffalo. Today the riverine buffaloes, apart from India and Pakistan are found in number of countries in Asia, Europe and America. Many countries have introduced crossbreeding program to improve genetic potential of local buffaloes. Males of superior river buffaloes from India and Pakistan are being utilized in such program.

To exploit maximum production or reproduction performance from a particular species of animal, accurate estimation of its nutrient requirements is a must. The most of the research data available on nutrient requirements of buffaloes are on river type buffaloes and data on swamp,
Mediterranean and crossbred of river and swamp buffalo are limited. The following section presents an overview of present state of knowledge on nutrient requirements of buffaloes.

Differences in digestion and utilization of nutrients in cattle and buffaloes

There are considerable physiological differences between cattle and buffaloes. Although considerable number of conflicting reports are available regarding superiority of one species over the other, results of meta-analysis of large number of experimental data indicated that the voluntary intake is significantly less (2.56 vs. 3.09% of BW) in lactating buffaloes than in cattle of similar production level, and that gross energetic efficiency (25.19 vs. 23.17%), net energetic efficiency (60.70 vs. 52.79%), gross protein efficiency (45.72 vs. 38.45%) and net protein efficiency (72.56 vs. 59.86%) are significantly higher in buffaloes than in cattle (Paul et al., 2003).

On the basis of overall average of 33 experimental groups of cattle and similar numbers of buffaloes fed on roughage based diet in India, dry matter (DM) digestibility was 4.5% (2.4 percentage point) higher in buffaloes whereas on the basis of average of 27 experimental groups, digestibility of crude fibre (CF) was 4.6% (2.7 percentage point) higher in buffaloes (Paul & Lal, 2010). Similar findings from Japan and Brazil have also been reported.

Most of the studies indicated that nitrogen retention is higher in buffaloes than in cattle on identical level of N and energy intake (Sebastian et al., 1970; Ranjhan & Krishnamohan, 1977; Kennedy et al., 1992; Hayashi et al., 2005). Kennedy et al. (1992) also found that the efficiency of net microbial growth in rumen was 20% higher in buffaloes than cattle (35 vs. 30 g N) per kg apparent digestion of organic matter in the fore stomach.

In a review conducted by us it was concluded that adult buffaloes have slightly slower rate of passage of digesta than adult cattle (Paul et al., 2004; Paul & Lal, 2010). Calorimetric studies have shown that fasting metabolism rate is lower (284.5 kJ vs. 334.7-343.0, kJ per kg MBS) in buffaloes than in cattle (Maymone & Bergonzini, 1960).

Methods used for estimation of energy and protein requirements in buffaloes

There is large variation in reported values for energy and protein requirements for buffaloes. In most instances differences between individual estimates are largely attributable to difference in experimental method employed for estimating requirement. This has been extensively reviewed by us (Paul & Mandal, 2002; Paul & Lal, 2010). Generally, the data on energy and protein requirements of buffaloes had mainly been estimated in three ways-a) short nutrient deprivation trial followed by estimation of fasting heat production or nitrogen excretion, b) short term energy or nitrogen balance trial where buffaloes were allowed to make small gains or losses in energy or nitrogen balance and then calculating the energy or protein needed to promote zero balance and c) long term feeding trial, where varying but known quantity of feed energy or protein were given to producing buffaloes and input output relation were estimated using multiple regression analysis model. The estimates emanated from the first two methods can be potentially unsafe for applying to producing buffaloes as they were not estimated in practical farm feeding condition in producing buffaloes. The estimates obtained by the third method can be considered as the practical estimates for nutrient requirements.

Recently nutrient requirements were estimated by meta-analysis of pooled data of multiple experimental long term feeding trial. Estimates based on such approach can be considered as best and such estimates formed the basis for the latest feeding standards prescribed for buffaloes in India (Paul & Lal, 2010).

Energy requirements of buffaloes

The units used in the feeding standards should ideally be in the same as those used in the evaluation of feeds, hence, the existing feeding standards have adopted the total digestible nutrient (TDN) and metabolizable energy (ME) values for expressing nutrient requirement of buffaloes. TDN or ME system works well as is evident from the fact that animal’s performance is closely related to TDN intake, when the intakes of other nutrients are adequate. Sufficient data on NE content of feed is not available and hence use of NE for feeding buffaloes cannot be adopted at present.

Energy requirements for maintenance

Calorimetric studies have shown that fasting heat production is lower (284.5 kJ vs. 343, kJ per kg metabolic body size (MBS or W^{0.75}); Maymone and Bergenzini, 1987). Khan et al. (1988) estimated fasting heat production in adult non-pregnant buffaloes as 284.5 kJ /kg W^{0.75}.

Estimates of energy requirements for maintenance (g TDN/kg MBS) of different category of buffaloes were recently reviewed by us (Paul & Lal, 2010) are as follows: Adult, 27 to 29.78; growing, 27.5 to 52 g and lactating, 35.3-49.2.
Huge variation in these individual estimates is attributable mainly to difference in method of estimation. However, now estimates of maintenance requirements of energy by meta-analysis of pooled data of long term feeding trials are available which are as follows: Growing: 35-39.9 g TDN/kg MBS (Udeybir & Mandal, 2001); Lactating: 35.3 g TDN/kg MBS (Paul et al., 2002). These values can be adopted safely as guideline for feeding buffaloes.

Milk production

The nutrient needs of lactating buffaloes depend upon the amount of milk being produced and upon its composition. The milk yield depends primarily on the type of breed. Buffalo milk contains more solids and fat than cow’s milk. Generally the fat content ranges from 5.5-13.5%.

Estimates of energy requirement for milk production in buffaloes as reviewed by us recently (Paul & Lal, 2010) ranges from 220 to 557 g TDN/kg 6% fat corrected milk (FCM).

In an earlier study, conducted at CIRB (Nabha), India, which was based on regression analysis of the data of long term feeding trials conducted so far in India (35) where energy was the sole limiting nutrient, energy requirement for milk production was worked out 406.32 g TDN per kg 6% FCM (Paul et al., 2002). This value can be adopted as safe guide for feeding buffaloes.

Growth

Buffaloes tend to deposit less fat in tissues compared to cattle of similar age. Fat content of buffalo carcass normally ranges from 2-5% at 100 kg, 5-8% at 200 kg, 10-16% at 300 kg body weight (Agarwal, 1974: Prakash, 1990; Pathak, 1996) depending on the plane of nutrition. The estimates of energy requirement of gain quoted in literature vary from 0.78 to 2.23 g TDN/g gain (Paul & Lal, 2010). The values of energy requirement for growth (g TDN/g gain) emanated from meta-analysis of pooled data of long term feeding trial, which can be used as safe guide for feeding buffaloes are as follows: growing buffaloes: 1.44-2.10 g TDN/g gain (Udeybir & Mandal, 2001); lactating buffalo: 1.97 g TDN/g gain (Paul et al., 2002).

Recent study indicated that energy requirement for growth in buffalo heifers are comparable to those of male upto 250 kg BW but rapidly increases thereafter and the value is as high as 3.49 g TDN/g gain at 375 kg BW (Paul & Patil, 2007).

Energy requirement for pregnancy, breeding bull and work

There is paucity of information regarding energy requirement of pregnant buffaloes, breeding bull or working buffaloes. The existing feeding standards have suggested use of feeding standards for cattle derived by NRC (2001) or AFRC (1991) for buffaloes considering that sufficient data is not available.

Protein requirements of buffaloes

The method most widely used in India for expressing the protein requirement for ruminants and the extent to which a feed could meet these requirements is mainly based on the measurements of crude protein (CP) or digestible crude protein (DCP). Basic experimental data on various factors required for rumen degradable protein (RDP) and rumen undegradable protein (RUP) based feeding standards are not available. However, recently we have developed feeding standards of growing buffalo heifers based on RDP and RUP system (Paul & Patil, 2007).

Protein requirements for maintenance, milk production and tissue gain

There is a large variation in the reported values for protein requirement in buffaloes which have been reviewed earlier (Paul et al., 2002; Paul & Lal, 2010). The range of estimates of DCP requirements for maintenance (g/kg MBS), growth (g/g gain) and milk production (g/kg 6% FCM) are 1.11-5.05, 0.20-0.45 and 53-68.6, respectively.

Recent estimates of protein requirements derived by meta-analysis of pooled data of long term feeding trials, which can be adopted as safe guide for feeding buffaloes, are as follows:

Maintenance (per kg MBS): Growing: 3.60 to 5.05 g DCP or 6 to 7.6 g CP (Udeybir & Mandal, 2001); lactating: 3.14 g DCP or 5.43 g CP (Paul et al., 2002).

Growth/weight change (per g gain): growing: 0.27-0.32 g DCP or 0.44-0.51 g CP; lactating: 0.23 g DCP or 0.33 g CP.

Milk production (per kg 6%FCM): 55.2 g DCP or 90 g CP.

The range of CP and MP requirements for buffalo heifers estimated at different body weight was as follows: maintenance (per kg MBS): 6.19 to 9.48 g CP or 3.57 to 6.3 g MP; growth (per g gain): 0.24 to 0.45g CP or 0.18 to 0.31 g MP (Paul & Patil, 2007).
The protein requirement values for Thai swamp buffaloes ranged 3.12 to 5.41 g CP/kg MBS for maintenance and 0.46 to 0.60 g CP/g gain (Tatsapong, 2009), which is comparable to reported values for river buffaloes.

Protein requirement for pregnancy, breeding bull and work

There is complete lack of information regarding nutrient requirement of pregnant buffaloes, breeding bull or working buffaloes. The existing feeding standards in India have suggested use of feeding standards for pregnant cattle derived by NRC (2001) or AFRC (1991) for buffaloes considering that no data is available.

Voluntary dry matter intake in buffaloes

Although dry matter (DM) does not come under the category of nutrient, it is considered as vehicle for other dietary nutrients. The dry matter intake capacity of different category of buffaloes has already been reviewed earlier (Paul & Lal, 2010). The range of values of DMI of growing buffaloes is 2.2 to 3.15% of BW. Similarly, the range of values for lactating buffaloes reported by different researchers is 2.5-3.25% of BW. Fairly accurate prediction equation for DMI has also been developed for lactating buffaloes (Mandal et al., 2001).

Water intake in buffaloes

Water intake in buffaloes is closely related to dry matter intake and the range of value for water intake is 5.2-5.5 litre per kg dry matter intake (Sebastian et al., 1970; Sengar & Dahiya, 1990; Singh et al., 1996; Paul & Mahapatra, 2001).

Requirements of minerals and vitamins

Sebastian et al. (1970) reported that lactating buffaloes have higher calcium and phosphorus balances than lactating cattle fed same diet. Singh (1933) and Rao (1948) observed that buffaloes are able to meet their requirements for calcium from coarse roughage; whereas, the cattle showed negative balances. Mudgal et al. (2007) reported that requirements of Se and Cu might be higher for buffaloes than the recommended levels of NRC (2001) for cattle. Quantifying of mineral requirements on the basis of scientific evidence is a necessity. However, experimental data being insufficient to develop feeding standards for mineral for buffaloes, requirements and tolerance levels prescribed by NRC (1989) and other standards for dairy cattle has been adopted by existing feeding standards for buffaloes.

Similarly, experimental data being insufficient to develop feeding standards for vitamins for buffaloes, requirements and tolerance levels prescribed by NRC (2001) and other standards for dairy cattle has been adopted by feeding standards for buffaloes.

Conclusions

The compilation of data generated on nutrient requirements of buffaloes indicates that substantial information is available on DM intake, energy and protein requirements of buffaloes. In this report, best estimates suitable for use as safe guideline for feeding buffaloes under tropical condition have been identified. However, no or little information is available on nutrient requirements of working, pregnant buffaloes or breeding bulls. Similarly, there is paucity of information of vitamin and mineral requirements of buffaloes. Data on swamp and Mediterranean buffaloes or their crossbred with river buffaloes are limited. So, in future, these areas need special attention.

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