DERLEME

REVIEW

Energy and Nutrient Requirements of Buffaloes

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Manda
Enerji Gereksinim
Besin Madde Gereksinim
Süt Kalitesi
Et Üretimi

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S U M M A R Y

Buffaloes are ruminants that resistance to diseases and environmental challenges, capable of effectively converting the poor quality fibrous feeds to milk and meat due to the features of digestive system. However, application of inadequate and unbalanced feeding policy may be associated with diseases and drop in productivity leading to significant economic losses. In this context, energy and nutrient requirements such as protein, minerals, vitamins, and water of buffaloes should be provided in full. This review discusses energy and nutrients demand of the buffaloes that hold a significant place in terms of mainly milk quality and meat production within country's animal population.

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Mandaların Enerji ve Besin Madde Gereksinimi

Ö Z E T

Manda çevre şartlarına dayanıklı, hastalıklara dirençli, sindirim sisteminin özelliği itibariyle düşük kaliteli kaba yemleri etkili şekilde süte, ete dönüştürme yeteneğine sahip ruminanttır. Ancak, bu hayvanlara uygulanacak yanlış ve bilinçsiz besleme programı hastalıklara, verim kaybına, dolayısıyla önemli ekonomik kayıplara neden olmaktadır. Bu bağlamda mandaların enerji ve protein, mineral, vitamin, su gibi besin madde gereksinimlerinin tam olarak karşılanması gerekmektedir. Bu derlemede ülkemiz hayvan populasyonu içinde başta süt kalitesi olmak üzere et üretimi yönünden de önemli bir yer tutan mandaların yaşama ve verim payı için gereksinim duyduğu enerji ve besin maddeleri hakkında bilgi verilmektedir.

GİRİŞ

Buffalo is a farm animal that has an economical strength because of not only quality of milk (mozzarella cheese) and meat production they provide but also pulling the carts elsewhere.[1-4] The buffalo is beign suggested as the future species to meet continuously increasing demands for quality milk and meat.[5] They are raised in both tropical and subtrpical zones such as Asian continent, the South and North America, and in all European countries except the Netherlands and Australia.[1] The number of buffaloes appears to be in increase in Italy thanks to the studies to enhace the composition and quality of milk (mozzarella cheese production), but in other countries and Turkey a great decrease is the case.[2] One of the major cause for this drop is that the buffalo population consists of mainly low yielding indigenous breeds, slaughtering of aged buffaloes, non-scientific methods of maintenance and feeding without consideration of buffaloe's actual nutrient requirements.[6,7]

Anatolian buffaloes raised in Turkey for centuries is one of the riverine buffaloes clustered within the Mediterranean breeds.[2,8] Usually damp, swamp and humid areas bear approriate environmental conditions for buffaloes.[9] They are concentrated exclusively in the Middle Black Sea, Middle Anatolia, Eastern and South Eastern Anatolia, West Anatolia and Marmara regions, usually in the form of family businesses together with the cattle under unhealthy conditions and slaughtered along with cattle.[8,10,11]

Buffaloes due to fast developing rumen with a rich bacterial flora able to efficiently consume poor quality feeds are convenient animals for pasture farming.[7,12-15] Moreover, they have fast growth and high yield performance and resistant to diseases and harsh environmental conditions.[16,17]

It is necessary to include a sufficient and balanced energy and nutrients as required into the buffalo's diet in order to proceed healthy maintenance, growth and development, and productivity.[18]

Factors Effecting Energy and Nutrient Requirements

To maintain life, reproduction and productivity buffaloes need energy and nutrients such as protein, minerals, vitamins and water. These requirements are under the influence of various factors.[18-23] These are:

1. Animal based factors: The age of animal, body weight (BW), production line, physiological status (growth, gestation, lactation etc), digestive system traits and health status.[18,21,24-26]

2. Ration associated factors: Feeds that used in ration and nutritional contents of these feeds, physical and chemical status, hygienic quality and presentation features.[26-30]

3. Environmental related factors: Climate, air temperature and humidity, daylight hours, stress miliue, feeding system, drinking water and hygiene of housing structure.[19,21,24,31,32]

Studies to determine energy and nutrient requirements of buffaloes mainly accummulate on the milking buffaloes. Energy and nutrient requirments are calculated according to milking cows feeding standards defined by Institute National de la Recherche Agronomique (INRA) 1988 [27,33] and the National Research Council (NRC) 1984 [32], 1988 [34], 1989 [24], 2001.[35] For growing male buffaloes NRC 1976 [36] and 2001 [37,38] datas are used.

While determining these levels at different physiological phases for buffaloes, requirements for the maintenance and growth change with regard to body weight and daily body weight gain (BWG) (Table 1), however body weight commensurates in heifers (Table 2). For an efficiency in buffaloes at lactation period, maintenance and in addition milk yield and milk composition, in particular percentage of fat in milk (Tables 3 and 4), and in buffaloes at dry period maintenance and changes during pregnancy that provide growth and development of fetuses (Table 5) all should be considered.

Dry Matter Intake

Daily intake of dry matter (DM) in an animal defines its capability of feed consumption. Energy and nutrient requirements should be efficiently included in the DM to reach aimed daily body weight and milk production, quality and fat. [16,39,40] In this context, the ration given to buffaloes should posses predominantly roughage and the remaining concentrated feed. [29,34,41] Feed consumption can be calculated from percentage of BW and/or value derived from metabolic body weight ($BW^{0.75}$). [21,29] Dry matter intake (DMI) is influenced by age, body weight, sex, physiologic status, type of production, reporduction features and health status of buffaloes. [20,42]

Studies indicated that daily DMI for the maintenace was 1.6-2.4% [39] and 1.2-1.3% of BW and 59.9 g/kg $BW^{0.75}$ [24], and it was 2.2-2.6% of BW in heifers[18,43], 2.5-3.0% of BW in fattening buffaloes[20,34], 2.2% of BW in breeding males[43], 1.99% of BW in castrated indigenous young males.[6] In pregnant buffaloes DMI starts to drop before parturition and levels up 1.8-2.5% of BW [33,41,43] and 68 g/kg$BW^{0.75}$ in dry period.[15] Low level of DMI at the late stage of gestation does not show a sharp increase when the milk production reaches the peak at the beginning of lacta-

tion, in other words, despite the fast increase in milk yield following the parturition upsurge in DMI is rather slow. Milk production of the animal usually peaks 4 to 8 weeks postpartum. However feed consumption ability does not immediately meet the demand for milk production. The highest feed concumption capacity is reached at around 150 days after parturition.[18,20] In accordance with this figure, daily DMI for buffaloes at lactation period is 2.0-2.2% of BW[16,40,43,44] and 119.2-137 g/kg BW $^{0.75}$ have been found.[15,44]

One of the factors affected DMI is composition, physical and chemical characteristics of the ration. Pathak[29] reported that mixture of good quality of roughage and palatable concentrated feed was dominantly consumed by buffaloes at lactating, dry and fattening period.[29] In another study, in buffalo rations, the effect of particle size of feed on feed consumption shows a significant selection activity against coarsa particles (>19 mm).[45] Again, in rations with different nutrient contents the rise in energy values increases DMI however increase in cell wall elements (NDF, ADF, ADL) and protein contents decreases DMI.[15,46] In indigenious breed fed with a ration that contains high levels of digestable protein starch unit and nutrient, DMI was high and utilization of feed was good.[28]

DMI is also influenced by daylight hours. The longer the daylight hours the higher the DM is consumed. DMI is 1.4-1.8% of BW in the winter and 2.2-3.0% of BW in the summer.[19]

Energy Requirement

In buffaloes, the energy is required for the maintenance, growth, development, reproduction and production performance.[20,34] Energy is generally acquired from carbohydrates such as starch and cellulose and fat. The physiological nature of digestive system in buffaloes makes the cellulose (exist in the roughage) a very important and rather cheap energy source.[34] To determine energy requirements, mainly values of metabolized energy (ME), total degradable nutrients (TDN), net energy lactation (NE_L) have been widely used.[18,34,39,44] Energy requirement in buffalo varies in accordance with age, BW, sex, physiologic status and production type (Tables 1-5). Particularly, as the fat content in the milk increase, buffaloes producing a higher fat testing milk require more energy per kg of milk (Table 4).

At the beginning of lactation in high yielders inadequate feeding is the case regarding the energy. So much so that when energy level decreased in the ration to prevent extra weight increase during the highest feed consumption (150 days after the parturition), this is clearly notable as imbalance between energy intake and energy utilization for milk production occurs. Animal compensates this gap from their body fat depots. Therefore a degree of BW loss is observed.[18,20,47] Where the energy deficieny is long standing and severe, milk production and fat percentage in milk significantly drops[20] and at the first 2 months of lactation more than 10% of BW loss cause post-partum anestrus, a delayed ovulation and a reduced percentage of large follicles, a shortening in lactation line and subclinic acidosis leading to endometritis.[47,48] Where the energy is excessive as a result of superfluous consumption of energy fatty liver cow syndrome is not observed in buffaloes. Chemical content of milk and especially fat level in milk considered as an important feature for this animal are affected.[18] In p-FSH superovulated buffaloes, increasing of the energetic concentration with a high starch dose reduces the number of embryos recovered for flushing.[49]

There are several studies focused on the possible effects of energy on buffaloes. Paul et al.[44] reported that the effect of energy utilization during lactation was very high and for per kg corrected milk of 4% fat, 695.9 g TDN was consumed, effectiveness of average gross energy was 30.53% and net energy was 69.16%. Again, in buffaloes at this period while daily TDN requirement was 35.3 g/kg BW$^{0.75}$ for maintenance, it was 406 g (1.47 Mcal/kg DM ME) for producing per kg 6% fat-corrected milk and, for 1 kg body weight gain it was 1970 g (7.13 Mcal/kg DM ME).[24] Energy requirement for pregnant buffaloes was 55.4 % TDN (2.00 Mcal/kg ME) in dry matter between 240 and 270 days of gestation whereas it was 60.6 % TDN (2.19 Mcal/kg ME) between 270 and 308 days.[50]

Energy requirement is also closely associated with type, amount, quality and presentation method of feed consumed by buffaloes. Therefore high demand of energy at lactation period should be fulfilled by quality roughage and grains that contain copious amount of energy in addition to feeding by means of low quality roughage.[19,47] Supplementation of adequate amount of fat enhances energy concentration, which may affect the percentage of fat in the milk.[3,34] However, the amount exceeding this level may be associated with drop in cellulose digestion and utilization of non-protein nitrogen compounds and calcium discharge increases. High level of fat consumption causes a decrease in feed intake and digestive system disorders. Unsaturated fatty acids of fats decrease the methane production in the Rumen.[34] Dietary rumen protected fats stimulate milk production with the increase of mobilization of body reserves; as proof, the levels of circulating non-esterified fatty acid (NEFA) result increased.[51] This phenomenon has been registered also in buffaloes that have received cryo-crystallized fatty acids from the beginning of lactation.[52] Studies in progress demonstrate that in buffaloes the increase of

diet energetic density using protected fats reduces the calving-conception interval from 48 to 38 days.[53]

Usmani and Inskeep[26] studied to determine the effects of pre-partum feeding (approximately 75 day before calving) on milk yield in buffaloes. In the 1st experiment they practiced moderate and high feeding and in the 2nd experiment high and very high feeding. In mid feeding each animal received daily green fodder; in high and very high feeding concentrate mixture in addition to green fodder was given. According to the result of the study estimated ME in both experiments was 2.00 Mcal/kg KM for green fodder fed buffaloes, 2.70 Mcal/kg KM for concentrate mixture; this value was 31.90 Mcal/day for mid feeding, 45.80 Mcal/day for high feeding and 50.60 Mcal/day for very high feeding. In conclusion estimated ME was 43% more for high feeding than for mid feeding at the 1st experiment and 10% more for very high feeding than for high feeding at the 2nd.

With a high environmental temperature and humidity, mean TDN requirement and utilization in buffaloes at lactation changed with respect to months. The TDN requirement for buffaloe milk that contain 6 % fat was 6632 g in August, 6179 g in November and 6030 g in March however the utilization of TDN was 9848 g in August, 8154 g in November and 8610 g in March indication that TDN utilization was higher than requirement.[31]

Cellulose Requirement

Cellulose one of the structural carbohydrates is degraded by enzymes secreted from rumen microorganisms.[54] To determine cellulose in feed, Acid Detergent Fiber (ADF) and Neutral Detergent Fiber (NDF) methods are commonly used.[29] While ADF includes cellulose, lignin and lignified nitrogen compounds, NDF contains cellulose, hemicellulose, lignin and lignified nitrogen compounds. NDF is the most reliable method to determine the total cellulose, and it is related to the feed consumption, rumenation and total chewing time.[55] The ration should have an adequate amount of crude cellulose, a healthy rumen texture, a balanced digestion feature, rumen microorganisms, preservation of pH medium in equilibrium, a normal chewing activity, rechewing, enough rumination activity and saliva production, keeping milk fat at optimum level, favorable milk fat generation, milk and meat production.[29,55] Cellulose requirement of buffaloes is achieved by addition of stacks of straw, lucerne hay, lucerne hay + legume mixtures or properly chopped corn and sorghum.[29]

In studies, NDF level in buffaloes increases with respect to BW (Table 2) and changes with the increase or decrease in milk yield (Tables 3 and 6) depending on the physiological stages. Again digestibility of NDF, cellulose and hemicellulose is 51.1, 50.9 and 66.6% respectively [25] however, with the increase in roughage in ration.[56]

Depending on the environment NDF requirement is altered (according to months; 7333 g in August, 7571 g in November and 7591 g in March) but average utilization of NDF (12622 g in August, 9801 g in November and 10967 g in March) is higher than the requirement.[31]

Protein Requirement

Protein is a necessary substance for the development and growth of muscles, nervous sytem and other tissues, fetus development, repair of aged tissues, milk and meat production.[3,54] Required ammonia for the growth of rumen microorganisms and optimal microbial protein synthesis is recompensated by supplementation of adequate level of protein and non-proteineous compounds.[25,54] Due to low level of protein/energy requirements in buffaloes, the protein demand is accomplished by very low, medium quality pastures and fodder. This requirement shows an increase among buffaloes especially during growth, gestation and lactation therefore, feeds such as meadow grass, leguminous forage, grain and oil seed cakes are used for feding.[18,34,57,58] This demand is rather calculated as crude protein (CP) and/or digestable crude protein (DCP).[18,39]

Protein insufficiency cause a decline in animals appetite and feed intake, a negative effect on feed utilization, a drop in cellulose digestion.[55] The reaction that buffaloes show in response to protein inadequacy is severe.[21,59] Animals those protein requirements are not met utilize thier own body protein.[18] In excess of protein, delay first heat and conception age, and increase the number of services required per conception may be observed.[60]

Protein requirement changes with respect to BW and/or BWG (Tables 1 and 2) and milk yield (Tables 3 and 5) depending on the physiologic status of the animal. At the same time depending on the increase in the protein level in the milk, for 1 kg milk production CP requirement increases (Table 4). In pregnant buffaloes protein requirement was 12% CP during 240-270 days of gestation whereas 14% CP for 270-308 days, below these levels CP did not affect milk yield at the early lactation, increased BW loss and delayed postpartum estrus.[50] Between postpartum days of 11 and 70 daily intake of 13-16 kg DM is acceptable for 13.5% of required protein level.[61] Moreover, protein utilization in lactating buffaloes is high. For per kg milk of 4% fat, daily 75.69 g DCP consumed, average gross protein effectiveness was 45.48% and net protein effectiveness was 80.15%.[44] Daily CP and DCP require-

ments for survival rate were 5.43 and 3.14 g/kg $BW^{0.75}$ respectively, whereas for producing per kg 6% fat-corrected milk it was 90.3 and 55.2 g respectively, for 1 kg BW increase it was 330 g and 230 g respectively.[24]

Puppo et al.[14] indicated a greater protein digestibility in buffaloes compared to cattle in diets with a high content of structural carbohydrates. This all leads to the conclusion that buffaloes have a greater capacity to utilize protein sources at least from those diets adapted for the dry phase, therefore giving the breeder the opportunity to formulate diets with a low protein content. Buffaloes have the ability to synthetize protein out of non-protein nitrogen substances.[25] It was reported that urea had a positive effect on daily BW increase and feed intake in young male buffaloes.[62] In growing buffaloes, ration with urea increased the rumen pH. The amount of ammonium nitrogen increased 1 h after intake of ration with urea whereas 1-3 h after intake of ration without urea. Those fed with ration lack of urea the levels of total free fatty acids, acetic acid, propionic acid and butyric acid increased.[63]

Depending on the environment protein requirement changes according to the month and milk of buffaloes containing 6% fat CP requirement (1232 g in August, 1129 g in November and 1103 g in March) is lower than CP utilization (1898 g in August, 1274 g in November and 1396 g in March).[31] CP requirement (5.43 g/kgBW $^{0.75}$/day) in lactating buffaloes in comparison to NRC utilization was found to be 57% higher than the value in NRC, 1989 (3.43 g/kgBW $^{0.75}$/day) and this is attributed to CP digestibility in tropical rations that contain poor quality of cellulose was lower than rations of warm regions.[24]

Mineral Requirement

Minerals are compounds that have substantial tasks in the organisms such as growth, development, reproduction and continuity of many other vital functions. Requirement for minerals is lesser than energy and protein demands, however the effects of lack or insufficiency of minerals are more instant than other nutrients' deficiencies. Minerals should be provided to buffaloes according to the level of production line and health status. But excessive provision of one mineral may effectively initiate an antagonism with other minerals, lower the utilization of other minerals, so causing toxication.[54,64,65]

Buffaloes require at least 15 minerals. These minerals are macrominerals such as calcium (Ca), phosphorus (P), magnesium (Mg), sodium (Na), chlorine (Cl), potassium (K) and sulphur (S) and are microminerals such as cobalt (Co), copper (Cu), iodine (I), iron (Fe), manganese (Mn), molybdenum (Mo), selenium (Se) and zinc (Zn).[19] They are exist in soil, feed and water in various levels. The level of supplementation of minerals to the ration should be set based on the quality, quantity and types of roughages. Where the soil and plants are deficient in microminerals the mixture of minerals should be used.[54,64,65]

Buffaloes are in need of more Ca and P than other minerals. Requirement for these two minerals increases concordance with the increase in BW and/or daily BWG (Table 1) however it decreases in heifers (Table 2). Buffaloe milk contains 1.8-2.0 g Ca and 1.1-1.2 g P. For per kg milk production daily requirement of Ca is at around 5.2-5.8 g and of P is 2.1-2.3 g.[66] According to the study of Proto[33] it was 6.7 g for Ca, 2.2 g for P and 0.9 g for Mg. For a 600 kg buffaloe at her 8th or 9th month of gestation daily Ca ad P requirements are 40 g and 35 g, respectively, (Ca/P ratio 1/1).[40] Moreover 2/1 ratio of Ca/P at lacation period and 1/1 at dry period of 120 days is important for the prevention of vaginal and uterine prolapsus.[34,67,68] Supplementation with hyperphosphoric salts (at least during the last phase of gestation) to obtain the ratios of the two microelements near to one, stimulates the parathyroid activity useful to bone re-arrangement immediately after calving.[61] Without considering the balance of Ca and P ratio, the feeding policy may result in not only drop in milk yield but also milk fever, haemoglobinuria and paralytic disorders emerge and increased incidence of health disorders, and reproductive problems such as infertility and delayed estrus, repeated estrus, low conception, retained plasenta and prolapsus uteri ocur.[35] Supplementation of mineral mixture to the ration during postpartum period increases the plasma progesteron level that is effective on uterine involution.[69] In heifers BW and early pregnancy rate were significantly increased in ration added by 5.7% Ca and 4.1% P, Na, K, Co, Cu, Fe, Se, Zn and N mixture than only 12% Ca and 6% P added ration.[70] Selenium one of the minerals is important for decrease in retentio secundinarium cases in buffaloes at dry period.[71] This mineral with vitamin E strengthen the immune system[72], 4.2 mg Se and 4200 mg vitamin E mixture reduces the calving-first heat interval after calving.[73] After calving supplementation of vitamin E and Se to cows increases milk production however reduces calving intervals, involution time, age of first-heat, ovulation and days without gestation.[23] In male buffaloes Se increases seminal plasma and testesteron levels in blood serum whereas decreases levels of seminal and serum estradiol having positive effect on semen quality.[74]

The salt requirement of buffaloes is maximum 0.45 % of DM in ration. This requirement various between 50 and 100 g with respect to daily BW increase and milk yield at lactation period however it was 30 g at dry period. In other words to survive or continue their life animal should be provided salt at a dose of 4-6 g/day for 100 kg BW and 1.5-1.8 g/day for 1 kg milk yield.[7]

Vitamin Requirement

Vitamins are organic compounds that have very important functions in the body for life and low quantities has great activity.[54,64] In buffaloes water-soluble vitamins such group B and C and fat-soluble vitamins such as K are synthetized in the body. Vitamins A, D and E should be obtained externally since not synthetized in the body. If animals are not in a position to use pasture or faced with negative effects due to the deficiency required vitamins need to be added to the ration.[19,34]

In buffaloes for survival rate and growth requirements of vitamin A (Tables 1 and 2) and D and E (Table 2) change according to BW further the association with reproduction indicates an important role for vitamins. Supplementation of 4200 mg vitamin E and 4.2 mg Se or with a AD3 vitamin complex to the ration, at dry period reduces the calving-first heat interval after calving.[73] Again, at the period before calving in buffaloes at their late stage of gestation from the 60th day of prepartum to 30th day of postpartum the addition of 2000 IU alfa-tocopherol acetat reduces retention of fetal membranes and metritis at a rate of 17%, whereas levels of 1000, 1500 and 2000 IU alfa-tocopherol acetat reduces milk yield in this term in comparison to the previous term, it was observed that 1000 IU from 30th day to 60th days of postpartum improved the reproduction performance but not effective on DM, CP and TDN consumption.[75]

Water Requirement

Water as a nutrient in the body is involved in realization of all metabolic activities such as the regulation of body temperature, the transportation of blood, lymph and intestine fluid as a main carrier, discharge of waste, growth, fattening and milk production.[54,64] Water is supplied through drinking water, feed and metabolic water that formed after biological oxidation in the body (oxidation of organic substances).[34]

Daily requirement of water in buffaloes depends on age, body weight, physiological status, production line, health, dry matter content of the feed eaten, environmental temperature and humidity. Buffaloes in comparison to cattle consume more water (approximately 25-30 % more than required by cattle in the same climatic conditions) and this demand increases especially with body weight gain and lactation period.[32,34] The water requirement per consumed DM is 3-5 L in winter and 5.5-6.5 L in summer.[7]

Water should be fresh, clean and in good quality, drinkable, hygienic, be a certain level of hardness, saltiness, nitrate and nitrite levels (Table 6) in the opposite case it causes a decrease in feed intake, negative effects on physiological status and yield.[32]

Salinity of water is seldom a problem in dairy buffalo feding. A salt content of up to 5 g/L of water can be used for buffaloes.[34]

Conclusion

It was concluded that the provision of adequate quantity and ratios of energy and nutrients as buffaloes require for maintenance, growth and production lot in rations generating positive effects on health and productivity will eventually contribute to the development of buffaloe farming ■

Table 1. Daily dry matter, energy and nutrient requirements of buffaloes for maintenance and growth.[39]
Çizelge 1. *Mandaların devam ve büyümeleri için günlük kuru madde, enerji ve besin gereksinimleri.* [39]

Body weight kg	Growth rate g	Dry matter kg	DCP g	TDN kg	Ca g	P g	Vitamin A 1000 IU
100	0	2,4	80	1,09	4	4	5
	250	3,0	195	1,78	9	8	6
	500	2,8	245	2,47	14	11	6
	750	2,8	313	3,16	20	14	6
150	0	3,3	109	1,48	5	5	6
	250	3,9	242	2,17	10	9	9
	500	4,1	319	2,86	14	12	9
	750	3,9	378	3,55	17	15	9
	1000	3,9	437	4,24	21	17	9
200	0	4,1	135	1,84	6	6	8
	250	4,8	281	2,53	10	9	10
	500	5,1	341	3,22	14	13	12
	750	5,1	400	3,91	19	17	13
	1000	4,8	471	4,60	23	20	13
250	0	4,8	160	2,17	8	8	9
	250	5,5	315	2,86	12	9	10
	500	5,9	374	3,55	15	12	12
	750	6,1	433	4,24	19	17	14
	1000	5,6	493	4,93	22	19	14
300	0	4,8	183	2,49	9	9	10
	250	5,5	343	3,25	13	12	11
	500	5,9	402	4,01	17	16	13
	750	6,1	461	5,04	21	19	15
	1000	5,6	521	5,52	26	23	16
400	0	7,0	227	3,09	11	11	13
	250	7,7	369	3,98	14	13	14
	500	8,4	428	4,88	17	16	16
	750	8,7	487	5,78	20	19	18
	1000	8,3	547	6,68	23	21	19
500	0	8,3	268	3,65	13	13	14
	250	9,1	374	4,69	15	14	16
	500	9,7	433	5,72	16	16	18
	750	10,2	492	6,76	18	18	20
	1000	10,4	552	7,79	20	20	23

Note: 1. Growth rate of zero indicates maintenance requrements only.
2. The normal range of daily gain for young animals (say upto 200 kg) is 250-500, unless diets containing large amounts of milk or its substitutes are fed.
3. The range of daily gain for older animals (200 kg or more) is 500-750 g.

Table 2. Average dry matter, energy and nutrient requirements in heifers.[18]
Çizelge 2. *Düvelerde ortalama kuru madde, enerji ve besin gereksinimleri.*[18]

	Body weight, kg			
	100-200	200-300	300-400	400-500
Dry Matter Intake (DMI), kg/day	3.5-4.5	4.5-7	7.9-9	9.5-11
Crude protein (CP),% DM	15-16	15-16	15-16	13
Neutral Det. Fibre (NDF),% DM	35	35	38	40
ME, Mcal/kg DM	1.40	1.40	1.40	1.30
Calcium,% DM	0.60	0.60	0.48	0.45
Phosphorus,% DM	0.40	0.40	0.32	0.30
Vitamin A, IU/kg DM	300	300	3400	3200
Vitamin D, IU/kg DM	1100	1100	1300	1200
Vitamin E, IU/kg DM	31	31	34	32

Table 3. Requirements of dry matter, energy and some nutrients according to milk yield in lactating buffalo herd (average body weight: 650 kg, normalized milk fat: 8.30 % and protein: 4.73 %).
Çizelge 3. *Sütçü manda sürülerinde süt verimine gore kuru madde, enerji ve bazı besin gereksinimleri (ortalama vücut ağırlığı 650 kg, normalize süt yağı: 8.30% ve protein: 4.78%).*

	Production of normalized buffalo milk, kg/day							
	< 6	6	7	8	9	10	11	12
Dry Matter Intake (DMI), kg/day	*13.3	*14.2	*14.7	*15.1	*15.6	*16.1	*16.5	*17.0
			**16.00	**16.25	**16.50	**16.75	**17.00	**17.00
Net Energy Lactation (NE_L), Milk FU/kg DM	*0.75	*0.79	*0.82	*0.84	*0.86	*0.88	*0.90	*0.92
			**0.74	**0.76	**0.79	**0.82	**0.85	**0.89
Crude protein,% DM	*13.0	*13.9	*14.3	*14.6	*15.0	*15.3	*15.6	*15.9
			**10.16	**11.16	**12.13	**13.06	**13.97	**15.08
NDF,% DM	*52.0	*47.0	*46.0	*44.0	*43.0	*42.0	*40.0	*39.0
			**46.70	**44.76	**42.87	**41.05	**39.27	**38.10
NSC,% DM	*25.0	*27.0	*28.0	*29.0	*30.0	*30.0	*31.0	*32.0
			**36.35	**36.71	**37.07	**37.41	**37.75	**38.63

NSC: Non-structural carbohydrate * Technical-Scientific Committee[40] ** Bartocci et al.,[16]

Table 4. Energy and protein requirements for the production of 1 kg of buffalo milk relative to the fat and protein content in lactating buffalo herd.[33]
Çizelge 4. *Sütçü manda sürüsünde yağ ve protein içeriğine göre 1 kg manda sütü üretimi için enerji ve protein gereksinimleri.*[33]

Energy requirements (Milk FU/kg of milk)													
Milk fat,%	6.5	7.0	7.5	8.0	8.3	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0
NE_L	0.61	0.64	0.67	0.70	0.72	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		99		105	111	116	122	128	134	139	145	151	157

Table 5. Dry matter, energy and some nutrient requirements in dry buffalo herd (average body weight: 600 kg).
Çizelge 5. *Kurudaki manda sürüsünde kuru madde, enerji ve bazı besin gereksinimleri (ortalama vücut ağırlığı: 600kg).*

Dry matter Intake (DMI), kg/day	10.5	10-12
NE_L, Milk FU/kg DM	0.65	0.63-0.65
Crude protein,% DM	10.5	10-11
Crude fibre,% DM	30.0	-
Neutral Det. Fibre (NDF),% DM	60.0	52-58
Starch + Sugars,% DM	9.0	8-10
References	Proto[33]	Bertoni et al.[41]

Table 6. The amount of some ions and salt in the drinking water of buffaloes.[32]
Çizelge 6. *Mandaların içme suyunda bazı iyon ve tuz miktarları.*[32]

Salt	Maximum concentration for stock, mg/L
Magnesium	400
Sulphate	1000
Nitrate	100
Nitrite	10
Fluoride	2
Sodium bicarbonate	1000

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