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the hotter part of the day and feeding roughage during the night.

Infectious Diseases

River buffaloes are susceptible to most diseases affecting cattle (Table 7). Compared with cattle, buffaloes show greater resistance to foot-and-mouth disease and brucellosis but have a higher incidence of parasitic diseases because of their wallowing habits.

The dairy buffalo is as susceptible to mastitis as the dairy cow. Bacteria causing mastitis, their treatment and control are similar to those for cattle (*see Mastitis Pathogens*: Contagious Pathogens; Environmental Pathogens).

There is a high incidence of calf mortality caused by *Toxocara vitulorum*, virulent strains of *Escherichia coli*, rota and corona viruses. Larvae of *To. vitulorum* are transmitted from the dam to the calf through the milk during the first month of life.

Puerperal metritis and retained foetal membranes occur in the buffalo. The high incidence of metritis and other genital infections has been partly attributed to the unhygienic practice of dilating the vagina with either inserting objects or blowing air for stimulating milk letdown.

Metabolic Disorders

High milk-producing river buffaloes are as susceptible to metabolic disorders as dairy cows. Apparently, the aetiology is similar because affected buffaloes respond to therapy and control as for dairy cows.

See also: **Buffalo Husbandry**: Mediterranean Region. **Dairy Animals**: Water Buffalo. **Developing Countries, Cow Management**: Asia. **Gamete and Embryo Technology**: Artificial Insemination; Multiple Ovulation and Embryo Transfer; *In vitro* Fertilization. **Mastitis Pathogens**: Contagious Pathogens; Environmental Pathogens. **Mating Management**: Detection of Oestrus. **Milk**: Introduction. **Milk Fat Products**: Anhydrous Milk Fat – Butteroil, Ghee. **Oestrus Cycles**: Puberty; Characteristics; Postpartum Cyclicity. **Pregnancy**: Parturition. **Replacement Management, Cattle**: Pre-ruminant Diets and Weaning Practices. **Stress, Heat, in Dairy Cattle**: Effects on Milk Production and Composition; Effects on Reproduction.

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Mediterranean Region

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Introduction

The buffaloes reared in the Mediterranean region are the Asian buffalo or water buffalo, i.e. *Bubalus bubalis*. This species includes two types: (1) the river type, with 50 chromosomes, with an adult male weight ranging between 450 and 1000 kg, and annual milk production of 1000–3000 kg; and (2) the swamp type, with 48 chromosomes, with an adult male weight of 325–450 kg, and annual milk production up to 600 kg. While the major purpose of the river buffalo is milk, the swamp buffalo is reared mainly for draught.

Only 3% of the world buffalo population is reared in the Mediterranean region, which includes a few

countries of Europe and the Near East; these buffaloes are all of the river type. The number of buffaloes in the Mediterranean region declined during the twentieth century for three reasons: Holsteinization of dairy cows, mechanization and the poor market demand of buffalo products.

Significant numbers of buffaloes (over 100 000) are at present found only in Italy, Romania, Egypt, Turkey, Azerbaijan, Iraq and Iran. In Bulgaria the number of buffaloes has decreased to fewer than 20 000. In all these countries, buffaloes represent only a very small portion of total livestock, except in Egypt, where buffaloes are more numerous than cattle. In the last 15 years, because of the strong market demand for buffalo cheese and as a consequence of the 'milk quotas' restriction imposed by the European Union, the number of buffaloes has increased in Italy. In Egypt, Iran and Azerbaijan also, there is a preference for buffalo dairy products compared to cows' milk products. During the 1990s, buffaloes have been imported to Germany, the United Kingdom and The Netherlands, where a few milk-producing herds can be found.

Buffaloes of the Mediterranean region differ phenotypically from country to country because of the different environment and management practices and because no exchange of genetic material between countries has occurred, except in Bulgaria, where crossbreeding with the Murrah breed was carried out by importing in 1962 a significant number of animals from India. Major morphological differences between the buffalo populations of different countries include: (1) the variable size, ranging between a minimum of 280 and 300 kg liveweight for adult females and males, respectively, in Egypt to a maximum of 900 and 1000 kg in Iraq, the most frequent weights being 600 and 800 kg; (2) the shape of the horns; and (3) the coat colour, from dark-grey and dark-brown to black, showing white spots in some cases.

Breeding Management

The main objective of breeding buffaloes in Europe and the Near East is milk production. Everywhere in this region, their milk is sold at a higher price than cows' milk.

Average herd size (number of females of breeding age) is below eight in the whole region, except Italy (90), Syria (35) and Iran (34). The proportion of breeding females to total buffaloes is 50% in all countries, with a minimum of 33% in Azerbaijan, where a dual-purpose line of buffaloes is maintained, and a maximum of 62% in Italy, where males have no market. In countries where the majority of buffaloes

are reared in very small herds there are also a few bigger private, cooperative or state herds (Bulgaria, Egypt and Turkey) (Figure 1).

The number of calves produced per cow per year varies from 0.5 in Egypt to 0.9 in Azerbaijan and Syria, with average of 0.7. The age at first calving averages 36 months. In Italy a good proportion of buffaloes calve at 28 months of age, whereas in Egypt and Syria a high number are 40 months or more at first calving.

In Mediterranean countries, all herds have their own bull except in the areas with very small herds (2–3 breedable buffaloes) in Romania, Bulgaria, Egypt and Turkey, where there are groups of bulls for breeding at village level.

Official milk recording for the productivity of buffaloes is performed in Egypt, Italy, Bulgaria, Romania, the United Kingdom, Azerbaijan and Iran. Genetic evaluation of buffaloes is done in Italy, Bulgaria, Romania, Egypt, Iran and Azerbaijan.

Choice of breeding bulls/heifers is made on the basis of:

1. Lactation yield (Bulgaria, Greece, Azerbaijan).
2. Lactation certificate (Italy, Egypt, Iran).
3. Cow indexes (Italy, Iran).
4. Bull indexes (Italy, Iran).

Where milk recording is not practised, a better bull is judged on his appearance, size and strength. Natural breeding stations exist in Egypt and Bulgaria. Bulls in the breeding stations are provided by development programmes of the government or other agencies. Due to difficulties in oestrus detection and lack of organization, artificial insemination (AI) is still practised only to a very limited extent for buffaloes in the Mediterranean region: in Italy for 2.5% of the buffaloes, in Egypt and Iran for 0.5% and in Romania for 0.1%. In the large cooperative and state farms in Bulgaria, AI is used on 80% of the buffaloes.



Figure 1 Egyptian buffalo, Nile delta. (Owner: Sami El Tahir.)

In the other countries it is not used at all. The low use of AI has slowed down the implementation of national selection schemes for genetic improvement of milk productivity. Research trials conducted in Italy have indicated that artificial insemination is feasible and successful in buffaloes using the following technique to synchronize oestrus and boost fertility. A progesterone-releasing intravaginal device (PRID) of silicon coils is inserted and left for 10 days; on the 7th day injections of 1000 IU of eCG (equine chorionic gonadotrophin) and 15 mg of luprostiol (prostaglandin $F_{2\alpha}$) are given; artificial insemination is performed at 48, 72 and 96 h after removal of the PRID on day 10.

Housing

The most common housing system is that referred to as 'traditional', consisting of keeping buffaloes indoors at night and confined in fenced areas during the day (Egypt, Turkey, Iraq, Syria); in the favourable season they are allowed to graze during the day (Romania, Turkey and on some farms in Italy). In the marshes in the southwest of Iran, buffaloes are kept outdoors on pasture throughout the year, whereas in the northern areas, around the Caspian Sea, they are kept in barns in winter. Lactating buffaloes are kept tied throughout the year in Bulgaria, Romania and Azerbaijan. In Italy, they are housed loose in paddocks all year, with the same modern systems used for dairy cows; one-third of Italian buffaloes are also put on pasture in spring. One-third of Iraqi buffaloes wallow in marshes all year, the water reaching a level halfway up their bodies. They swim far and wide to find food and when the water is high, they stand on platforms made of papyrus, reeds and mud; on these platforms the farmers sometimes build huts to house the buffaloes; these platforms can be pushed to different places in the marshes.

Lactation

The length of lactation varies from 200 to 290 days, the most frequent being 260. Average lactation milk yield is 1600 kg. Italian buffaloes give the highest average yield (almost 2000 kg) (Figure 2), while in Turkey, average yield is below 1000 kg. In the Iraqi marshes buffaloes produce no more than 700 kg in 180 days. The fat content of the milk throughout the lactation is over 8% in Italy, Turkey, Azerbaijan and Iraq, around 7% in Bulgaria, Romania and Egypt, and less than 7% in Iran.

The average daily milk yield of river buffaloes shows very wide variability, depending on the breed, the country and especially the management and



Figure 2 Italian buffalo, in her fifth lactation; she produced 2730 kg milk in 270 days, at 8.7% fat, 4.75% protein. (Tor Mancina farm, Rome.)

feeding system. It can range from 3 to 4 kg day⁻¹ for poorly fed animals (grazing and fed byproducts) to 15 kg day⁻¹ in intensive management systems.

In the large commercial herds in Italy and Bulgaria, buffaloes are machine-milked, twice a day. In the smaller herds elsewhere in the Mediterranean, buffaloes are usually hand-milked, and often the calf is allowed to stand with its dam to assist letdown which otherwise may be slow.

Feeding Management

Extensive management systems, as practised in Europe and the Near East, include grazing in the favourable seasons. In all cases, green forage 'cut-and-carry' – composed of legumes varying from country to country – concentrates and byproducts are the basic foodstuff. Green forage and hay are made mainly of lucerne (alfalfa) in Italy, Bulgaria, Romania and Turkey and *Trifolium alexandrinum* in Egypt. The most common byproducts fed to buffaloes are brewers' grains in Italy and Bulgaria, sugar-beet pulp in Italy, Bulgaria and Iran, cotton waste in Egypt and Azerbaijan, tomato peel in Italy, apple-juice wastes in Iran, sugar-cane wastes in Egypt and Iran, maize stalk and cobs in Iran, Egypt and Romania and straw everywhere.

In the Iraqi marshes, when the buffaloes return at night to the floating islands where they live, they are fed green forage cut by the farmer during the day; this forage is composed of reeds, papyrus, various water plants, and rice hulls when available. In Italy, dairy buffaloes are managed in the same intensive way as dairy cows, maintained in loose housing paddocks throughout the year. Maize silage and grass silage are the main feeds. Average yearly milk production for buffaloes in Italy is 2000 kg although 5% of recorded buffaloes yield more than 3000 kg. An example of

Table 1 Example of daily feeding schedule for a buffalo producing 10 kg day⁻¹ in Italy

Component	kg	kg dry matter	Milk feed units	Crude protein (g)	Fibre (g)
Lucerne (alfalfa) hay	7.5	6.45	3.87	650	2220
Maize silage	16.0	5.12	4.56	385	950
Concentrate (38% protein)	3.0	2.64	2.90	1000	320
Maize grains	1.3	1.14	1.45	115	25
Total	27.8	15.35	12.78	2150	3515

feeding schedules for high-yielding buffaloes is given in [Table 1](#).

Similar high-energy diets (0.80–0.85 milk feed units (MFU) kg⁻¹ dry matter) are used in Italy for particular selected genotypes where highest milk yield is desired because of the high prices for buffalo milk and because such diets increase milk protein (4.5–5.0%) and milk fat (8–9%) resulting in higher cheese yields.

Health Management

Buffalo pathologies are similar to those described for cattle. Few diseases are peculiar to buffaloes. They tend to show more resistance to diseases than cattle, perhaps because of their adaptation to hot–humid climates.

Parasitic Infections

Parasitic infections, particularly in developing countries, are very common in buffaloes. They include: gastrointestinal helminths (*Strongyloides*, *Toxocara*, *Moniezia*, *Mammomonogamus*) and coccidia (*Eimeria*, *Giardia*, *Cryptosporidium*), liver parasites (*Fasciola*), tick parasites (*Hyalomma*, *Sarcoptes*) blood parasites (*Theileria*), all of which produce important economic losses in buffalo breeding.

Bacterial Infections

Escherichia coli can cause gastroenteric pathologies in buffaloes, particularly in calves, associated with other bacteria (*Enterobacter*, *Pseudomonas*, *Klebsiella*) or with coccidia or verminosis or virosis. Respiratory diseases are caused by *Pasteurella*, *Staphylococcus*, *Streptococcus*, *Escherichia coli*, and can result in high mortality, if the animals are not treated with antibiotics.

Pasteurella multocida is responsible for haemorrhagic septicaemia, the most serious disease in buffaloes because of the high mortality particularly in tropical Asian countries; however, it can be controlled with antibiotics and vaccines. Tuberculosis, produced by

Mycobacterium, is a serious zoonosis, which could be eradicated after tuberculin diagnosis. Brucellosis, caused by *Brucella*, is another zoonosis that needs to be eradicated after serological diagnosis. It can cause serious disease in the human population and reproductive disorders and infertility in buffaloes. Vaccination can be applied only in developing countries.

Leptospirosis is another zoonosis, produced by infection with *Leptospira* from water sources contaminated by rodents. Listeriosis, caused by *Listeria*, produces meningoencephalitis, abortion and septicaemia: the source of the infection may be silage in the buffaloes' diet. *Chlamydia*, *Rickettsia* and Johne's disease (caused by *Mycobacterium tuberculosis*) are present even in developed countries also, and the evidence of mastitis incidence links them to dairy buffaloes.

Viral Infections

Prophylaxis is very important to control some viral infections that could cause neonatal diarrhoea (Rotavirus, Coronavirus), particularly in intensive systems. Bovine rhinotracheitis (IBR), bovine diarrhoea (BVD) and bovine herpesvirus (BHV) have all been diffused by animals in intensive buffalo farms. Buffaloes are also susceptible to foot-and-mouth disease.

Other Pathologies

Buffaloes are affected by fungal infections, tumours and reproductive disorders including prolapse of the uterus.

Milk and Milk Products

Compared to that of cattle, buffalo milk is richer in fat (6–9.5%) and protein (4–5%); it has a lower cholesterol content and higher tocopherol content. It is richer in calcium and phosphorus and has less sodium and potassium. Peroxidase activity is 2–4 times higher than in cows' milk so that it can be preserved longer; β -carotene is more completely transformed to retinol and therefore the milk looks whiter than cows' milk. The milk can be consumed in liquid form or processed into a wide range of products, either alone or mixed with milk from other livestock: fermented milks, butter, ghee, condensed and powdered milk, and cheeses are produced.

Cheese and Byproducts from Cheese-Processing Plants

Many farms produce their own cheese and cream which they sell directly. Classifying the types of

cheese according to water content, the following are typical:

1. Soft cheese (water content >45%): Karish, Mish and Domiati in Egypt; Madhfor in Iraq; Mozzarella in Italy; Alghab in Syria; Vladeasa in Romania.
2. Semi-hard cheese (water content 40–45%): Beyaz peyneri in Turkey.
3. Hard cheese (water content <40%): Braila in Romania; Rahss in Egypt; white brine in Bulgaria; Akkawi in Syria.

The more common classification of cheese is based on the type of coagulation: either enzymatic coagulation (by rennet), or acid coagulation (after natural acidification or by the action of lactic bacteria). Most of the cheeses produced in the Mediterranean area, including Mozzarella, belong to the acid-enzymatic category, meaning that acid coagulation prevails. The demand for high-quality Mozzarella in Italy and the world has stimulated an increase in buffalo farming in Italy and improved animal management techniques. Mozzarella production is higher than all other cheeses and is forecast to increase still further.

Fermented Milks

Yoghurt is produced in Bulgaria, Romania and Albania from either buffaloes', cows' or sheep's milk. In Egypt, rayat is produced from natural acidification of raw milk, after the removal of cream, with no addition of bacteria, and zabadi is produced industrially. Raha is the fermented milk of Iraq, produced either from whole or skim milk, and laban or khather are the fermented milks of Syria, all of which are often produced from buffaloes' milk.

Creams

Creams also show variable techniques of production. In Egypt, queshta mosakhana is the floating cream removed after boiling milk. Gaymar in Iraq is obtained both from spontaneous floating or from spinning, in which case it is then pasteurized. In Italy, cream from buffalo milk is obtained after spinning; it is then pasteurized. After thermoacid coagulation (citric acid) of cream, another dairy product is obtained, called mascarpone. Quishada (made in Syria) is obtained from raw or boiled milk; sometimes, this cream is heated to make it more concentrated.

Butter and Ghee

Industrial butter is produced by churning of cream, often after pasteurization. The home-made product is

obtained simply by churning acidified milk. A peculiarity of buffalo butter is the colour, which is much whiter than cows' milk butter, due to the lack of carotenoids. Ghee is obtained by boiling butter. It was very popular in Egypt and was found very useful in the baking industry. In Azerbaijan ghee is the only product obtained from buffalo milk.

It is evident that the dairy products made from buffalo milk in the Mediterranean area need to be more deeply studied; the variability of their technologies is an important part of global biodiversity.

See also: Buffalo Husbandry: Asia. Cheese: Pasta-Filata Cheeses. Concentrate Feeds: Byproduct Feeds. Dairy Animals: Water Buffalo. Dairy Farm Design and Layout: Building and Yard Design, Warm Climates. Diseases of Dairy Animals, Infectious: Brucellosis; Listeriosis; Tuberculosis; Johne's Disease. Fermented Milks: Middle East. Milk: Introduction. Milk Fat Products: Anhydrous Milk Fat – Butteroil, Ghee; Milk-Fat Based Spreads. Milking Machines: Principles and Design. Parasites, External: Tick Infestations. Parasites, Internal: Gastrointestinal Nematodes.

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