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Review

Embryonic and fetal mortality in river buffalo (*Bubalus bubalis*)

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A B S T R A C T

River buffalo are able to adapt to diverse climatic zones and are widespread globally. The resource use efficiency of buffalo is highly relevant in a resource-constrained world and the increasing requirement to produce more food. Buffalo clearly have an important role in meeting the growing demand for animal protein. In the Mediterranean and higher latitudes, buffalo show annual cycles of ovarian activity, embryonic development, and pregnancy rate. In buffalo, the CL starts to develop early in the cycle, and there is also an early increase in concentrations of progesterone (P_4) in circulation. This appears to be necessary for optimal embryonic development. The failure to establish a pregnancy in buffalo can occur before Day 21 (early embryonic mortality), from Day 21 to 45 (late embryonic mortality), and from Day 46 to 90 (fetal mortality) after mating. Treatment with P_4, hCG, and GnRH on Day 5 after mating increases P_4 in circulation and reduces early embryonic mortality in circumstances where concentrations of P_4 are relatively low. The same treatments applied on Day 20 to 25 after mating can lower the occurrence of late embryonic mortality and fetal mortality.

1. Introduction

Buffalo have been associated with humans since antiquity. They have provided draught power, food, and fuel, and they have also had cultural and ceremonial significance [1]. The most common buffalo are water buffalo (*Bubalus bubalis*), which have separated into two subspecies, the river buffalo and the swamp buffalo. The river buffalo is larger than the swamp buffalo, and the former has become an important source of milk in both developed and developing countries. Buffalo have a relatively high efficiency of feed utilization compared with cattle, which has important implications for resource use and the environment [2,3].

The river buffalo adapts well to broad climatic zones including equatorial, tropical, subtropical, Mediterranean, and higher latitudes. This has enabled the river buffalo to become widely distributed throughout Asia, Europe, the Middle-East, Northern Africa, North and South America, and Australia [4].

Reproductive function in female river buffalo is closely linked to the environment. In equatorial and tropical regions, reproduction is most strongly influenced by nutrition [5]. In the Mediterranean and higher latitudes, where there are distinct annual cycles in day length, female river buffalo are responsive to photoperiod [5]. In Southern Europe, buffalo behave as a short-day breeder and show an increase in reproductive function during the summer-autumn transition (decreasing day length) and a decrease in reproductive function during the winter-spring transition (increasing day length) [5]. The latter period is characterized by reduced ovarian activity and a higher incidence of embryonic mortality [5,6]. The photoperiodicity of female river buffalo in the Mediterranean and higher latitudes has implications for the continuity of

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ovarian function, pregnancy, parturition, and milk production in commercial buffalo milk production systems [7]. Other general features of reproduction in female buffalo, which are somewhat independent of the environment, are delayed puberty and the tendency for extended periods of postpartum anestrus [5].

This review firstly provides a general description of ovarian function and embryonic development, with reference to buffalo where information is available. The review then addresses strategies that have been used to manage annual fluctuations in patterns of conception and embryonic mortality in female buffalo that occur as a response to photoperiod. This has become highly important to achieve a greater continuity and consistency in cycles of pregnancy, parturition, and milk production in river buffalo. Continuity of reproduction is also very relevant to enhance the rate of genetic improvement. It was previously mentioned that buffalo have a better resource use efficiency compared with cattle [2,3]. This raises the question of whether there could be greater utilization of buffalo for the production of high-quality animal protein.

2. Ovarian function

Similar to other ruminants, buffalo have ovarian follicular waves and two waves in each estrous cycle is the most common pattern [8–10]. The interval between the onset of estrus and the LH surge can vary from 1 to 12 hours in buffalo [5,11–13]. Ovulation occurs between 26 and 33 hours after the LH surge [13,14]. The length of the estrous cycle can be influenced by photoperiod depending on location [5].

The CL in buffalo tends to be smaller than in cattle, and concentrations of progesterone (P_4) in circulation also tend to be lower than those in cattle [15]. In the Mediterranean and higher latitudes, buffalo show annual changes in ovarian activity that are reflected in greater size of the CL and increased concentrations of P_4 in circulation during decreasing day length in the summer-autumn transition [16]. This is accompanied by increased rates of fertilization to artificial insemination (AI), higher embryonic survival, and increased pregnancies [16–18]. The significance of annual changes in reproductive function in river buffalo is discussed later in the review.

3. Embryonic development

3.1. Embryo transport from the oviduct to uterus

The general features of embryonic development in buffalo are similar to other ruminants although there are some important differences (Fig. 1). In Mediterranean river buffalo (Mediterranean buffalo), embryos remain in the oviducts for 74 to 100 hours after insemination and reach the uterus at 4.5 to 5.0 day [19]. In Nili-Ravi river buffalo, embryos were found in the oviducts at 85 hours after insemination, and at 4.5 day, most embryos were located in the uterus [20]. Buffalo embryos are at the early morula stage when they reach the uterus at 4.5 to 5.0 day, which in cattle corresponds to 5.0 day or later [21]. In Mediterranean and Nili-Ravi buffalo, compact morulae are observed from 125 to 152 hours after estrus and blastocysts from 141 hours [22]. There is evidence from *in vivo* [20] and *in vitro* [23] studies that buffalo embryos are morphologically advanced by between 12 and 24 hours compared with cattle embryos.

3.2. Blastocyst hatching

Hatching of the blastocyst and direct exposure of the trophectoderm to the uterine environment represents a new phase in embryonic development. There is no

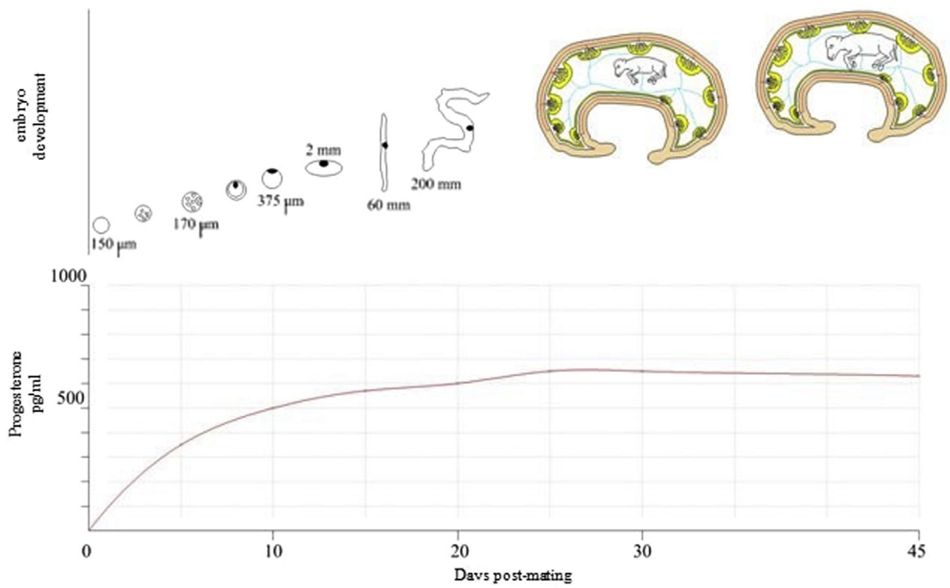

Fig. 1. Embryo development and milk whey progesterone concentrations in buffalo until 45 days after mating.