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Comparison of sperm quality of Belgian Blue and Holstein Friesian bulls

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Abstract

Few data are currently available on sperm quality of Belgian Blue (BB) bulls. The present study compared sperm quality of BB to Holstein Friesian (HF) bulls of several age categories, by means of a classical semen evaluation. Volume and concentration, and consequently total sperm output depended largely on age. Gross, total, and progressive motility, % live and % normal spermatozoa were significantly lower in the BB breed. Primary sperm abnormalities, such as nuclear vacuoles, midpiece defects and cytoplasmic droplets which were noticed most frequently, occurred far more in the BB breed. Hence, disturbances in spermiogenesis are deemed to be the cause of the poorer BB sperm quality. Since these sperm abnormalities occur significantly more in the BB breed than in the HF breed, it seems as if the BB breed is genetically predisposed to a higher susceptibility to environmental stresses which are known to interfere with normal spermiogenesis. The small scrota typical of the inbred BB breed might in part be responsible for this, and therefore selection for larger scrota in the BB breed is advisable.

Keywords: Sperm quality; Bull; Belgian Blue; Holstein Friesian

1. Introduction

Male fertility is an important factor in bovine reproduction since a single pasture bull is generally bred to numerous cows. Hence, evaluation of male fertility prior to breeding is of paramount importance to achieve breeding success. To this purpose, breeding soundness evaluations of bulls have been used over the past 50 years and are widely accepted [1,2]. The evaluation of potential breeding soundness of a bull consists of several aspects, among which semen quality evaluation is a substantial element [3–5]. Furthermore, artificial insemination (AI) has become common practice in bovine reproduction, enabling the use of semen of any given bull on a large number of cows. Cryopreserved semen of good quality is imperative in order to obtain acceptable non-return and/or conception rates [6].

Overall, semen analysis is probably the most relevant procedure to evaluate male fertility potential [6–10]. Several methods can be used to evaluate the quality of a fresh ejaculate or of frozen-thawed semen, but subjective evaluation using standard optical microscopy is by far most commonly used. The semen parameters that are routinely examined using standard optical microscopy are the concentration, the percentage of motile spermatozoa and the morphological

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grading of the sperm cells [6,11]. Concentration can be determined in different ways, such as by means of a hemocytometer, a spectrophotometer, flow cytometrically, and by means of computer assisted sperm analysis [12]. Motility, both total and progressive, is generally estimated subjectively on a pre-warmed glass slide. Sperm morphology is the most reliable criterion to qualify an ejaculate, since it is least influenced by the collection process [5]. Morphology can be assessed using different techniques, but supravital staining procedures such as eosin–nigrosin staining are commonly used and allow both a morphology differentiation and a live-dead assessment [13]. This live-dead assessment is based on the physical intactness (i.e. structural integrity) of the membranes, only allowing the stain to penetrate the damaged sperm cells, resulting in both eosin penetrated (dead) and unstained (live) spermatozoa.

In Belgium, the two predominant cattle breeds are the Belgian Blue (BB) for beef, and the Holstein Friesian (HF) for dairy. The BB breed stems from the Durham Shorthorn, which was introduced in Belgium in 1841 and crossed with local dairy breeds, resulting in a breed called the ''Blue of Limon'' which was further mixed with local breeds. In 1938, selection for a white colour was started, resulting in the ''White breed of Middle and High Belgium''. Based on a limited number of well muscled animals, selection for a better muscularity was started, which finally led to the present hyper muscled BB breed, which is famous for its low feed conversion ratio and its extremely high percentage of lean meat [14].

In contrast to the HF breed, data on semen quality of BB bulls are scarce. However, recently, a suboptimal semen quality in BB bulls was demonstrated, although this study only reported on a few semen parameters [15]. The aims of the present study were to evaluate and compare the semen quality of the two predominant cattle breeds in Belgium, namely the BB beef breed and the HF dairy breed, with special emphasis on sperm morphology.

2. Materials and methods

2.1. Study population

From February 2002 to February 2004, semen quality of 158 Belgian Blue (BB) bulls in Belgium and 270 Holstein Friesian (HF) bulls in The Netherlands (since no HF AI bulls are present in Belgium) was assessed. All semen samples were collected by means of an artificial vagina. In order to increase the efficiency of data gathering, the semen samples were collected at AI centres. To this end, the AI centres were visited four times a year and all the collected semen samples were examined.

The BB AI bulls were purchased from selection centres as well as from private farms based on their linear classification, which is a scoring system describing several physical characteristics of the bull (concerning size, muscular development, meaty type, stand and general appearance), and after a quarantine period of one month, they were accepted for AI purposes without further selection. However, bulls with poor libido or repeated poor semen motility before ($<$60% progressive motility) and after ($<$30% of total or $<$15% of progressive motility) cryopreservation were discarded keeping only ''more fertile'' bulls with increasing age. Furthermore, aggressive or injured bulls were also eliminated. This selection procedure resulted in three groups of BB bulls which could arbitrarily be divided as follows: (1) the unselected youngest bulls ($<$2 years), (2) the active breeding bulls between 2 and 4 years old which were intensively selected, and (3) the bulls of proven fertility of over 4 years of age considered to be veterans which survived culling for different reasons.

This was in contrast to the HF bulls, where bull calves were purchased based on their expected genetic value. At approximately 11 months of age, these bulls were transferred to an AI facility, where, after a quarantine period of 1 month semen was collected. Only when these bulls passed a strict semen quality test (two consecutive ejaculates collected with 3 or 4 days interval $\geq$2 mL containing $\geq 600 \times 10^6$ spermatozoa/mL, with $\geq$65% motility, $\geq$80% normal morphology and $\geq$50% intact acrosomes) were they accepted for AI purposes.

When an accepted bull had produced 3000 straws, which was in average at approximately 14.5 months of age, semen collection was stopped for at least 3 years until the milk production data of his daughters became available. Only those progeny-tested bulls with good production indices were kept and semen collection was then restarted. This system resulted in three groups comparable to the three groups of BB bulls: (1) an unselected young group, (2) a group of selected young bulls that passed an initial semen quality test, and (3) a group of old bulls with good production indices in progeny tests that passed the semen quality test when they were young. Hence four comparisons were made:

1. The unselected young HF and BB bulls $<$2 years of age, hereafter referred to as ''the unselected bulls'';