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Feeding programs promoting daily feed intake stability in rabbit males reduce sperm abnormalities and improve fertility

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ABSTRACT

Feeding programs promoting daily feed intake (DFI) stability in rabbit males could be useful to ensure successful coverage of their nutritional requirements and for continued production of quality semen. To evaluate two feeding systems designed to reduce DFI variability, 115 rabbit males at age 1.2 years were randomly assigned to three different treatments for 294 days: CS, animals fed *ad libitum* with a control diet (127-g starch and 281-g total soluble fiber [hemicellulose + soluble fiber] kg^{-1} dry matter); SF, males fed *ad libitum* with diet enriched in soluble fiber (86-g starch and 330-g total soluble fiber kg^{-1} dry matter); and R, animals fed with CS diet but daily restricted to maintenance requirements. Feed intake, body weight, body condition, and variability of DFI were controlled every 42 days, and individual semen volume and sperm motility, concentration, acrosome status, and abnormalities every 15 days. In six commercial farms, the number of females inseminated, pregnant and kindling, as well as the number of kits born alive, was registered for 15,893 inseminations with pooled semen from each treatment. DFI was significantly lower for R males than for the other treatments (on average, -12 ± 4 g/day; $P < 0.001$). Daily weight gain of R males was close to zero and significantly lower than in the other groups (-1.42 g/day; $P < 0.001$). Variability of DFI was significantly ($P < 0.01$) lower for R males (7%) than for males of dietary treatments CS (13%), with SF males showing intermediate values (11%). Semen from R males presented lower sperm abnormalities (-5.9%; $P < 0.05$) and higher percentages of normal and motile spermatozoa (-3.4% than SF males; $P < 0.05$). Dietary treatments formulated to reduce DFI variability (SF and R) led to an improvement of kindling to pregnant and kindling to insemination ratio ($+0.039$ and $+ 0.060 \pm 0.015$, respectively; $P < 0.05$) compared with CS treatment. In conclusion, a moderate restriction of rabbit males may be useful to fit their needs and provide a constant daily supply of nutrients, with some sperm morphologic characteristics being improved, as well as the fertility of their pooled semen.

1. Introduction

The great development undergone by the practice of artificial insemination (AI) in modern rabbit farming over the last two decades encouraged the emergence of specific farms of rabbit males for semen production. From that

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moment on, the development of specific feeds for rabbit males began to make more sense, taking into account their nutritional needs and the purpose of their breeding, the production of high quality semen for dissemination [1,2].

However, there is not much scientific knowledge on adequate feeding programs for rabbit males, and even a lack of recommendations to cover their nutritional requirements in the most recent and accepted literature [3]. Although some of the studies have been addressed to determining the effect of dietary energy [4,5] and protein content [6] on the seminal production of these animals, most of the literature on this topic has focused on evaluating the effect of supplementation with micronutrients (n-3 fatty acids, vitamins, trace minerals, and so forth) on sperm membrane fluidity and integrity, or as antioxidants to prevent the high susceptibility to peroxidation of the highly unsaturated spermatozoa membrane (reviewed by Castellini et al. [2]).

On the other hand, an additional problem with this type of animals could be due to their feeding behavior. As animals under low production conditions (close to maintenance), rabbit males could show a lack of regular consumption. Pascual et al. [5] observed that adult males show periods of high consumption that can lead to overfattening, sometimes associated with an increase in abnormal spermatozoa and a high risk of fertility problems [7], and other periods where the animals consume nothing or very little, with the consequent negative effects of occasional undernourishment on semen production and quality [8]. Therefore, the development of a well-adjusted feeding program promoting DFI stability could be useful to cover the nutritional requirements and for ongoing production of quality semen in rabbit males. The simplest method to ensure a constant intake is by daily feed restriction. Although excessive feed restriction in males is not recommended [9], adjustment of feeding to daily needs has been proposed as useful to reduce problems associated with fatness [8] and ensure a regulate DFI. An alternative to feed restriction could be the *ad libitum* provision of diets enriched with soluble fiber (SF). High water-binding capacity of SF in some feedstuffs (such as pulps), which promotes digestive tract filling [10], could also be useful to regulate the voluntary feed intake of animals with overfeeding tendency.

Therefore, the present study evaluated two feeding systems designed to reduce daily feed intake (DFI) variability, either by daily restriction to maintenance requirements or increasing the level of dietary SF, as well as their effect on semen characteristics and fertility in commercial farms.

2. Materials and methods

2.1. Animals and housing

A total of 115 adult rabbit males aged 1.18 ± 0.22 years and weighing 5.40 ± 1.00 kg were used in this trial. Rabbit males belonged to three different genetic types: Hyplus PS40 paternal line (Grimaud Frères, n = 62), Caldes paternal line (IRTA, n = 24), and Prat maternal line (IRTA, n = 29), housed in the same room at the INCO Artificial Insemination Center (Valderrobres, Teruel, Spain). Previously, males were trained for 3 weeks and selected for semen production when 20 weeks old (selection was performed according to their libido and adaptation to an artificial vagina) and housed in individual wire cages designed for rabbit males in AI (60 × 50 × 50 cm), all equipped with slats, feeders, and cup drinkers. From selection to culling, the males were subject to the same semen collection management, two ejaculates a week.

Housing and husbandry conditions followed the current recommendations on principles of ethical care and protection of animals used for experimental purposes in the European Union [11]. Animals were housed with light altering on a cycle of 16 light hours and 8 dark hours, and the room was equipped with environmental control equipment such as hot air heaters or cooling systems (trying to maintain the temperature at 20 °C in summer and 18 °C in winter). Figure 1 shows the status of daily maximum and minimum temperatures in the experimental room throughout the trial.

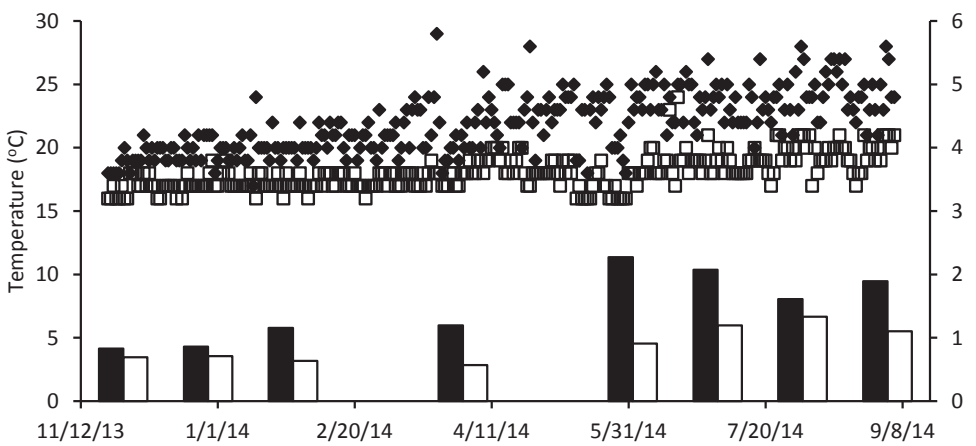

Fig. 1. Evolution of maximum (◆) and minimum (□) temperatures in the experimental farm throughout the trial, as well as the standard deviation of maximum (black bars) and minimum (white bars) temperatures during the previous 45 days.