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HEREDITARY ASPECTS RELATED TO MATERNAL-FILIAL BEHAVIOR AND CALF SURVIVAL

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Abstract: The behavior displayed by the cow and the calf in the peripartum has a great impact on the survival of the calf, and therefore, on the productivity of breeding systems. Such behaviors depend on factors intrinsic to the calf, its mother's behavior, and environmental causes. In this article, a review of the literature concerning hereditary aspects of maternal-offspring behavior that impact the survival of calves is presented.
Keywords: Behavioral patterns, behavioral genetics, calves, environment.

LITERATURE REVIEW

In this article, known forms of inheritance will be discussed, related to maternal care and the vigor and survival of the calf, which include genetic components responsible for the constitution of the individual (from the point of view of musculoskeletal conformation, neuroendocrine, digestive, thermoregulatory, among others), which may play an important role in determining the calf's survival potential.

MATERNAL EFFECT

All inheritable traits have what is called a **direct component (or effect)**, that is, the effect of an individual's genes on his or her performance. Some features, in addition to the direct component, also present a **maternal component (or effect)**, which refers to the effect of an individual's mother's genes influencing the performance of the individual, through the environment provided by the mother to the offspring (BOURDON, 2000).).

At the beginning of the 20th century (20s and 30s) the interactions between genotypes and environments began to be studied, and the influence of the mother on the offspring (through care and nutrients provided by the uterus and mammary gland) began to be considered. as a special case of joint action between genotype and environment, in which the expression of the maternal genotype was assumed to be an environmental influence on the offspring (ROBISON, 1972). Thus, the mother contributes in at least two ways to the phenotypic value of the progeny (through the maternal effect and the sampling of half of the maternal genes), while the father contributes only with the sample of half of his genes (Willham, 1972). In turn, maternal performance can be influenced by both genetic and environmental causes, related to the level of food, and extreme weather conditions, among others (BRADFORD, 1972; LEGATES, 1972).The environmental effects that the mother exerts on the offspring can undergo temporary variations (annual variations), resulting in differentiated milk productions between years, or permanent, related to the genetic potential of milk production, defining: the **temporary environment** effect as the maternal environment effect that influences an individual's productive potential for one production cycle or more, but not permanently; the **permanent environment** effect the maternal environment effect that permanently influences an individual's performance (for the calf, in the case); and the **common environment** effect, which refers to the increase in similarity of performance between family members, caused by having shared the same maternal environment (BOURDON, 2000). From a practical point of view, the identification of effects of the temporary maternal environment can be of great importance for producers, since they can be changed by management, while effects of the permanent maternal environment, although often beyond the control of the producers, has great importance for genetic improvement (SAATCI et al., 1999).

Paternal half-siblings provide the main estimate for the additive genetic contribution of individual effects (KOCH, 1972). However, estimation of maternal effects and corresponding genetic parameters have been considered inherently problematic, where not only are direct and maternal effects often confounded (except in cases of embryo transfer and exchanges between mothers and offspring), but also the expression of maternal and maternal effects. be limited by sex, occur later in the female's life, and have a gap (or "gap") of one generation (MEYER, 1997). Thus, the range of variation regarding a cow's permanent environment can vary if the ½ sibs are from adjacent calving or separated by two years or more, as characteristics such as milk production undergo changes throughout the cow's productive life. 1972).

The main purpose of isolating the maternal effect is to increase the accuracy in measuring the direct genetic merit of an individual, which can also be useful to improve maternal ability (THOMPSON, 1976).

According to ALENCAR et al. (1988), maternal ability is of fundamental importance in any beef cattle farm. Maternal ability refers to the expression of maternal effects and comprises characteristics related to feeding and protection provided to the offspring by the mother, during pregnancy and between birth and weaning (LEGATES, 1972).

Maternal ability is usually measured through calf weight performance, referring to differences in birth weight or gain rates between birth and weaning, conditioned by the maternal environment provided by cows during gestation and suckling, with weight being at weaning used as the main indicator of maternal ability (KOCH, 1972; AMAL & CROW, 1989; NOTTER & CUNDIFF, 1991). According to FRIES & ALBUQUERQUE (1998), in studies of genetic improvement, the maternal effect of milk production is translated almost literally, understanding the weight of the calf at weaning as an indication of the cow's milk production. However, PARANHOS DA COSTA et al. (1998) commented that in beef cattle this correlation is not consistent, since calf performance until weaning can be influenced by factors other than maternal milk production, where calf behavior itself can be an important variable on your performance. In addition, environmental characteristics, such as the quality and quantity of forage supply in the pastures that are kept until weaning, or the supply of food supplements during the suckling phase, can also influence the calf's weight gain.

TRUS & WILTON (1988) stated that the role of maternal behavior in beef cattle may be underestimated. According to CROMBERG & PARANHOS DA COSTA (1997), a more adequate selection must take into account behavioral characteristics related to ease of suckling and maternal ability. SAATCI et al. (1999) drew attention to the fact that the models traditionally used ignore maternal factors related to the survival of the products, since those who died are not included in the database.

GENETIC PARAMETERS OF MATERNAL ABILITY ASSOCIATED WITH VIGOR AND SURVIVAL OF CALVES

Survival-related traits may be associated with the direct component of the young animal's genes, which affect its physical integrity, immune response and survival instinct, and the maternal component, linked to the mother's ability to nourish and protect the offspring (BOURDON, 2000).

Reported heritability estimates for survival are usually of low magnitude, with values ranging between 0.04 and 0.10, with no consistent race effects (GREGORY et al., 1978a; BAILEY & MOORE, 1980; MARTINEZ et al., 1983; CUBAS et al., 1991; VOSTORÝ et al., 2015; FUEST-WALT & SØRENSEN, 2010; BUNTER & JOHNSTON, 2013). These results may be conditioned by the reduced mortality rates reported in many of the studies consulted, as well as the statistical tools used, as this characteristic has a binomial distribution, and the analyzes performed in these studies considered it to have a normal distribution.

Greater evidence of variability regarding the survival of calves is reported in studies that compare the percentage of survival between breeds and between bulls, highlighting studies such as that by RILEY et al. (2001), who, in a study in Texas (USA), found differences between paternal breeds for the number of calves born and the survival rate of calves until weaning, concluding that crosses of Nelore and Gir, but not of Indubrasil, could present reproductive performance as good as, or even superior to, breeds traditionally used in American crossbreeding programs, and that of KINDAHL et al. (2002), who found the existence of Swiss Friesian bulls producing a high incidence of stillbirths, ranging from 2 to 27%.

There are indications that the fetal growth pattern has a genetic basis (ROBINSON et al., 1999). Changes in this pattern can lead to variations in birth weight, a characteristic that is highly linked to survival. Moderate to high heritability estimates for birth weight have been presented, with values ranging from 0.12 to 0.80, and repeatability estimates ranging from 0.16 to 0.21, in which breed, sire and year effects have been commonly reported (BROWN & GALVEZ, 1969; KALIL et al., 1978; ITULYA et al., 1987; CANTET et al., 1988; CASANOVA et al., 1999; KOÇAK et al., 2007).

The results found in the literature, regarding genetic parameters associated with dystocia, have been quite divergent, with heritability estimates ranging from 0.07 to 0.43, and repeatability of 0.11, with a significant relationship having also been described (P< 0.05) and positive between the heifer's mother's dystocia score and her own dystocia score at first calving, where effects of paternal and maternal breeds have generally been reported, also indicating that there is variation between populations (GREGORY et al., 1978a; MARTINEZ et al., 1983; RUTTER, 1983; CUBAS et al., 1991; CASANOVA et al., 1999; BENNETT & GREGORY, 2001).

The duration of gestation has shown effects of paternal and maternal race, with a low magnitude repeatability estimate (0.17), which was suggested as an indication of the importance of the calf genotype for this trait (GREGORY et al., 1978a; MCGUIRK). et al., 1998; CASANOVA et al., 1999).

Milk production has been consistently reported to be dependent on genetic factors, with heritability estimates ranging between 0.18 and 0.46, and repeatability values between 0.23 and 0.28 (ALBUQUERQUE et al, 1993; MILLER & WILTON, 1999; SNOWDER et al., 2001).

As for the characteristics of teat size and udder conformation, moderate to high heritability estimates have been presented, with values ranging between 0.10 and 0.67, with an estimate of mastitis resistance of the order of 0.25, and reported moderate genetic correlation between teat and body characteristics, such as height and body length, with indications of variation between races (VANVLECK, 1964; SEYKORA & MCDANIEL, 1985; SMITH et al., 1985; LE NEINDRE, 1989, RILEY et al., 2001).

The concentration of immunoglobulins in cow's milk and calf's blood, despite an important environmental influence, has shown variation between lines and between paternal and maternal breeds, resulting from genetic variations of the cow in terms of immunoglobulin production, maternal behavior and variations fetal genetics that influence colostrum production, and in terms of vigor and intestinal permeability of the calf, with heritability estimates reported between 0.02 and 0.69, and relatively high repeatability (value citations were not found), indicating that the differences in the level of immunoglobulins observed between cows are due, at least in part, to genetic differences, also suggesting the possibility of practicing selection for different absorption rates of the calf (JENSEN & CHRISTENSEN, 1975; STOTT et al., 1979). ; NORMAN & HOHENBOKEN, 1981; MUGGLI et al., 1984; DONOVAN et al., 1986; MACHADO NETO et al., 1997).

INHERITANCE OF BEHAVIOR

The similarity between the behavior of relatives can be explained in several ways (BATESON, 1983). There are, however, two main ways in which behavior is inherited or passed on to the next generation. One concerns the inheritance of genetic material from the parents. For example, TRYON (1934), through selective crosses, established the formation of two strains of rats, which were distinct in terms of behavior, making it apparent that they were determined by differences in the genetic constitution between the strains.

According to Burrow (1997), behaviors in farmed species are innate (under genetic control) or learned, and it is possible that most of the behaviors learned in beef cattle are acquired as a result of the mother's influence on her offspring.

Learned behaviors, when passed on to subsequent generations, can be referred to as behavioral inheritance, in which behaviors dispensed to the puppy by the parents and/or social group, especially during the early stages of life, can influence the puppy's way of acting in future situations, for example in maternity, presenting this behavioral pattern to the progeny.

In addition, knowledge of behavior patterns, such as the maternal behavior, allows humans to respond appropriately to the needs of animals and avoid errors that may result in injuries and economic losses (PARANHOS DA COSTA et al., 1996).

The selection of behavioral traits has been practiced since man began to create animals, as he reproduced and kept in the herd only those that best fit the desirable behavioral responses (BUCHENAUER, 1999).

Currently, it is accepted that behavioral variation between species, populations and individuals often has a genetic basis (PARTRIDGE, 1983). According to HALLIDAY & SLATER (1983) it is difficult to think of any behavioral characteristic where it is negligible, or which is not subject to change through selection.

According to Murphey (1998), although the pure demonstration that behavior variation is related to genetic variation may seem trivial nowadays, it is necessary as a first step towards more specific goals. In the past, genetic analysis of behavior often consisted of selection experiments that determined the degree to which the variance of a specific behavioral pattern was genetically based, as well as general comparisons between animals that were known to be genetically different, looking at how their behaviors matched. changed (HALLIDAY & SLATER, 1983). Most current research focusing on genetic variation of behavioral traits is based on cross-breed comparisons, rather than within-breed comparisons of genetic variation (SIMM et al., 1996; BUCHENAUER, 1999).

Behavioral genetics can be studied from several angles, including: the importance of genetic variability in producing behavioral variability; the importance of genes in the presentation of normal behavior patterns; the way behavior is linked to the nervous system and other structures; the study of behavioral

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differences that have a recognized genetic origin, et cetera (PARTRIDGE, 1983).

However, the evaluation of the genetic components of behavior is difficult to be carried out, as behavioral measures are usually of long duration, thus making it difficult to obtain sufficient data for genetic analysis. magnitude of the intervals between generations, the reduced progeny obtained in a reproductive cycle, as well as the late sexual maturation of the animals (BUCHENAUER, 1999).

The genetic inheritance of behavior involves the genetic analysis of behavioral phenotypes. This genetic background, the environment, and the interaction between them result in the phenotypic expression of a behavior (GRANDIN & DEESING, 1998). Previous experiences among observed animals may lead to differences in heritability estimates. Vanvleck (1964) reported that heritability estimates for temperament are considerably different for older and younger animals, with heritability estimated at around 0.16 for young cows and close to zero for older cows, which indicates the importance to consider this factor, in order to minimize the confusion between what is genetic and what is environmental (BUCHENAUER, 1999).

In a review on behavioral genetics, BUCHENAUER (1999) stated that the estimates of heritability of maternal behavior found in the literature are quite scarce, and the number of data used is also quite small. According to Hohenboken (1986), the importance of genetic variability in the behavior of farmed animals has been the subject of only sporadic investigations, with relatively few specific experiments that have examined genetic variation in behavioral traits within populations of farmed animals.

BUCHENAUER (1999) reported that the estimated heritability values indicate that most behavioral traits would respond to selection. However, these traits typically have a polygenic inheritance pattern, in which many loci are responsible for variations in a single pattern of behavior, which in turn tends to include activities that involve the entire organism, causing selection for a trait to occur. behavior often incurs changes (behavioral or otherwise) in other trait(s), with indications that genes affected by selection for behavior may also be related to developmental traits (PARTRIDGE, 1983; MURPHEY, 1998; TRUT). , 1998; BUCHENAUER, 1999; GAULY et al., 2001). According to Burrow (1997) the nature and magnitude of the relationships between behavior and other productive and adaptive characteristics need to be quantified in order to predict the possible consequences of behavioral changes resulting from traditional selection processes.

There is evidence that aspects of maternal behavior are heritable (DWYER & LAWRENCE, 1998). Some articles have registered differences between lines, correlated responses to selection, differences between groups of monozygotic twins, and chromosomal or gene effects on various behavioral traits (PARTRIDGE, 1983). The author also stated that strains selected for extreme values gradually diverge over generations, evidencing that much of the phenotypic behavioral variability observed in unselected populations has a genetic basis, citing examples of successfully selected traits in this sense, which include spontaneous activity in rats, preference for alcohol in mice, reproductive behavior in chickens, among others. There is evidence that the genetic constitution of an animal can influence the intensity of fear reactions (GRANDIN & DEESING, 1998). FRASER & BROOM (1994) stated that there is a lot of variability between the behavior of mothers of different species, as well as within the same species.

Racial and individual differences were

observed between ewes in relation to maternal behavior, regarding the frequency of response to the calls of their lambs, the propensity to abandon them, the presentation of aggressive behavior towards them, the time dedicated to their care, the behaviors that make breastfeeding difficult and the time they remained lying down; and among lambs, in relation to vigor and intensity with which they try to suckle, which resulted in racial differences in relation to the number of lambs that suckled unaided, and this fact was directly related to differences in mortality rates and weights. at weaning (HOLTMANN & BERNARD, 1969; O'CONNOR et al., 1985; SIMM et al., 1996; DWYER & LAWRENCE, 1998).

In cattle, variability in maternal behavior and calf vigor has been reported both between beef and dairy breeds. There is consistency among the studies found, favoring beef breeds, reporting differences regarding the intensity of maternal behavior, the readiness to start it, the frequency of cows that are not interested in the calf, differences in shape, size and insertion udder and teats; and in relation to the calf, differences were observed in terms of vigor, latency to stand, suckling impulse and suckling latency. These differences were associated with the differentiated selection that has been practiced between beef and dairy cattle, possibly resulting from a relaxation in the selection for these traits in dairy cattle for many generations, contrary to what occurs with beef cattle (BRINGNOLE & STOT, 1980; LE NEINDRE, 1995; GRANDIN & DEESING, 1998; BUCHENAUER, 1999).

Behavioral differences between European beef cattle and Zebu cattle have also been described, with Zebu cows reported to remain longer with their calves and express agonistic behaviors against calves of other cows more frequently than crossbred, and that European calves were faster to stand up after birth compared to zebu (PARANHOS DA COSTA & CROMBERG, 1998; DAS et al., 2001; BUENO, 2002).

In a study evaluating Angus, Hereford, Charolais and Red Poll cows, it was found that the former paid more attention to their calves, as well as being more aggressive towards the cowboys (BUCHENAUER, 1999). Comparing Nelore crosses with Angus and with Simmental, the occurrence of lower latencies ($P<0.01$) for standing and suckling for the first cross was reported, and no differences were detected in relation to maternal behavior between crosses (BUENO, 2002). Evaluating the maternal-offspring behavior of three zebu breeds (Nelore, Guzerá and Gir) and one taurine (Caracu) behavioral variation was identified between taurine and zebu, in which Caracu and Nellore calves suckled in a shorter time after birth than Guzerá and Gir (PARANHOS DA COSTA & CROMBERG, 1998). These same authors reported a higher percentage of time in contact between the cow and the calf ($P<0.05$) for the Nellore breed, compared to the Guzerá and Gir.

Evaluating Limousin heifers in a progeny test, LE NEINDRE et al. (1995) stated that docility was significantly influenced by the bull, presenting heritability estimates for docility between 0.18 and 0.22. They reported that the main sources of variation regarding differences in docility were related to management and genetic variability, which was highly significant in this experiment. Thus, among the 34 bulls evaluated, eight had a desirable genetic index for docility score, and four had a less desirable index. However, Grandin & Deesing (1998) emphasized that the selection for low reactivity, through traditional crossing methods, can cause serious damages to the productive system, because a cow with these characteristics may not take such good care of her calf, perhaps she also does not defend it from predators as much as necessary, that grazing animals may not have the necessary motivation to walk long distances in search of better pastures, and there must be a good intermediary between extreme temperaments, between nothing and very reactive.

BUCHENAUER (1999) cited a single study that estimated the heritability of maternal temperament, in which BROWN (1974) obtained heritability estimates for maternal temperament scores in beef cattle, presenting values of 0.17 for Angus (N=266) and 0. .32 for Hereford (N=162). With another approach, EDWARDS (1982) suggested the existence of a direct genetic effect of calf vigor, with differences in the vigor of progenies of different Holstein bulls.

Hohenboken (1986) emphasizes that important questions for future research must not be so much whether hereditary differences exist, but why they exist and the best ways to manipulate such differences in order to achieve human and animal welfare.

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