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Induction and synchronization of estrus with exogenous hormones and sexual biostimulation in multiparous sows at weaning

Inducción y sincronización del estro con hormonas exógenas y bioestimulación sexual en cerdas multíparas al destete

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ABSTRACT

The aim of the present study was to evaluate whether boar biostimulation is sufficient to stimulate the sexual response of multiparous sows at weaning. In general, independently of the experimental group, 70% of the sows responded to estrus. The percentage of females that responded to estrus was higher in the control group (CG), than in the biostimulated group (BG) ($P < 0.05$). The vocalizations and nudging were higher in the CG than in the BG, on days 3 and 5 ($P < 0.05$). On the other hand, the sexual behavior of the boar was greater when were exposed to CG than to BG of females ($P < 0.05$). There was an increase in days 3 and 5 in the nudging, anogenital sniffing, vocalizations and mounting without or with ejaculation in the male exposed to the females of the CG than to the BG ($P < 0.05$). In conclusion, the boar's sexual biostimulation is not enough to provoke the sexual response of sows during weaning.

Keywords: Sexual bioestimulation, behavior, lateral attacks, pheromones, salivation.

RESUMEN

El objetivo del presente estudio fue evaluar si la bioestimulación del verraco es suficiente para estimular la respuesta sexual de las cerdas multíparas al destete. En general, independientemente del grupo experimental el 70% de las cerdas respondieron al estro. El porcentaje de hembras que respondieron al estro fue mayor en el grupo testigo (GT), que en el grupo bioestimulado (GB) ($P < 0.05$). Las vocalizaciones y aproximaciones laterales fueron superiores en el GT que en el GB, en los días 3 y 5 ($P < 0.05$). Por su parte, la longitud del estro fue similar en las hembras de ambos grupos ($P > 0.05$). Por otro lado, el comportamiento sexual del verraco fue mayor cuando se expuso al GT que al GB de hembras ($P < 0.05$). Existió un incremento en los días 3 y 5 en las aproximaciones laterales, olfateos anogenitales, vocalizaciones y montas sin o con eyaculación en el macho expuesto a las hembras del GT que al GB ($P < 0.05$). En conclusión, la bioestimulación sexual del verraco no es suficiente para provocar la respuesta sexual de las cerdas durante el destete.

Palabras clave: Bioestimulación sexual, comportamiento, embates laterales, feromonas, salivación.

INTRODUCTION

The world pork production grew 1.6% from 2007 to 2016, in 2017 it reached the historical maximum of 111 million tons of meat, which represents an annual increase of 2.6% (FIRA, 2017). In 2016, China was the main producer of pork (47.9%), followed by the European Union (21.6%), the United States (10.4%) and Brazil (3.4%); together, they contributed 83.4% of total production (USDA-ERS, 2017).

For its part, Mexico only contributed 1.3% of world production, and it is in ninth place, with a production of 1.45 million tons (FIRA, 2017). 76.5% of the national production (millions of tons) was concentrated in Jalisco states (20.7%), Sonora (17.3%), Puebla (11.9%), Yucatán (9.8%), Veracruz (8.8%) and Guanajuato (8.1%) (USDA-FAS, 2017).

Currently imports account for 32% of national consumption, observing a shortage of domestic production. In this context, the state of Oaxaca has a low production (27.9% of meat) and a low number of pigs (201 125 pigs) (FND, 2014, SIAP, 2016). The state's pork industry presents problems of a reproductive nature, which is why it is common to use estrogen synchronization protocols with exogenous hormones to increase the productivity of the sow (Hemsworth and Tilbrook, 2007). There are studies where they mention that more than 90% of the sows synchronized with synthetic hormones (PG-600®) that contain lyophilized serum gonadotropin and freeze-dried chorionic gonadotropin come into heat in a shorter time (Casida, 1935, Estienne *et al*., 2001 Breen *et al*., 2006; Ulguim *et al*., 2018). However, this reproductive technology increases production costs. Therefore, biotechnologies that allow the total or partial reduction of the use of hormones in the pork industry are required. Thus, it has been found that the combination of hormanas with the stimulation of the male causes an improvement in the sexual response of the sows during the breeding (Signoret, 1974, Hughes et al., 1990, Weaver et al., 2014).

Studying the sexual behavior of the stallion during the breeding season is important, since its activity is indicative of whether or not it has adequate plasma levels of testosterone and a high libido, consequently if the sperm are suitable for fecundating the female (Hemsworth and Tilbrook, 2007). There is little evidence of the sexual behavior of commercially used boars, although some studies mention that these males are eliminated when they have problems copulating and because of the low sperm quality (Melrose, 1966, Rasbech, 1969, Hemsworth and Tilbrook, 2007, Kaneko and Koketsu , 2012). It should be noted that the sexual behavior of the male is very varied, although the essential feature is pelvic thrust and penetration with ejaculation. Other components of the boar are attacks towards the posterior region and the flanks; On the other hand, in the goats and rams, anogenital sniffing, flehmen, tongue movement and vocalizations are important (Booth, 1988, Ladewing *et al*., 1980, Fraser and Broom, 1997, Fernández *et al.,* 2018). On the whole, the sexual behavior of the male is essential to stimulate the female irrespective of whether or not synthetic hormones are used.

In the literature there is information on the use of the boar to advance puberty in virgin sows (Brooks and Cole, 1970, Kaneko and Koketsu, 2012); but not to stimulate estrus to multiparous sows at weaning. With this alternative, as in sheep (Martin et al., 2004), goats (Shelton, 1960) and bovines (Roberson *et al*., 1987), the concept can be coined: green, clean and ethical; and with this decrease the use of synthetic hormones and increase animal welfare in pigs (Montossi *et al*., 2014). For the aforementioned, the objective of the present study was to evaluate if boar biostimulation is sufficient to stimulate the sexual response of multiparous sows at weaning.

MATERIAL AND METHODS

Study area

The present study was conducted in the "Rio Grande" community, Villa de Tututepec municipality, Juquila district of Oaxaca state, Mexico. The climate of this region is tropical, the average annual temperature is 27 °C, precipitation of 1,309 mm and coordinates: 16 ° 00'41''LN, 97 ° 30'13''LW (García, 1973).

Animals and treatments

In the experiment a total of 10 sows from 3 to 4 Landrace x Yorkshire calves with 30 d of calving were used; Likewise, two males of the Duroc breed were used. The females were divided into two groups: a control group (GT; n = 5) and a biostimulated group (GB; n = 5); both groups stayed without a male for a month prior to the start of the study. At the beginning of the experiment the GB was separated more than 300 meters away from the GT. In addition, the GT was applied an estrus synchronization protocol, while the GB remained intact. The protocol consisted in the application of a dose of PG-600® (Intervet America Inc., the hormone contains 400 IU of lyophilized serum gonadotropin and 200 IU of lyophilized chorionic gonadotropin) intramuscularly (im), 24 h after the application of the hormone (day one) a male was introduced into both groups of females. At that time and for 6 consecutive days were registered the variables of sexual behavior of females (response to estrus, length of estrus, vocalizations and lateral approaches) and males (attempts to mount, ride with penetration, anogenital sniffs, lateral approaches and vocalizations). The sexual behavior of both sexes was observed and recorded for one hour per group by a previously trained person.

Food and lodging

During the experimental phase the animals were fed a formulated diet and mixed manually (Table 1), provided in the morning (07.00 h, 4.00 kg) and in the afternoon (17:00 h, 4.00 kg), also he provided them with free access water. The animals were housed in pens 2.5 m wide by 6 m long, roofed with asbestos lamina, concrete floor, provided with drinking troughs and feeders.

Table 1. Ingredients of the diet offered to the breeding sows during the experiment.

Ingredients	Value in kilograms
Maize	63.50
Soy	12.00
[1]DDG	6.00
Wheat bran	17.00
Minerals	1.50
	100.00

Mix of ingredients for the diet. 16 % of crude protein (PC). [1]DDG: distillery grains.

Statistical analysis

All data presented in the submitted manuscript were analyzed with the statistical program SYSTAT 13, under a completely randomized design in which each animal was considered as an experimental unit. The data of the sexual behavior variables of the females, the males, and the observation days were analyzed with the Krukal-Wallis test of non-parametric statistics. To compare the means, the Mann-Whitney U test was used (Siegel and Castellan, 1994).

RESULTS AND DISCUSSION

Sexual response of females

In general, independently of the experimental group, 70% of the sows responded to estrus. In fact, the percentage of females that responded to estrus was higher in the GT (5/5, 100%), than in the GB (2/5, 40%, P <0.05). The vocalizations and lateral nudging were superior in the GT (29.8 ± 0.21 and 27.6 ± 0.18 occasions) on days 3 (17.2 ± 0.57), 4 (20 ± 0.56) and 5 (29.8 ± 1.8 occasions), than in the GB (7.8 ± 2.04 and 11 ± 2.28 occasions) days 1 (5.8 ± 1.16), 3 (4 ± 0.94) and 5 (1.2 ± 0.26 occasions, P <0.05). On the other hand, the length of estrus in the females of both groups was similar (44 vs. 49 h, P> 0.05).

The results of the present study are consistent with those reported in other studies where they show that the majority of multiparous sows synchronized with PG-600® responded to estrus in the first 48 h after the application of the hormone (Estienne *et al*., 2001 Breen *et al*., 2006; Ulguim *et al*., 2018). Contrary to these results were reported by Trujillo *et al*., (1997) since only 23.33% of the females showed estrus.

On the other hand, estrus length was similar to that observed naturally (36 h, Soede *et al*., 2011), but different from that reported by other authors when they synchronize estrus with progestogens (Degenstein *et al*., 2008). In the case of vocalizations in pigs and goats are very important at the time of courtship to trigger a sexual response (Booth, 1988, Vielma *et al*., 2009, Martinez *et al*., 2014). In the same way, the lateral approximations are indicative of a high libido in males and very important during sexual biostimulation in sheep and goats (Delgadillo *et al*., 2009, Fernández *et al*., 2018). For example, in sows the vocalizations of the male act synergistically with the olfactory and tactile signals (lateral nudging) in the immobilization of the female to facilitate the copulation, in the red deer it has been demonstrated that the vocalizations of the male advance the moment so that the females enter estrus (Davies, 1986; Signoret, 1974; Tilbrook and Hemmsworth, 1990; Garcia *et al*., 2013).

The results reported in these investigations are consistent with those of the present study in the case of vocalizations and lateral nudging. In the case of the GT of the present study, they were higher in the days while the females were approaching the moment of estrus; this is probably due to the pheromones released by the females. Contrarily in the GB they occurred in the first 3 days of contact, evidently it was presented in the only females that presented estrus. These results are interesting since the presentation of estrus allows a greater stimulation of the male and synergistically this potentiates the stimulation of the sow to display an intense sexual behavior.

Sexual behavior of males

The sexual behavior was greater in the boar exposed to the GT of females than to the GB ($P < 0.05$). In fact, there was an increase on days 3 and 5 in the lateral nudging, anogenital sniffing, vocalizations and mounts without and with ejaculation in the male exposed to the females of the GT that, at GB, anogenital sniffing and vocalizations ($P < 0.05$; Figure 1).

The sexual behavior of the male is very varied, although the essential characteristic is pelvic thrust and penetration with ejaculation. Other components such as anogenital sniffing, flehmen, tongue movement and vocalizations are indicative of goats and rams (Ladewing *et al.,* 1980, Fraser and Broom, 1997, Martínez *et al*., 2014, Damián *et al*., 2018). . In effect, these results are similar to the sexual behavior displayed by the photo-stimulated goats when they are exposed to anestric goats. The number of lateral nudging and the anogenital sniffing increase in the first days of contact between both sexes, (Ponce *et al*., 2014, Fernández *et al*., 2018).

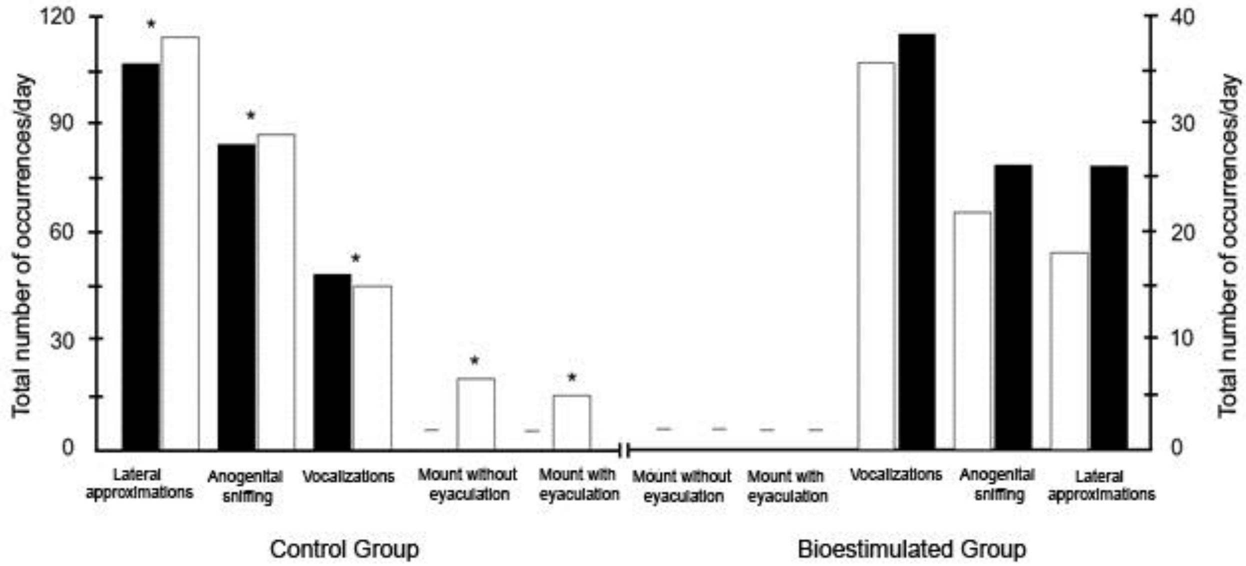

Figure 1. Sexual behavior displayed by the boar days 3 (■) and 5 (□) contact between the sexes, for each variable (lateral nudging, anogenital sniffing, vocalizations and mount without and with ejaculation). The control group on the left side and the biostimulated group on the right side, the - indicates zero behavior, * represents significant difference between groups (P <0.05).

In the case of the boar this happened as well since the sexual behavior was more intense on days 3 and 5 after the introduction; the high sexual behavior displayed by the GT males in these first days was probably due to the olfactory motivation perceived by the male due to the release of pheromones by the females since it coincided with the occurrence of estrus in all the sows (Booth, 1988 Petrulis, 2013). Likewise, the vocalizations are similar to those reported in synchronized sows put in contact with a boar (Signoret, 1974). This was because at that time there was greater social interaction between the two sexes, therefore, they had good auditory stimulation that allowed them to respond in this way. The findings found in this study are outstanding since the presence of the male potentiates the sexual response of the females provided they are previously synchronized with exogenous hormones. It would be interesting to look for alternatives to increase the response of the sows to the male stimulation , this in order to decrease the application of synthetic hormones and increase animal welfare.

CONCLUSION

The boar's sexual biostimulation is not enough to provoke the sexual response of the sows. However, the combination of exogenous hormones with the boar's sexual biostimulation stimulates the sexual response of multiparous sows at weaning.

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