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Altering prolactin concentrations in sows

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ABSTRACT

Prolactin has a multiplicity of actions, but it is of particular importance in gestating and lactating animals. In sows, it is involved in the control of mammary development and also holds essential roles in the lactogenic and galactopoietic processes. Furthermore, low circulating concentrations of prolactin are associated with the agalactia syndrome. The crucial role of prolactin makes it important to understand the various factors that can alter its secretion. Regulation of prolactin secretion is largely under the negative control of dopamine, and dopamine agonists consistently decrease prolactin concentrations in sows. On the other hand, injections of dopamine antagonists can enhance circulating prolactin concentrations. Besides pharmacologic agents, many other factors can also alter prolactin concentrations in sows. The use of Chinese-derived breeds, for instance, leads to increased prolactin concentrations in lactating sows compared with standard European white breeds. Numerous husbandry and feeding practices also have a potential impact on prolactin concentrations in sows. Factors, such as provision of nest-building material prepartum, housing at farrowing, high ambient temperature, stress, transient weaning, exogenous thyrotropin-releasing factor, exogenous growth hormone-releasing factor, nursing frequency, prolonged photoperiod, fasting, increased protein and/or energy intake, altered energy sources, feeding high-fiber diets, sorghum ergot or plant extracts, were all studied with respect to their prolactinemic properties. Although some of these practices do indeed affect circulating prolactin concentrations, none leads to changes as drastic as those brought about by dopamine agonists or antagonists. It appears that the numerous factors regulating prolactin concentrations in sows are still not fully elucidated, and that studies to develop novel applicable ways of increasing prolactin concentrations in sows are warranted.

1. Introduction

Prolactin is a peptidic hormone that is present in all vertebrates and is known for its great versatility in terms of biological functions. It is not only involved in the lactation process but also in metabolism, osmoregulation, behavior, and immunoregulation [1]. It is mainly secreted from the lactotroph cells of the anterior pituitary and has a very unique neuroendocrine control whereby it is predominantly under hypothalamic inhibition [2]. This is not seen in any other hormones and can be attributed to the diversity of target cells by prolactin and to the fact that lactotroph cells have a high basal secretory activity [3].

The key role of prolactin for lactation is most important in swine because sow milk yield is a crucial determinant of suckling pig performance, and it is in fact a limiting factor for piglet growth rate [4]. An early study indicated that serum concentrations of the hormone prolactin are lower 41 to 58 h postpartum in sows with lactation failure (mastitis-metritis-agalactia syndrome) compared with unaffected sows [5]. Prolactin concentrations were also reported to be lower during later lactation in sows with disturbed milk production [6]. This hormone was clearly demonstrated as being a major effector of sow milk yield by

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playing an essential role for mammary development in late gestation [7,8], and for the initiation and the maintenance of milk production throughout lactation [9]. Recent results also suggest a relationship between circulating prolactin concentrations 30 to 40 h prepartum and colostrum yield in sows [10].

The control of prolactin secretion is largely under the negative regulation of dopamine. Hence, dopamine agonists are given to inhibit prolactin secretion [7–9,11,12], whereas dopamine antagonists can increase prolactin concentrations [13,14]. However, numerous other factors can also influence circulating prolactin concentrations in sows. This review will cover the effects of using dopamine agonists and antagonists in late-pregnant and lactating sows on their circulating prolactin concentrations. It will also describe the various genetic, management, housing, nutritional, hormonal, and environmental variables that can come into play to alter prolactin secretion during late pregnancy and lactation. A global overview of the effects of various treatments on prolactin concentrations in gestating or lactating sows is shown in Table 1.

2. Prolactin concentrations in sows

2.1. Gestation

The first report on prolactin concentrations in pregnant sows showed concentrations as high as 140 ng/mL at mid or late gestation [29]. Yet, in more recent studies, plasma prolactin concentrations were reported to be low (below 10 ng/mL) during most of gestation [81–83] and increased during the last 2 wk prefarrowing to reach values between 45 and 70 ng/mL [56,82,83]. Van Landeghem and Van de Wiel [22] appear to be the first to have demonstrated the prepartum increase in circulating prolactin concentrations in sows, which was corroborated by various other authors [9,81,82]. Values for this peak were generally around 100 ng/mL [22,81] but could be as high as 280 ng/mL [9].

2.2. Lactation and the nursing stimulus

Studies aiming to determine circulating concentrations of prolactin in sows were first carried out in the 1970s and were linked to the development of porcine prolactin radioimmunoassays. Concentrations of prolactin were shown to be greatest around farrowing, reaching values above 100 ng/mL [9,22,29], which then decreased steadily with advancing lactation [9,21–23,73,75,84]. Concentrations during lactation generally ranged between 10 and 30 ng/mL [20,21,73,75,84,85] but could be as high as 65 to 75 ng/mL in other reports [9,22,41]. For instance, Armstrong et al [19] reported concentrations of approximately 80, 65, and 50 ng/mL on days 6, 12, and 20 of lactation, respectively, with no evidence of a clear diurnal rhythm of prolactin during lactation. Concentrations were also not correlated with the number of suckling piglets in the study of Bevers et al [20], whereas Mulloy and Malven [21] reported greater prolactin concentrations in sows nursing 12 vs 8 piglets.

A surge of prolactin release was observed in response to the suckling stimulus [22,24–26], and Algers et al [84]

Table 1
Global overview of the effects of various treatments on prolactin concentrations in gestating (G) or lactating (L) sows.

Treatment	Effect	Reference
Environment and husbandry		
G: pen vs stall housing	⇧Prepartum	[15]
G: multiparous vs primiparous	⇧Prepartum	[16,17]
G: abundant nesting material	⇧Prepartum	[17]
L: multiparous vs primiparous	⇧Peripartum	[18]
L: time of day	None	[19]
L: number of suckling piglets	No correlation with prolactin⇧	[20]
L: 12 vs 8 piglets suckling	⇧	[21]
L: suckling stimulus	⇧	[22–27]
L: 2 h vs 1 h nursing interval	⇩	[25]
L: 70 min vs 35 min nursing interval	No effect	[26]
L: multiple cross-fostering	No effect	[28]
L: temporary separation of piglets	⇩	[20,29–32]
L: weaning of piglets	⇩	[20,22,30,33–36]
L: split-weaning of piglets	No effect	[34]
L: Chinese vs European breeds	⇧In early lactation	[37]
L: Chinese vs European breeds	No effect in late lactation	[37,38]
L: snare restraint stress	No effect	[32,39]
L: heat stress	No effect	[35,36,40]
L: photoperiod	No effect	[41–43]
Dopamine and opiates		
G: dopamine agonists	⇩	[7,8]
G: dopamine agonists	⇩Prepartum peak	[9,11]
G: dopamine antagonists	⇧	[14]
L: dopamine agonists	⇩	[9,12,44–47]
L: dopamine antagonists	No effect	[39]
L: opioid antagonists	⇩	[24,25,48–52]
L: opiates	⇩	[53,54]
Nutrition and toxins		
G: increasing fiber intake	Tendency to⇧	[55]
G: increasing fiber intake	Tendency to ⇧ prepartum	[56]
G: increasing fiber intake	No effect peripartum	[57]
G: feeding silymarin	Transient⇧	[58]
G: altering energy source	No effect	[59]
G: feeding sorghum ergot	⇩	[18]
L: feeding sorghum ergot	⇩	[60]
L: feed restriction	No effect	[35,61]
L: 16 or 24 h fast	⇩	[19,62]
L: refeeding after a fast	⇧	[19,62]
L: protein intake	No effect	[63,64]
L: specific amino acid intakes	No effect	[65]
L: energy intake	No effect	[66]
L: altering energy source	No effect	[59,67,68]
L: *Escherichia coli* endotoxin	⇩Postpartum	[69,70]
L: *E coli* endotoxin	No effect on day 6	[70]
Hormones		
G: farrowing induction with altrenogest	No effect prepartum	[71]
G: farrowing induction with alfaprostol	Transient ⇧ prepartum	[72]
L: exogenous oxytocin	No effect	[13]
L: exogenous TRF	⇧	[39,70,73,74]
L: exogenous GRF	No effect	[73,75,76]
L: exogenous porcine prolactin	⇧	[77–80]

Abbreviations: GRF, growth hormone-releasing factor; TRF, thyrotropin-releasing factor.