WHICH HORMONES HELP TO OPTIMIZE PIGLET PRODUCTION?

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Abstract

Sows are kept and piglet production nowadays generally according to the periodic group farrowing system with the use of artificial insemination. To this end, it is necessary to control the reproductive events in the sows. Their aim is to bring the sows in a group into heat almost at the same time so that they can be inseminated at the same time. This guarantees almost the same farrowing dates for the sows in a group. The most important measure in the sow group is at the end of the suckling period the date for the simultaneous weaning of the piglets from the sows. In order to support the synchronization of the reproductive processes in the sows in a group, the use of exogenous hormones in the respective cycle phases of the animals is recommended. In the article the hormones available for this (biotechnics) are presented with their effects. Reproductive hormones are differentiated according to their place of synthesis and their target organ. This includes the hypothalamus with the target organ pituitary gland (releasing hormone, GnRH), the anterior pituitary lobe with the gonads (gonadotropins, FSH, LH), the posterior pituitary lobe with the smooth muscles (oxytocin) and the sex steroids (prostaglandin) formed on the ovary (corpus luteum) call. As a tissue hormone, prostaglandin F2α is important with regard to its luteolytic effect. Finally, the environmentally relevant importance of hormone treatment in sows is discussed. Currently 10 to 15 percent of sows are treated with hormones. The scope of use of hormonal reproductive control in sows is decreasing.

Key Words: Sows, piglet production, hormones, biotechnology, environmental relevance

In the agricultural sow production for the production of piglets is working on the principle of group farrowing system already since 1935. In this year Fritz HOFMANN had proposed using a timed cover and farrowing system to control the breeding dates of a herd of sows in such a way that winter-related seasonal effects on the state of health of Pomeranian and East Prussian sow herds are avoided with the help of the production process. This system was perfected in the late 1950s after HOFMANN was appointed Professor and Director of the Animal Breeding Institute at the University Jena. Under his leadership, a very creative working group at this institute undertook the preparatory phase for the application of sophisticated, periodic farrowing systems and the "all-in-all-out system" for all groups and production stages (KÖNIG, 1982). At that time, these activities had a relationship to the large, sow-holding farms that were being created.

In parallel with this development, the beginning and the comprehensive introduction of artificial insemination of sows was used in practicals farms more and more (KÖNIG and TSCHINKEL, 1966; SCHLEGEL, 1969). Activities were necessary now in the larger farms, which made group-farrowing more accurate in time and more accurate in time. In this time these developments were significantly facilitated by the availability of first control substances for the stimulation or blocking of endocrine activities in the ovary cycle of the female animal. Numerous results from the basics and applied research in German and international literature had been

published (for example Mc CANN et al., 1960; DZIUK and GEHLBACH, 1966; KARG, 1968; SMIDT, 1969; NISWENDER et al., 1970; MATSUO et al., 1971; CERNE and SCHILLING, 1972). At that time, the essential scientific foundations for biotechnologically assisted reproductive control processes in sows, especially cycle synchronization, were laid. The idea of HOFMANN from the year 1935 for the periodic farrowing system according to the "all-in -everything-out principle" with permanently integrated service periods for the stable compartments was perfected and refined in this way. Today, the periodic farrowing system is the most important part of responsible, health and performance-based sow husbandry and piglet production. Far-reaching advantages, which are aimed primarily at the health of the stock, are combined with it and make this form of production organization for sow stocks essential:
Organization of All in – all out system for the management of the barn units, in particular the farrowing pen. This includes regular service periods with firmly integrated cleaning and disinfection after each production period in the barn, when the animals occupate the barn. In the pig with its short production periods, disruption of pathogen chains is of paramount importance in order to effectively counteract pathogen hospitalization.

- The work in the respective stable compartments takes place with uniform groups of animals. It means the animal groups are balanced by age, developmental and reproductive status. In the care of such groups, there are demonstrably positive specialization effects among the colleagues active here.
- In the pig with its short production periods, disruption of pathogen chains is important in order to effectively counteract pathogen hospitalism.
- The subdivision of the total sow population of the farm into smaller groups of sows provides the conditions for a homogeneous immunity in the groups. This in turn allows a high maternal immunity and low excitation density.
- The separation of all sows in a stock in different groups with the same age and production stages interrupts chains of infection. It reduces or delays the course of infection.
- All production gets a long-term visibility with high transparency, ensuring good, safe planning and health control in the animal groups.
- The group farrowing system allows a well-organized birth control by humans. It allows a litter compensation (cross forstering) in the relevant sow group, which is geared to animal health and zootechnical aspects, so that suckling piglet losses are minimized.
- Biotechnical partus induction in the sows, which should be partially carried out in the context of group farrowing, helps to reduce very long gestation times, reduce the proportion of dead or weakly born piglets and reduces the occurrence of puerperal diseases (MMA) in the sows.

For the organization and securing of group farrowing systems a control of reproduction in the sows is necessary. Their goal is to make the sows of a group nearly simultaneous with one another, so that all the sows in one of these groups can be inseminated within a narrow time window. Simultaneous dates for insemination cause limited farrowing dates in all these animals to an average of 115 gestation days. This is wanted and useful compared with the first mentioned advantages of a group farrowing system.

Reproduction control in sows is relatively easy to handle. The decisive advantage of this species is that sows in the puerperium and in the lactation phase usually do not develop any heat symptoms, they are in a lactation anestrus. The endogenous release of GnRH in the hypothalamus is blocked by the high, endogenous prolactin level during this time and, as a result, follicle maturation is suppressed. The estrogen level is at the base level. Only with the weaning of the suckling pig, it means with the removal of the suckling stimulus the sow comes in heat again. There is a resumption of the ovarian cycle activity. The prolactin level drops rapidly, which stops the gonadotropin blockade. The now

increasing level of FSH and later of LH stimulates follicular growth and the concomitant estrogen synthesis. The ovarian cycle begins again, the sow gets the oestrus 4 to 8 days after weaning from its piglets.

Control of Reproduction with time for weaning

The main instrument for reproductive control in a stock of sows farmed on the group farrowing system is the date of simultaneous weaning of sows from their piglets at the end of lactation. This moment is the decisive prelude to the re-entry of estrus in all sows in this group. The date for weaning creates the crucial prerequisite for a temporary insemination of all remote sows and thus for the group farrowing system.

This group farrowing system has been used in larger stocks of sows for about 50 years, it means it is applied for nearly 18 sow generations. During this very long time, sows whose individual processes in the endogenous reproduction processes deviated greatly from the physiological average fell or fell out of the reproductive process, it means out of the herd. It thus always had a very massive selection pressure, so that in comparison to previous generations today sow groups thereby gradually with conditionally, temporally much more uniform shape their reproductive processes and behavioral patterns. Undoubtedly, this contributed to the ease of reproductive control in the sows of a group.

Additional zootechnical measures, which specifically include factors of posture, feeding, hygiene and management, have a supporting effect on this effect. This zootechnical effect is based on the stimulating effect of the different dosage or intensity of the successive stimulus factors, but also on the sequence of different key stimuli, such as tactile (body contact), acoustic (lute), visual (eye contact) and olfactory (odor) stimuli.

Biotechnical treatments for control of reproduction

In order to allow the reproduction processes in all sows of a group in the respective physiological time frame, which is determined endocrinologically for the respective events such as follicle growth and maturation, ovulations, gestation period, relatively concentrated and thus to run according to the biology temporally limited, the use of hormones offers in the respective cycle phases. This happens as part of biotechnical measures for reproductive control of gilts and sows. The goal is generally solely the support of the already running endocrine processes in animals for the purpose of a safe and timely occurrence of reproductive events. Such reproductive control is principally based on the interaction of stimulation and blockade of endocrine events. The principle of any hormone treatments is: "as much as necessary, as little as possible". This makes it clear that it is not the aim of biotechnical treatments to increase the number of piglets per litter by higher ovulation rates and to squeeze biological-physiological processes in the animal in a pattern that alone the work organization, the labor savings or relief and thus only economic aspects serves. The currently sow lines with very high reproduction potential require no further performance increase.

Obligatory conditions for the application of any biotechnical measures are the optimal environmental conditions (management), the health of the sows, the normal, physiological development of the animals with puberty and cycle activity with appropriate breeding condition. There are no hormones or drugs to cover management problems. This may not be the goal of reproductive control measures in sows.

When hormones are used, active ingredients are used which correspond to the body's own hormones and thus have the same effect as these. Depending on the amount present, the hormones promote or inhibit each other. This change mechanism represents already principle of the regulation of the sex hormones. Sex hormones act regulate, but can never initiate a process regardless of the reaction situation of the organism. This principle is subject to any biotechnical treatment of sows for reproductive control. Stimulatory effects are always directed to the subordinate levels of the hypothalamic-pituitary-gonadal system. Blockades, on the other

hand, aim at the upstream, higher levels in the system.

Exogenous agents with stimulating effect stimulate the secretion of the body's own hormones in the target organ or in the downstream organs according to the hormonal action cascade (hypothalamic → pituitary → gonads) or support them. The naturally occurring reproductive processes are promoted in this way. On the other hand, blocking substances cause a secretion stop in the respective higher levels in the hypothalamic-pituitary-gonadal system.

Hormonal agents are used in piglet production to synchronize sexual cycles in gilts, to support ovarian function in sows after weaning piglets, to stimulate ovulation in gilts and sows, and to induce parturition. This is based on scientifically based studies with an extremely high number of animals.

For reproductive control in sows, natural and synthetically produced hormones are used. Natural hormone preparations are gonadotropins obtained from serum-bearing mares (Equine chorionic gonadotrophin - eCG, also known as PMSG - Pregnant serum genonadotrophin) and from the urine of pregnant women (Human chorionic gonadotropin - hCG).

The synthetically produced hormones resemble or correspond in their structure to the natural hormones. Often, natural hormones are very difficult to obtain. In addition, the use of natural substances is not always risk-free. Synthetic hormones with a clear biochemical structure can be safely produced and usually have a better effect, so much lower amounts must be applied to achieve the same effect as natural hormones. In sows, synthetic hormones are used to stimulate follicular growth and ovulation (GnRH), to induce labor and to support contractions (prostaglandins, oxytocins) and cycle synchronization in gilts (Altrenogest). Natural and synthetically produced hormones, which are used for reproductive control in sows, are assigned to five categories or classes according to their secretion sites and directions of effects:

Synthesis site hypothalamus - target organ pituitary

The gonadotropin-releasing hormone (GnRH) formed in the hypothalamus acts as a release hormone in the pituitary (pituitary anterior lobes - HVL), the secretion of the hormones, which act on the target organ, the gonad (ovary). The GnRH is pulsatile delivered in a frequency of about 20 to 30 minutes. It triggers in the downstream organ, the pituitary gland, the secretion of LH and, to a lesser extent, FSH. GnRH is synthetically produced and used for ovulation stimulation in sows with synchronization of etrus (synchronization of ovulation with timed insemination). Since longer timer, a separate FSH releasing factor has been suggested (Mc CANN et al., 1998). This factor corresponds to the lamprey GnRH-III (lGnRH-III) found in the lamprey (SOWER et al., 1993). Since autumn 2008, a synthetic GnRH preparation containing this active substance has been available (ENGL, 2010). After luteal phase it leads to the growth of the follicles in sows and thus to stimulates estrus (ENGL, 2010).

In general, the half-life of GnRH is functionally very short. It is only 5 to 10 minutes. This applies to all synthetically produced gonadotropin-releasing hormones. There are no waiting period for edible tissue after administration of GnRH preparations.

Synthesis site pituitary anterior lobes-target organ gonads (ovary)

The gonadotropic hormones FSH (follicle stimulating hormone) and LH (luteinizing hormone), which are produced by GnRH in the pituitary anterior lobe (HVL), induce follicular growth (FSH) and ovulation (LH) on the ovaries. Both hormones are always related. For these hormones, natural extra-pituitary gonadotropins (eCG, hCG) are used for reproductive control in sows. The eCG (synonym PMSG) is used in gilts after drug cycle block and in remote sows for cycle stimulation (cycle start), it means it will be used to stimulate follicular growth. It should be

noted that the eCG molecule combines two endocrine modes, FSH and LH.

The natural hCG corresponds in its effect to the endogenous LH. Both hormone preparations eCG and hCG have a very short half-life of only a few minutes due to their function. A waiting period for edible tissue is not specified. Both eCG and hCG induce in the sows analogous to their endogenous gonadotropins FSH and LH on the ovary in addition to morphological-functional changes, the formation of so-called subordinate sex hormones (sex steroids) such as estrogens (17-βÖstradiol) in the growing follicle and progesterone in the corpus luteum.

In addition to the natural exogeneous-hypophysial gonadotropins, the synthetically produced GnRH is increasingly being used. This is the derivative of the natural gonadotropin releasing hormone. It contains the active ingredient D-Phe 6-LHRH. Thanks to its high efficacy, it is particularly suitable for ovulation initiation after previous cycle stimulation in a very low dosage.

Synthesis site pituitary backbone - target organ smooth muscle

The release of the hormone formed and stored in the posterior pituitary (HVL), oxytocin, is usually initiated by mechanical stimuli (nipple stimulation, piglet pressure during expulsion from the birth path, penile pressure in the vagina during mating). It triggers contractions of smooth muscle (myometrium) of the uterus and myoepithelia in the wall of the alveoli of the mammary gland (milk injection). Due to its short half-life of only 1 to 9 minutes, no waiting period is specified.

Natural and synthetically produced oxytocin preparations are used in the following indications in sows:

- Labor-stimulation in case of labor-weakness
- Stimulation of milk injection,
- Stimulation of the birth processes after previous birth induction with a prostaglandin F2α dose,
- Promotion of postpartum uterine involution.

Synthetic oxytocin analogues with a prolonging effect (active substance carbetocin) show a change in the oxytocin molecule. The result is, there is an extension of the chemical and metabolic stability. In the case of an equally rapid onset of action, in comparison to the original oxytocin, a greatly prolonged duration of action on the rhythmic myometrial contractions of the uterus is achieved without unphysiological reactions occurring. Depot oxytocin preparations, for example Depotocin® (VEYX Pharma GmbH) is used in the partial partus induction after previous birth induction with a prostaglandin F2α dose for the purpose of stimulating the birth processes.

In the case of pregnant sows, they also stimulate labor, independently of the induction of the partus. The half-life of such synthetic oxytocin analogs is 2 to 4 hours. There is no waiting time for edible tissue and milk.

In artificial insemination of the sows, adding natural oxytocin to the inseminate may stimulate the myometrial contractions in the uterus during insemination, which has a beneficial effect on the transport of sperm into the ampoule to the place of fertilization. This promotes the absence of instrumental seed transfer stimuli to the uterine epithelium and myometrium, which become active during natural mating by penis and ejaculate.

Sexual steroids (place of formation: ovary)

In Germany, only one steroidal active substance is approved for use in sow production, the "Altrenogest" (Allyl Trenbolone), which contains the active substance in oily solution,. The producer of the active ingredient is the company Roussel Uclaf (F). Other types of steroid such as estrogen, which are widely used in human medicine, are not used in sows for piglet production.

Sexual steroids with this drug are predominantly administered orally only to gilts as a cycle blocker for oestrus synchronization. This synthetically produced progestagens corresponds in its effect to endogenous progesterone. Through the natural feedback

mechanism (bloodstream), Altrenogest blocks the further secretion of gonadotropins (FSH, LH) in the pituitary gland. The growth of ovarian follicles is thus inhibited. It can only be up to the size reached in the diestrus. The ovary cycle is blocked with it. During the 18-day medication with a daily dose of 20 mg per animal of the active ingredient altrenogest takes place in the animals, the luteal body regression. At the end of the maximally 18-day administration of the progestogen, the corpora lutea have regressed in all gilts so treated. The new cycle starts uniformly in all sows. As a steroidal substance, Altrenogest has a longer half-life than the hormones produced in the hypothalamus and pituitary (GnRH, FSH, LH). The waiting time for edible tissue is set at 9 days.

Tissue hormon prostaglandin (PGF2α)

As further endogenous hormones in piglet production the prostaglandins are important, especially those of the type PGF2α. These are derivatives of fatty acids with multiple functions in the field of reproduction. The natural prostaglandin F2α is synthesized in the uterine mucosa and in the placenta. In cyclical sows, it triggers luteolysis during the ovary cycle after the 12th day of the cycle. At the end of gestation, PGF2α is increasingly produced in the placenta, causing luteolysis and thus initiating the end of the progesterone phase. The birth begins after that. In addition, the PGF2α, with the participation of oxytocin, stimulates the recurrent, rhythmic uterine contractions and thus supports the contractions and expulsion of the fruits.

The synthetically produced PGF2α fulfills these same functions. In the sow husbandry it is used in the context of the synchronization of parturition in sows of a group which are inseminated in the same time.

Birth synchronization in a group of sows is characterized by partial birth induction. This means that only those sows receive a birth induction with Cloprostenol (PGF2α), which have not yet terminated when the average duration of pregnancy has been reached. This affects only about 50% of the sows.

The waiting time for edible tissue after PGF2α treatment is 2 days. In Germany, about 50% of the sow herds of any herd size are subjected to birth synchronization with partial partus synchronization.

Hormone use in sows and possible environmental pollution

In sows, no estrogens are used in high long-term doses. Only low-dose glycoproteins, gonadotropins and biological or synthetic release factors from the interbrain are used. In general, in animals, the metabolites of the body's own and exogenous hormones on excretions in the environment.

Most substance classes used in sows have a very short duration of effect and therefore also very short half-lives, which does not result in waiting times for edible tissue. Therefore, no significant environmental impact is expected from these substances. In addition, the absolute amounts and concentrations of the hormonal degradation products are extremely low. This deviates only with the steriodal Progestagen "Altrenogest". Progestagen "Altrenogest" has been in use since the beginning of the 90s. During the 18-day medication, the gilts excrete the resulting degradation products with the urine. It should be noted, however, that this is a progestin and not estrogen-like substances. Like the estrogens, progestagens do not belong to the group of "endocrine disruptors" that are known to have carcinogenic and mutagenic effects.

Scope of application of hormonal treatments of sows

According to estimates of the Federal Chamber of Veterinarians today 10 to 15% of sows are treated hormonally. That's between 205,000 and 307,000 animals a year in Germany. Of all the gilts only about 30% get a biotechnical treatment for cycle synchronization.

Large farms that manage their sowing stock every 7 days often use biotechnical seldom. It is not

necessary to perform an additional heat synchronization of the gilts, if in general every week an insemination period with the deposed old sows is due. The brittle gilts can easily be assigned to the respective old sow group and thus incorporated into the company group farrowing system. In addition, the use of biotechnics in Germany has declined in recent years because predominantly the large farms, which are mostly located in East Germany and often work with foreign sow genetics, do not use biotechnical treatments and consequently no hormones. These include very fertile sows of various breeding companies, which are used as sows for mother lines.

Sow stocks that are managed in a two-week or three-week rhythme and that supplement their stock with the purchase of a few, but larger groups of gilts from the higher breeding level-stage, often rely heavily on the application of biotechnical gynecological synchronization aids to the needed gilts for remontation in the respective insemination group of the weaned sows in smaller numbers easily integrate.

In general, it should be noted that the use of biotechnical drugs in sow husbandry optimizes work processes and makes animal movements more controllable. For animal health, for example through controlled animal contact and better cleaning and disinfection, and for well-being through optimized animal observation in groups, each with the same reproduction phase, this undoubtedly has a positive effect. As a result, above all antibiotics should be saved, whose application and documentation have been newly regulated by the legislator in the sense of a lower burden on animals and humans.

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