

Potential Use of Follicles in the Ovary to Increase endogenous Secretions of Estrogen and Progesterone during Pregnancy in Improving Reproduction and Production Performances of Mammalian Animals



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Abstract

A review about the potential use of follicles resources in the ovary as sources of endogenous pregnant hormones secretions to improve prenatal growth of the offspring and mammary gland growth and development that will improve postnatal growth of the offspring. Observations in sheep, goats, and swine showed that endogenous secretions of estrogen and progesterone could be improved and optimized to improve prenatal growth and mammary gland growth that eventually improved prenatal growth and birth weight. Improved milk production during lactation finally improved pre-weaning growth performances of the offspring with better growth rates and lower mortality and morbidity until maturity.

It is potential to produce superior and healthy offspring by increasing maternal endogenous secretions of pregnant hormones during pregnancy to improve uterine environment that eventually improves prenatal growth and mammary gland growth and development. The improved prenatal growth and birth weight as well as milk production will optimize pre-weaning growths of the offspring that eventually improve post-weaning growth and survival until maturity.

Keywords: Superovulation; Gonadotropin; Estrogen; Progesterone; Uterine growth; Prenatal growth; Birth weight; Postnatal growth rate; Milk production

Introduction

The productivity of mammalian animals is determined by the success of reproduction process to produce healthy and superior off spring with better growths and developments from birth to weaning until maturity. The fitness and health of the newborn off spring until maturity is determined by the growth and development during prenatal period with the final results of improved birth weight. The main limitations in animal production are the low birth weight and the survival or fitness of the newborn off spring. The number and the weight of weaned off spring are determined by the birth weight, survival during pre-weaning growth, and milk production during pre-weaning or lactation period.

The main signals that start the whole process of reproduction in female mammalian animals are estrogen produced by the growing follicles prior to ovulation during estrus cycle and progesterone produced by the corpus luteum and the placenta during pregnancy. These hormones of pregnancy are the main signals that initialize the process of reproduction

comprehensively from the preparation of ovum and sperm, fertilization, preparation of uterus for implantation, as well as the growth and development of the placenta, embryo, and fetus [1-4]. The improved uterine and placental growths during pregnancy will improve the flows of nutrients and oxygen for developing embryos and fetuses [5,6] and genetic expression in developing embryos and fetuses that further affect birth weight and pre-weaning growth until maturity [7-9]. The same hormones also affect the growth and development of the mammary glands to prepare production of colostrum for supporting the immune system of the newborn off spring and milk to meet the nutrients requirement of the newborn off spring during pre-weaning period.

Birth weights of the newborn off spring are determined by the uterine and placental environments during the prenatal growth and development that are accumulations of growth and development from zygote to embryo and fetus until parturition [10]. Birth weight is the final result of the works of complex

systems of hormones and growth factors regulating the growth and development of uterus and placenta as well as embryos and fetuses [11-13]. Prenatal growth is determined by the uterine and placental environments [14,15] and the levels of utero-placental vascularization [16] that determine the supplies of nutrients and oxygen for developing embryos and fetuses [17-19]. The limitation in growth and development of uterus and placenta during pregnancy will modulate the endocrine status and gene expressions related to development [20-25] that eventually also limits the growth and development of embryos and fetuses that finally decrease birth weights and the survival of the offspring with the lower postnatal growth [26-29]. Therefore, the availabilities of optimum pregnant hormones produced by the follicles, corpus luteum and placenta [30] during pregnancy are very important in controlling the growth and development of uterine tissues and glands, the embryos and fetuses, the placenta, and the mammary glands that eventually will affect the success of the mother to raise the newborn off spring until weaning that is the final steps of reproduction processes.

Female mammalian animals have hundred thousands of primordial follicles in the ovaries at birth. However, only small parts of the primordial follicles that will be used to ovulate during the life cycle of the female mammalian animals. The large number of follicles are potential sources of endogenous secretions of reproductive and pregnant hormones (especially estrogen and progesterone) to be used to optimize the process of reproduction to produce new off spring. Instead of injections of synthetic exogenous hormones, the utilization of the natural potential of follicles to produce estrogen and progesterone as key hormones in reproduction and mammary gland growth and development during pregnancy to stimulate the growth of the uterus, embryos, fetus, and mammary glands. Therefore, the follicles of female mammalian animals are potential sources of endogenous secretions of estrogen and progesterone that initialize and control the whole endocrine, chemical, and biological processes of pregnancy until parturition to produce healthy and superior off spring.

The increased number of recruited, developing, and finally ovulating follicles and the corpora lutea formed after ovulation is usually stimulated by the super ovulation technique by using exogenous and synthetic gonadotropin. Super ovulation is proven to increase the number of developing and ovulating follicles and the number of corpora lutea formed after ovulation [31-35]. The increased number of developing and ovulating follicles and corpora lutea in super-ovulated female mammalian animals increases endogenous secretions of estrogen prior to ovulation [36-41] and progesterone during the luteal phase of estrous cycle and during pregnancy [42-47].

The roles pregnant hormones in improving reproduction and production

The success of reproduction in mammalian animals is depend on the success of reproduction that is further

determined by the success of the mother to produce healthy and fit off spring to grow and develop better from birth until weaning and further mature age. The number and weights of offspring at weaning are determined by the birth weight, health, growth, and development of the off spring as well as maternal milk production during lactation or pre-weaning period. Birth weight is determined by the process and environment during prenatal growth and development in the uterus and placenta that is accumulation of growth from zygote to embryo and fetus until parturition. Prenatal growth is determined by the uterine and placental environments where the embryos and fetuses are maintained to grow and develop before parturition. The growth during the embryonic stage is mostly affected by the readiness of the uterine endometrium to provide nutrients and other compounds (growth factors and hormones) that will further guide and regulate the growth and development of embryo [48]. The growth and development of uterine glands is under the control of reproductive hormones produced by the ovary during estrous and by the corpus luteum during the luteal phases of the estrous or at the beginning of pregnancy [49,50].

After organogenesis is finished (as the end of embryonic stage of pregnancy), the embryos will be inside of the placenta that further become fetuses and the fetuses get their nutrients and oxygen requirements for live, growth, and development from the maternal circulation through the placenta [51]. Therefore, fetal growth and development is depend on the degree and completeness of growth and development attained in the previous embryonic stage, the growth and development of the placenta, and the availabilities of nutrients in the maternal circulations that reach the placenta.

From parturition to weaning growth periods, mammalian off spring depend on milk produced by the mammary glands of the mother as a source of nutrients and compounds for their growths and developments until weaning stage. The growth and the health of the off spring are further affected by birth weight of the offspring and milk production of the mother during lactation or pre-weaning stage. Milk production of the mother during lactation is determined by the level of mammary gland growth and development during pregnancy [52,53] and the nutrients availability in the secretory cells of the mammary glands [54]. The growth and development of the mammary glands during pregnancy is mainly controlled by hormones that are also pregnant hormones (estrogen, relaxin, progesterone, and placental lactogen) and the availability of prolactin, somatotropin, cortisol, and thyroxin [55-58].

Therefore, the availabilities of pregnant hormones produced by the corpus luteum and placenta during pregnancy play critical roles in controlling the growths and developments of uterus, embryos, placenta, and fetuses as well as the growth and development of mammary glands that eventually will determine the success of the mother to raise the offspring until weaning that is the final stage of reproduction in mammalian animals.

Results

The results obtained in the use of gonadotropin injection as an agent of super ovulation in sheep, goats, swine, and cattle to increase endogenous secretions of pregnant hormones that further improve the growth and development of uterus, embryo, fetus, and mammary glands. The increased endogenous secretions of pregnant hormones will improve prenatal growth, birth weight, maternal milk production, and the survival of the offspring, the pre-weaning and post-weaning growths of the offspring until maturity as factors affecting the success of reproduction and production in mammalian animals.

We succeeded in improving maternal hormonal conditions during pregnancy in sheep and goat by increasing the number of growing and ovulating follicles and corpus luteum by injecting the experimental animals with gonadotropin prior to mating that further increased the endogenous secretions of estrogen and progesterone as key hormones of pregnancy. The increased endogenous secretions of pregnant hormones during pregnancy eventually improved uterine and placental growth and developments as well as the growth and development of embryos and fetuses [59] that eventually improved the birth weight and weaning weights of the offspring [60,61]. The improved maternal hormonal conditions during pregnancy dramatically improved the growth and development of the mammary glands during pregnancy [62,63] and the activity of key enzyme in lactose synthesis [64] that eventually improved milk production of the mother during lactation by 59% in sheep and by 32% in goat [65]. The improved mammary glands growth and development during pregnancy and milk production during lactation were also caused by the improved mammary gland conditions until the end of lactation. The end results of improved birth weight of the offspring and maternal milk production were the improved growth and survival of from birth until post-weaning and maturity.

The applications of the super ovulation technology in sheep and goat in the small scale farmer also showed good results i.e. the improved production of off spring almost increased twice in super-ovulated mothers as compared to control mothers [66,67] that automatically increased the income and economical returns that was also almost twice. The applications of this super ovulation technology in improving endogenous secretions of pregnant hormones in goats raised in extensive system without feed supplementation showed the greater growth rates in the offspring born to super-ovulated goats with the different in averages body weight of 4kg at the age of 7 months [68].

Kids born to does injected with gonadotropin prior to mating also showed the better survival and health as compared to kids born to control does without gonadotropin injections prior to mating. Infection of the lambs born to ewes injected with gonadotropin prior to mating showed a significant resistance and resilience with a positive growth rate during the infection while the lambs born to control ewes showed a decreased body weight during infection [69]. The future expectation is that the offspring

born to super-ovulated mothers having better and optimum prenatal growth and obtaining better maternal milk production during pre-weaning period will grow and develop to be superior offspring. Therefore, the offspring born to the mother injected with gonadotropin prior to mating had potentials to be used as parent stocks with a better growth rate similar to superior breeds. We also found the right time and dose of gonadotropin injection to increase endogenous secretions of estrogen and progesterone without super ovulation response in goat [70].

The results obtained in swine, with the polytocus traits, with the litter sizes that can reach 18, showed that the improved endogenous secretions of pregnant hormones significantly improved the growth and development of uterus, placenta, embryo, and fetus [71], and improved birth weights and the pre-weaning growth of the off spring [72-74], and maternal milk production [75]. The final results were lower mortality rate, better growth of piglets until weaning and finishing weight with a better meat quality. In addition, sows injected with gonadotropin prior to mating had higher maternal serum thyroxin concentrations during pregnancy [76] that are supposed to contribute to the improved prenatal growth of the offspring. The observation in local breed of pigs showed a higher and better result in improving birth weights, pre-weaning and post-weaning growth rates with mortality that decreased dramatically that finally increased the productivity per sow.

These results indicate that the reproductive performances of the sows as indicated by the improved birth weight and decreased mortality that eventually increased the number and weights of piglets weaned and reached finishing stages. In addition, the piglets born to sows injected with gonadotropin prior to mating have higher and better growth rates so that they can reach the final body weight of 95kg two weeks faster than those born to control sows. The better growth rate of the piglets and reaching a faster final body weight was also associated with the better carcass quality i.e. higher carcass weight, carcass percentage, and loin eye area as well as carcass length with lower thickness of back fat. The improved prenatal and postnatal growth of the offspring was confirmed associated with the improved expression of growth hormone gene [77,78].

Conclusion

From the limited results observed it is clear that the follicle resources in the ovary of the female mammalian animals can be used to increase endogenous secretions of pregnant hormones to improve and optimize the process of pregnancy to produce superior and healthy off spring.

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