



UNIVERSITI PUTRA MALAYSIA

**ASSESSMENT OF THE EASE OF INSERTION, RETENTION RATE, EASE
OF REMOVAL AND PIG BEHAVIOUR TO A NOVEL INTRAVAGINAL
INSERT FOR PIGS**

JONG KWANG YAN

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RETENTION RATE, EASE OF REMOVAL AND PIG
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ASSESSMENT OF THE EASE OF INSERTION, RETENTION RATE,
EASE OF REMOVAL AND PIG BEHAVIOUR TO A NOVEL
INTRAVAGINAL INSERT FOR PIGS

JONG KWANG YAN

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DEGREE OF DOCTOR OF VETERINARY MEDICINE

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It is hereby certified that we have read this project paper entitled “Assessment of the Ease of Insertion, Retention Rate, Ease of Removal and Pig Behaviour to A Novel Intravaginal Insert for Pigs”, by Jong Kwang Yan and in my opinion it is satisfactory in terms of scope, quality and presentation as partial fulfillment of the requirement for the course VPD4999 – Final Year Project.

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DEDICATIONS

To:

My dearest family,

Friends,

And to all my teachers who have committed themselves to this project and everyone who work in the swine industry.

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Million thanks to my project supervisor, Dr Ooi Peck Toung for his time, wisdom, expertise and guidance that he granted me throughout the duration of this project. His experience and knowledge in the pig industry had been a great motivation for me to involve myself in the industry.

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LIST OF ABBREVIATIONS

%	Percent
°C	Degree Celcius
BCS	Body condition score
Dr	Doctor
FSH	Follicle stimulating hormone
GnRH	Gonadotropin releasing hormone
hCG	Human chorionic gonadotropin
IACUC	Institutional Animal Care and Use Committee
LH	Luteinising hormone
LL	Long length, large base
LS	Long length, small base
LYD	Landrace-Yorkshire-Duroc
ML	Medium length, large base
MS	Medium length, small base
PGF2- α	Prostaglandin F2 alpha
PMSG	Pregnant mare serum gonadotropin
Prof	Professor
SL	Short length, large base
SS	Short length, small base
USA	United States of America

ABSTRAK

Abstrak daripada kertas projek yang dikemukakan kepada Fakulti Perubatan Veterinar, Universiti Putra Malaysia untuk memenuhi sebahagian daripada keperluan kursus VPD 4999 – Projek Ilmiah Tahun Akhir.

PENILAIAN KESENANGAN PEMASUKAN, KADAR PENGEKALAN, KESENANGAN MENGALIHKAN DAN KELAKUAN KHINZIR TERHADAP ALAT INTRA-FARAJ BAHARU UNTUK KHINZIR

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Reproduksi merupakan aspek penting dalam industri ternakan khinzir. Ia merupakan salah satu faktor yang menentukan jumlah khinzir yang boleh dijual oleh penternak. Oleh sebab Malaysia mempunyai industri ternakan khinzir yang signifikan, kemahiran reproduksi khinzir yang berkesan adalah penting kepada para penternak. Kajian ini menilai kegunaan alat intra-faraj baharu yang mengandungi progesteron dalam mencapai penyelarasan estrus pada khinzir dara betina. Kajian ini melibatkan sebuah ladang contoh yang terletak di Bidor, Perak. Enam khinzir dara betina yang berumur 8 bulan dipilih untuk kajian ini. Haiwan-haiwan ini dibahagikan kepada 3 kategori iaitu sayap bersaiz pendek dengan pangkal bersaiz kecil (SS) dan besar (SL),

sayap bersaiz sederhana dengan pangkal bersaiz kecil (MS) dan besar (ML), dan sayap bersaiz panjang dengan pangkal bersaiz kecil (LS) dan besar (LL). Kesenangan pemasukan dan pengeluaran alat, kadar pengekatan alat dan kelakuan khinzir direkodkan. Alat SL dan LL gagal dimasukkan kerana pangkal besar. Alat LS dikeluarkan pada hari kelima kerana menyebabkan ketidakselesaian. Alat SS, MS dan ML berjaya dikeluarkan pada hari ke-tigabelas. Kesimpulannya, alat ini berjaya mencapai matlamatnya untuk penyelarasan estrus tetapi memerlukan kajian lanjut untuk menentukan bahan dan saiz yang sesuai.

Kata kunci: Alat Intra-faraj Baharu, Khinzir Dara Betina, Penyelarasan Estrus, Progesteron, Reproduksi khinzir,

ABSTRACT

Abstract of a project paper submitted to the Faculty of Veterinary Medicine, Universiti Putra Malaysia in partial fulfilment of the requirement for the course VPD 4999 – Final Year Project.

ASSESSMENT OF THE EASE OF INSERTION, RETENTION RATE, EASE OF REMOVAL AND PIG BEHAVIOUR TO A NOVEL INTRAVAGINAL INSERT FOR PIGS

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Reproduction is an important aspect of the swine livestock industry. It is one of the parameters that decides the amount of pigs that can be sold by pig farms. As Malaysia has a significant swine industry, having an effective reproduction is essential to the pig producers. This study evaluates the use of novel progesterone loaded intravaginal inserts to achieve oestrus synchronisation in gilts. It involves a model pig farm located in Bidor, Perak. Six gilts aged 8-months-old were used in this study. They

were divided into three categories which were – short length size with small base (SS) and large base (SL), medium wing size with small base (MS) and large base (ML), and long length size with small base (LS) and large base (LL). The ease of insertion and removal of the device, the retention rate and pig behaviour were recorded. Devices SL and LL were not successfully inserted due to the large base. Device LS was removed 5 days after insertion as it caused discomfort. Devices SS, MS and ML were successfully removed on day 13th. In conclusion, the device achieved its aim of oestrus synchronisation but requires further studies to determine the appropriate materials and size.

Keywords: Gilts, Novel Intravaginal Device, Oestrus Synchronisation, Progesterone, Swine Reproduction

1.0 INTRODUCTION

Swine is a type of food producing animal that contributes to the economy. According to Holden and Ensminger (2005), besides providing profitable returns to the farmer, swine also produce food, convert inedible feeds into valuable products, enhance soil fertility, serve as a companion for feed grain production, provide unique products such as heart valves, for pharmaceuticals, and also used as nutritional and medical research animals to study human health issues.

The production of pork from the swine industry requires systematic management from the producer. One of the main components of achieving maximum production is the wise management of swine reproduction. For the commercial breed of swine such as Landrace, Yorkshire and Duroc, their reproduction rate is very important to the producer. Under normal conditions, gilts reach puberty at the age of 6 to 7-months-old. The oestrous cycle starts when puberty is reached. It is exhibited year-round that average 21 days. Since the oestrous cycle has started, breeding can be carried out. Once bred, the gestation length is 114 days, which equals to 3 months, 3 weeks and 3 days. The lactation length of 21 to 28 days depends on the management system of the producer. Normally it would take at least 5-7 days for the sows to be bred again. This makes the total cycle in the range of 150 days. Hence, the ideal reproduction rate for a sow is 2.4 times per year (Pond and Mersmann, 2001; Holden and Ensminger, 2005). To achieve this target required good husbandry management and careful planning.

In order to achieve the reproduction rate of 2.4 times per year, controlled reproduction has to be included in the management system. Aspects of controlled

reproduction in pigs include control of oestrus, fixed-time artificial insemination, control of farrowing, increasing farrowing frequency, increasing litter size, embryo transfer and breeding pigs at a younger age (Gordon, 1997). The development of effective hormonal procedures for oestrus control would enable producers to plan all aspects of their breeding programmes on a time basis, with all matings or inseminations of a particular group of pigs being concentrated into a few days (Gordon, 1997). According to Holden and Ensminger (2005), synchronisation of sows is a relatively simple matter compared to gilts. When litters are weaned from a group of sows at the same time, a large percentage of sows will come into heat within 4 to 7 days post weaning. For gilts to synchronise naturally, oestrus is difficult to achieve in high proportions. Moving gilts from a finishing barn, transporting them to a new site, or exposing them to a mature boar will stimulate the oestrous cycle but with variable results.

Therefore, an effective oestrus synchronisation method is required for gilts. In this study, a novel intravaginal device loaded with progesterone was tested on selected gilts to determine its suitability for oestrus synchronisation. This is to examine that whether the device is suitable to be used effectively as an oestrus synchronisation method. The ease of insertion of device, retention rate of the device, ease of removal of device and pig behaviour when the device was inserted were all assessed during this study.

This study was undertaken to fulfil the objective of determination of the retention rate of a new intravaginal device for pigs. Meanwhile, the following

hypothesis was proposed for this study which was the device was able to be retained in the vaginal cavity of the pig.



2.0 LITERATURE REVIEW

2.1 Reproduction Hormone in Gilt/Sow

Reproduction hormones in livestock animals are important to understand in order to achieve good production. The hormones include gonadotropin releasing hormone (GnRH), follicle stimulating hormone (FSH), luteinising hormone (LH), progesterone, and oestrogen. Each of the hormones has its own function. For example, GnRH causes the release of FSH and LH from the anterior pituitary gland, FSH stimulates oestrogen secretion while LH stimulates progesterone and oestrogen secretion.

Oestrogen is required for the psychologic manifestations of heat or oestrus, stimulates secondary sexual characteristics, growth of reproductive tract, uterine contraction and mammary duct growth. Progesterone acts synergistically with oestrogen in promoting oestrous behaviour, preparing the reproductive tract for implantation, stimulates endometrial secretion, maintains pregnancy and stimulates mammary alveolar growth. High levels of progesterone inhibit oestrus and the ovulatory surge of LH, thus establishing the importance of this hormone in the regulation of the oestrous cycle (Hafez, 1980).

2.2 Physiology Associated with Oestrus

Oestrus takes place under the influence of three organs - the hypothalamus, the pituitary gland and the ovaries. They interact with each other in a coordinated fashion

to produce follicles that can produce high levels of oestrogen and are ready to ovulate and release eggs. The hypothalamus, which is located in the brain, receives input from both the external environment and within the animal's own body and translates them into a hormonal signal. The hormone produced by the hypothalamus is GnRH. The pituitary gland is then stimulated by GnRH to produce two hormones, which are LH and FSH. The pituitary gland serves to amplify information processed by the hypothalamus. Small amounts of GnRH secreted by the hypothalamus would in turn trigger the secretion of large amounts of LH and FSH.

Both LH and FSH in turn, cause follicles on the ovaries to become larger in size and hence, mature. As follicles mature, they are able to produce oestrogen. High levels of oestrogen stimulate the standing reflex or immobilization response, a surge in LH secretion and eventually ovulation. As a result, the female is ready for breeding as ovulation takes place. Synchronisation of oestrus involves controlling the time frame over which this sequence of events takes place in a group of females (Pond and Mersmann, 2001; Holden and Ensminger, 2005)

2.3 The Need for Control of Oestrus and Ovulation

The control of oestrus and ovulation is helpful in enhancing profitability for the farmers. The production of the farms especially the number of porkers available to meet the market demands during certain seasons can be achieved through the control of oestrus and ovulation. Besides, by performing control of oestrus and ovulation, the farmers can gain a few more benefits.

According to Rathbone *et al.*, 2000, the control can reduce the time and labour which is devoted to oestrous detection and allow for more cost effective implementation of timed insemination programs. Besides, it also can increase the use of artificial insemination with fresh, transported or frozen semen in order to utilise desirable genes. Meanwhile, it reduces natural service hence decrease the transmission of communicable diseases. Lastly, the control synchronises donor and recipients for embryo transfer allowing the use of new assisted reproductive technologies such as superovulation, in vitro fertilization, intracytoplasmic sperm injection and cloning. The control of oestrus and ovulation allows the farm owner to have an efficient management system in terms of farm supply and market demand.

2.4 Oestrus Synchronisation

Production calendars for most swine farms are based upon the reproductive cycle of sows and gilts. The key event of reproduction that decides the beginning of reproductive cycles is the onset of oestrus. Oestrus occurs spontaneously in gilts and non-pregnant sow, where the oestrous cycle normally lasts for 18-21 days. The oestrous cycle would occur again if the gilt or sow remains non-pregnant. From the aspect of production and management, it is difficult to predict or control the number of females in heat. Hence, oestrus synchronisation, also known as the ability to precisely control the onset of oestrus, is needed (Dr. Flowers, 2001).

2.4.1 Oestrus Synchronisation in Prepubertal Gilts

The hypothalamus, pituitary gland and ovaries mature into adult form at different times during sexual maturation. The ovaries and pituitary gland mature first, followed by the hypothalamus. After maturation of the organs, additional period of time is needed for the integration of the three organs, enabling them to interact with each other. Most of the commercial swine breeds have mature reproductive organs by 150 to 160 days of age while the integration of the three organs would be completed by 160 to 180 days of age. Hence, the time frame of 160 to 180 days of age is the most suitable time for effective synchronisation of oestrus.

There are two methods suitable for gilt oestrus synchronisation at this stage. The first method is boar exposure and the second method is boar exposure together with the use of PG600[®] (InterVet, Inc.; USA). The boar exposure method is completed through the introduction of the boar to the gilts. The sight, sound, smell and physical presence of the boar are external stimuli that are translated by the hypothalamus of gilts into GnRH secretion, followed by oestrus and finally ovulation. This is known as the “boar effect”. Under normal conditions, 70 to 80% of gilts would exhibit oestrus within the next 28 days, with most of them in the range of the next 10 to 14 days. Boar exposure or the boar effect involves the production of a type of chemical compound or hormone known as pheromones. Pheromones are produced in the saliva and urine of boars and emitted into the air. Mature boars are able to produce high concentration of pheromones in the saliva. Once the pheromones become air-borne, they will be picked up by the gilts, which in turn trigger their olfactory systems. This activates the hypothalamus to start releasing GnRH, and the whole process of oestrus starts. The next factor of this method is the frequency and duration of contact between the boar

and the gilts. Daily boar exposure of 5 to 10 minutes per group of gilts is important for the success of oestrus synchronisation.

The second method is the boar usage together with PG600[®] (InterVet, Inc.; USA), is applied on young gilts that are unable to respond to boar exposure alone. PG600[®] is a pharmaceutical compound made up of two naturally occurring hormones – equine chorionic gonadotropin (or pregnant mare serum gonadotropin - PMSG) and human chorionic gonadotropin (hCG). When PG600[®] is used in combination with boar exposure, the hypothalamus is stimulated through external stimuli provided by the presence of boar and the follicles on the ovary are stimulated through the gonadotropins in PG600[®]. With the second method, young gilts exhibit swollen vulvas and show signs of mucus discharge within several days of treatment. However, one of the problems associated with this method is the lack of standing reflex. The possible explanation is the amount of oestrogen produced by ovaries through the effect of PG600[®] is enough to induce some changes associated with the onset of oestrus, but not sufficient to trigger the standing reflex. The boar exposure must always be present under this method. The use of PG600[®] alone is not effective for oestrus synchronisation in mature gilts that exhibit normal oestrous cycle (Flowers, 2001)

2.4.2 Oestrus Synchronisation in Mature Sows and Gilts

Under normal circumstances, mature sows and gilts would exhibit normal oestrous cycle after puberty. The normal oestrous cycle pattern prevents the use of boar exposure and PG600[®]. The reason behind this is the existence of progesterone. After ovulation, the follicular cells remaining on the ovary form the corpus luteum

which signals the start of progesterone production. Progesterone has a suppressive effect on the ovaries. Once present, it causes the hypothalamus to decrease GnRH release, at the rate just enough to prevent the growth of medium follicles into large follicles, but not the growth of small follicles into medium follicles. This stops ovulation from taking place. The stimulatory effect of boar exposure and PG600® cannot overcome the suppressive effect of progesterone on the growth of follicles, hence making them unsuitable to be used. When the animals are not pregnant, the corpus luteum continues to produce progesterone and regresses after day 12 to 14, causing the progesterone concentration to decrease. Without progesterone, the follicles can continue their growth into large follicles and progress to the ovulation stage. Hence, in order to synchronise oestrus, it is important for progesterone to be reduced or removed at the same time. Hence, the method used for this stage is through the use of Matrix® (InterVet, Inc.; USA). Matrix® is an orally active, synthetic progesterone-like compound for oestrus synchronisation in mature sows and gilts. It is added to the feed and the feeding regime continually for 14 days. On average, oestrus occurs 4 to 9 days after the removal of Matrix® from the feed. Since it is a progesterone-like synthetic compound, it shares the same function as progesterone in suppressing the release of GnRH and the growth of follicles. With this method, the feeding of product is stopped at the same time for all the females involved, which results in oestrus synchronisation. The common result of using this product is that 85 to 90 % of the treated females undergo oestrus in the following 4 to 9 days after the product is discontinued, with the majority of them experiencing oestrus in the following 4 to 6 days. In order for the product to be effective, three conditions must be fulfilled. Firstly, the sows and gilts must be sexually mature and undergoing normal

oestrous cycles. Next, the product needs to be fed for 14 days otherwise the dose would be insufficient. Feeding periods less than 14 days typically are not sufficient to control follicular growth and oestrus for females in the early stages of the oestrous cycle. Lastly, the product has to be fed individually to ensure each female receives the same amount of the product. Feeding in pens or groups would cause some of the individual to consume less of the feed, hence receiving less of the product (Flowers, 2001).

2.4.3 Oestrus Synchronisation in Weaned Sows

For weaned sows, oestrus synchronisation is normally acquired through routine management. The suckling action of the piglets produces an inhibitory effect on the hypothalamus, hence reducing the release of GnRH. This in turn causes reduced levels of LH and FSH and also the stoppage of medium sized follicular growth.

After the piglets are weaned, the suckling action is removed and thus the inhibitory effect on hypothalamus is also removed. The LH and FSH levels will then increase as in normal oestrous cycles and the medium sized follicles will grow into large follicles to allow the sows to be in oestrus and finally, ovulation. Therefore, weaning the same group of sows on the same day is an effective method of oestrus synchronisation, which can be easily achieved under good management (Flowers, 2001)

2.5 Oestrus Synchronisation Products Available in the Market

2.5.1 MATRIX®

MATRIX[®] is an orally active, synthetic progesterone-like compound for oestrus synchronisation in mature sows and gilts. It is added to the feed and the feeding regime continues for 14 days. On average, oestrus comes 4 to 9 days after the removal of Matrix[®] from the feed. The mechanism of MATRIX[®] has been explained in section 2.4.2. MATRIX[®] gives swine producer unparalleled control of oestrus synchronisation in sexually mature, cycling females. This leads to maximal operating efficiency and profitability.

It is applied for synchronisation of oestrus in sexually mature gilts that have had at least one oestrous cycle. Treatment with altrenogest solution 0.22% results in oestrus (standing heat) 4 to 9 days after completion of the 14-day treatment period (Flowers, 2001).

2.5.2 PG600[®]

According to information retrieved from Merck Animal Health USE website, PG600[®] is used for induction of oestrus in prepubertal gilts and weaned sows experiencing delayed return to oestrus. The product is the combination of PMSG (Pregnant Mare's Serum Gonadotropin) and hCG (Human Chorionic Gonadotropin), which mimics naturally occurring reproductive hormones, FSH and LH. The mechanism of PG600[®] has been stated in section 2.4.1.

PG600[®] will not induce oestrus in mature gilts, in which the gilts have begun to cycle. Besides, gilts that are less than five and a half months of age or that weigh

less than 85 kg may not be mature enough to continue normal oestrus cycles or maintain a normal pregnancy to full term after treatment

2.5.3 Prostamate[®] and Lutalyse[®]

They are products of various forms of the naturally occurring prostaglandin F2 alpha (PGF2- α). These two products are the only prostaglandin products currently approved for use in swine in the USA. If one of these products is administered at the labelled dose between day 21 and 42 of gestation, they will induce pregnant gilts/sows to abort and reabsorb the litter. Breeders wanting to synchronise groups of sows that are in random phases of their oestrus cycle may use these prostaglandin F2 alpha products. After administration, the pregnant sows would abort their litter. Hence, oestrus synchronization can be achieved (Information taken from The Pig Site).

3.0 MATERIALS AND METHODS

3.1 Sample Selection

This study was conducted at a model farm in Bidor, Perak with good management and husbandry practice. The farm practiced a farrow-to-finish, intensive,

closed house system. In this study, six 8-month-old commercial cross-LYD-3 ways cross gilts weighing more than 120 kg were selected. All animal are in good health status without any disease or physical abnormalities. The animals were placed in individual gestation pens and divided into 3 groups. This study was approved by the Institutional Animal Care and Use Committee (IACUC), with the reference number UPM/IACUC/AUP-R005/2015.

3.2 Categorisation of Sample

The intravaginal device was made up of aluminium and consisted of the length (L) and base (B). The length had 3 sizes which were short, medium and long while the base had 2 sizes, which were small and large size. The measurement of each device was not disclosed to us.

The devices were divided into 3 categories. Category 1 consisted of the short length size with small base (SS), and short length size with large base (SL). Category 2 included medium length size with small base (MS) and medium length size with large base (ML). Category 3 included long length size with small base (LS) and large length size with large base (LL). For the design of the device, please refer to Appendix I.

3.3 Length of Study

The length of this study was 18 days. Day 1 involved physical examination of the gilts, allocation into pens, insertion of the device into the vagina of the animals, recording of the ease of insertion and visual assessment of the pig's reaction. From

Day 2 to Day 13, determination of the presence or absence of the device and assessment of pig behaviour were carried out daily. On Day 13, the device was removed using a specially designed hook. The pig's reaction during and immediately after device removal was assessed visually. From Day 14 to Day 18, onset of oestrus was determined. On Day 18, the animals were sacrificed to examine for lesions in the reproductive tract and for ovarian follicular status.

3.4 Examination of Gilts

Gilts were examined before insertion of device and before removal of device in terms of demeanour, body condition score (BCS), rectal temperature (°C), pulse (beats per minute) and respiration (breaths per minute).

Examination of vulva was also carried out before insertion and after removal of the device. The colour of vulva, secretion, moistness, mucosal appearance and presence of any anatomical dysfunction were assessed.

3.5 Insertion of device

After physical examination and examination of vulva, the pigs were restrained by snaring their snouts. Before insertion, the devices were lubricated with K-Y® Jelly

(Reckitt Benckiser; England, United Kingdom) to reduce friction between the devices and the vulva wall and also to prevent physical trauma.

The vulva lips were parted and upon insertion of the device, the ease of action was recorded. This was to determine the appropriate size of the device in terms of effectiveness and animal welfare. Visual assessment of the pig's reaction immediately after insertion was done to determine whether the sample pigs were having any uneasiness or uncomfortableness. Any pigs that appeared to be in pain or in excessive discomfort would have the device removed.

3.6 Monitoring of Gilts

Monitoring was carried out daily to check the retention rate of the device. Changes in pig behaviour such as change of appetite, fever, tail wagging, rubbing of the perineum, back arching and restlessness were recorded. If any pig appeared to be in pain or excessive discomfort at any time in the study, the device would be removed and the pig sacrificed if it was deemed necessary.

3.7 Removal of Device

The pigs were restrained before removal of the device. They were snared at the snout region. Removal was carried out carefully in order to take care of the animal

welfare. The vulva lips were parted in to locate the device and a specially designed hook was used to remove the device.

The pig's reaction during and immediately after device removal were visually assessed. The condition of the vaginal wall was examined after removal of the device. The pig's vagina was then flushed with diluted povidone iodine (10% solution) for disinfection purposes.

3.8 Oestrus Status

Four days after removal of the device, the animals were assessed for their oestrus status. Heat was detected through introduction of a mature boar and confirmed through post-mortem of the reproductive organs.

4.0 RESULTS

4.1 Ease of Insertion

In this study, the intravaginal devices were inserted on Day 1. Upon insertion, the ease of action was recorded. Table 4.1 shows the ease of insertion of each of the gylts. Devices SS, MS, ML and LS were successfully inserted. SS and ML were inserted with moderate resistance, MS was inserted easily with no resistance while LS was inserted with slight resistance. SL and LL were not successfully inserted as the base was too large. (Refer to Appendix II and III)

Table 4.1: The ease of insertion of the novel intravaginal device on Day 1

Device Code	Insertion	Ease of Insertion
SS	Inserted.	Moderate resistance.
SL	Not inserted.	Could not be inserted as base too large.
MS	Inserted.	Easy with no resistance.
ML	Inserted.	Moderate resistance.
LS	Inserted.	Slight resistance.
LL	Not inserted.	Could not be inserted as base too large.

4.2 Retention Rate

The retention of devices was taken into consideration as the devices had to be inserted into the vagina for 13 days. It was recorded from Day 1 until Day 13. SS, MS and ML were successfully retained in the vagina until Day 13. LS device was removed on Day 5 as the device was too long in size, causing the vulva to be in open condition. Since SL and LL were not inserted, the retention of the devices was not applicable.

Table 4.2: The retention rate of the novel intravaginal device from Day 1 to Day 13

Device Code	Retention until Day 13
SS	Yes.
SL	Not applicable.
MS	Yes.
ML	Yes.
LS	Removed on Day 5 as the device was too long, causing the vulva to be in open condition.
LL	Not applicable.

4.3 Ease of Removal

The devices were removed on Day 13 of the study. Upon removal, the ease of removal was recorded. All these three devices SS, MS and ML were easily taken out once adhesion between the caudal part of the device and vagina wall was broken. LS was easily taken out on Day 5 without any complication. Since SL and LL were not inserted, the removal of device did not take place. (Refer to Appendix V)

Table 4.3: The ease of removal of the novel intravaginal device on Day 13

Device Code	Ease of Removal on Day 13
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SS	Easily taken out once adhesion on caudal part of the device was broken.
SL	Not applicable.
MS	Easily taken out once adhesion on caudal part of the device was broken.
ML	Easily taken out once adhesion on caudal part of the device was broken.
LS	Easily taken out on Day 5.
LL	Not applicable.

4.4 Pig Behaviour

Pig behaviour such as appetite of gilts, occurrence of fever, tail wagging, rubbing of perineum, back arching and restlessness were monitored throughout the study. Observation was done by us when we were present at the farm and by the farm workers when we were absent. The occurrence of any abnormal behaviour was recorded. Gilts SS, MS and ML were all showing normal behaviour. Gilt LS was also displaying normal behaviour despite having opened and swollen vulva. Since SL and LL were not inserted, the pig behaviour of both gilts was not taken into consideration of the study. (Refer to Appendix IV)

Table 4.4: Pig behaviour (such as appetite, fever, tail wagging, rubbing perineum, back arching and restlessness) when the device was inserted from Day 1 to Day

Device Code	Pig Behaviour
SS	Normal.
SL	Not applicable.
MS	Normal.
ML	Normal.
LS	Normal despite opened and swollen vulva.
LL	Not applicable.

5.0 DISCUSSION

Based on the results collected, the devices with large base were not suitable for insertion. Both SL and LL devices were not successfully inserted due to size issue. ML was successfully inserted but the insertion was carried out with moderate resistance. On the other hand, devices with small base were all successfully inserted. The smaller diameter of the base enabled easier insertion of the devices. Although the insertion of SS was completed with moderate resistance, MS was inserted easily with no resistance and LS was inserted with only slight resistance.

Besides, devices with long length were also not suitable for insertion, it leads to incomplete insertion. LS was inserted on Day 1 but vulva remain open as the device was too long. The vulva was hardened due to device incomplete insertion. On Day 5, the LS device was removed as it was not success fully inserted. The inability to device LL was partly due to the size of the length. SS, MS and ML were able to retain in the vagina cavity up to Day 13 with the vulva remained close.

The removal of device was also assessed. LS was easily taken out without any complication on Day 5. All three SS, MS and ML devices were easily taken out once adhesion between the caudal part of the device and vagina wall was broken. The complication was the adhesion lengthened the time of device removal and possibly caused physical trauma to the inner vaginal wall. The devices were only easily removed after the adhesion was broken.

For the pig behaviour, the results collected might not reflect the true status of the gilts. This was due to the observation was mostly carried out by the farm workers, where the reliability of the results was unknown.

The use of aluminium as material of device was not an appropriate choice. It caused trauma to the inner vaginal wall of the gilts. This was due to adhesion reaction occurring between the aluminium device and the inner vagina wall. During removal, the adhesion had to be broken down, hence causing physical trauma to the inner vagina wall.

From the results, devices SS and MS are suitable to be developed in further research. They are small sized enough to be inserted and retained in the vagina until Day 13. Device ML might not be suitable for continued research development as a larger gilt was used compared to devices SS and MS.

6.0 CONCLUSION

In conclusion, the intravaginal device can achieve oestrus synchronisation in pigs, as shown in gilts SS, MS, and ML. The SS and MS devices are more appropriate to be used for further study.

The long length devices are not suitable as the insertion of LS was not complete while device LL cannot be inserted. The large base devices are not suitable as the insertion of SL and LL cannot take place.

Besides, the use of aluminium material is not suitable as trauma was introduced to the inner wall of vagina of the gilts. The shape design of the device has to be revised to reduce injury to the vagina inner wall during insertion and removal.

7.0 RECOMMENDATION

This is still a plenary study and required a larger sample size if similar research work planning to be done again. Increase samples size enable the researcher to collect more data regarding the ideal device design and oestrus synchronisation rate.

The research team suggested that in future study the device should be made of nylon plastic or polyester material. The use of aluminium as material for the device has higher possibility of causing physical trauma in the vagina, as shown in this study.

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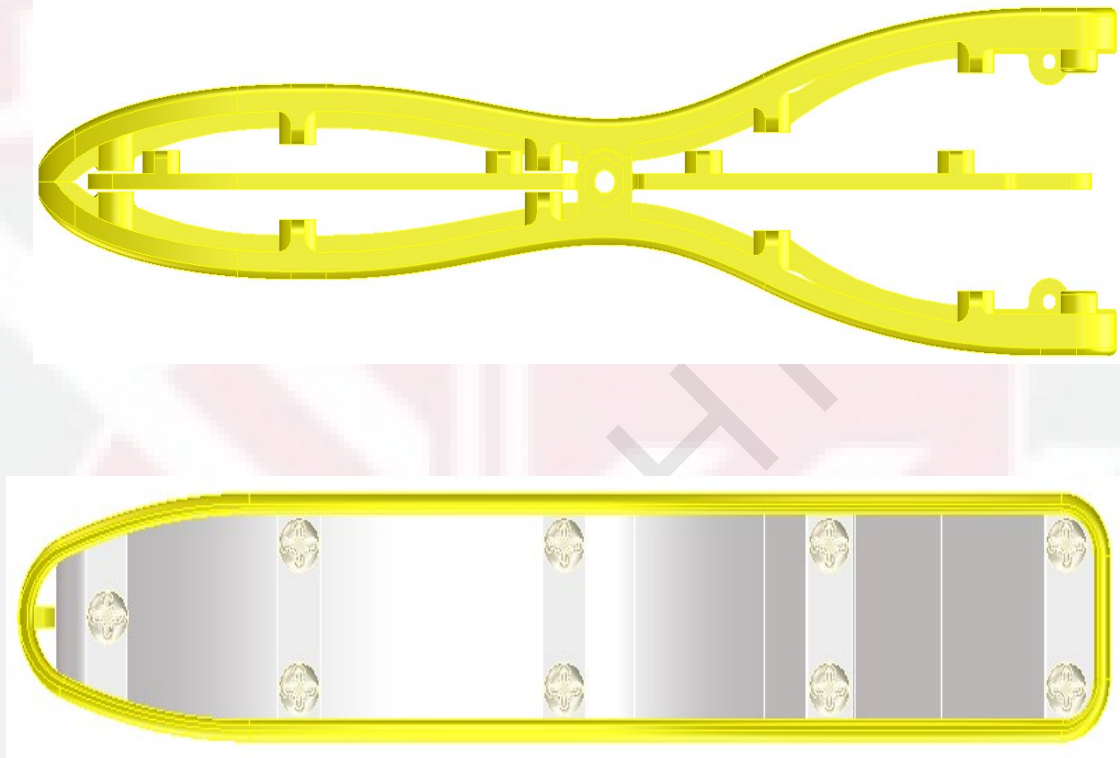
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Appendix I

The design of the novel intravaginal device



Appendix II

The application of K-Y Jelly onto the device and insertion of the device into the vagina of pig on Day 1



Appendix III

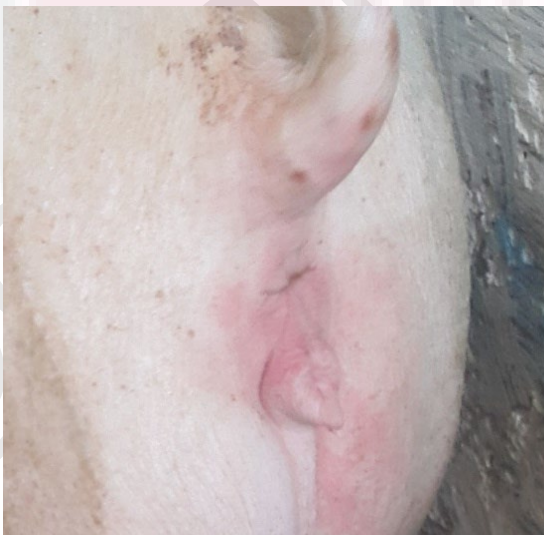
The closed vagina of gilt SS



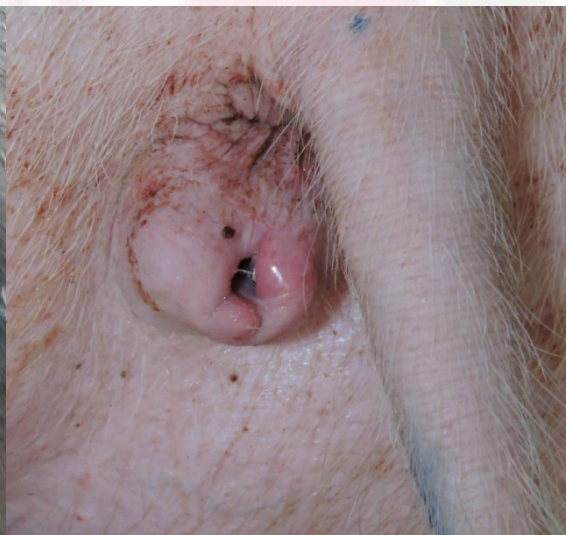
The closed vagina of gilt ML



The closed vagina of gilt MS



The opened vagina of gilt LS



Appendix IV

Monitoring of pigs from Day 1 to Day 13, including observation for behaviours (top), obtaining heart rate (bottom left) and temperature (bottom right)





Appendix V

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Removal of the device from the pig on Day 13



Flushing of vagina after device removal using diluted povidone iodine

