

THE IMPROVEMENT AND APPLICATION OF EI-GUN (ELECTRICAL INSEMINATION GUN) FOR ARTIFICIAL INSEMINATION (AI) USING GOAT FRESH SEMEN

Mirsa Ita Dewi Adiana¹⁾, Gatot Ciptadi²⁾ and Lilik Eka Radiati²⁾

¹⁾Student at Faculty of Animal Husbandry, University of Brawijaya

²⁾Lecturer at Faculty of Animal Husbandry, Brawijaya of Brawijaya

email adianamirsa@gmail.com

ABSTRACT

Electrical Insemination Gun (EI-GUN) was a tool for Artificial Insemination (AI) using fresh semen with an electric control system. The research objective was to produced EI-GUN for AI using fresh semen on small ruminants (goat). The research was conducted from March to June 2015. The process of EI-GUN creation implemented in Design and Prototype Laboratory and Aero Modeling Research Laboratory at Engineering Faculty, University of Brawijaya (UB). Testing tools EI-GUN on goat was conducted in the Sumber Sekar Laboratory, Animal Husbandry Faculty, UB. The methods of research were literature study, tool specification determination, designing EI-GUN, running test, semen evaluation passed EI-GUN and application on Goat. EI-GUN has seven important parts, which supports each other in this operating system. Those parts consist of stilet, servo, system controlled, insemination pump, connecting rod, battery, and holder. EI-GUN work system sucked the semen into insemination pump as much as 5 ml, and release the semen 0.25 ml appropriate standard of AI. It was applicable for 20 times AI. The results showed that the cell motility of spermatozoa $\geq 70\%$ were still in ranging of Indonesian National Standard (SNI).

Keywords: artificial insemination, EI-GUN, fresh semen.

BACKGROUND

One of technological advances in the field of animal husbandry to improve the local livestock in Indonesia is Artificial Insemination (AI). AI is currently the most practical technology for optimizing reproductive efficiency. AI technology is quite good in Indonesia, but on a small livestock such as sheep and goats was limited. According to Roca, et. al., (1997) at Pamungkas, F.A. (2009) reported that the success rate of AI in goats ranged between 33-73%. Whereas, In Tunisia, the success of AI is 46-68% (Djemali, et. al., 2009) and Indonesia is less than 30% (Inounu, 2014). A number of factors were reported to affect the success of AI including nutrition, breeding season,

environmental conditions, parity, breed, farm, depth of semen deposition, extender composition and hormone treatment and the most importance one is quality of semen (Mellado et. al., 2004 and 2006; Nunes and Salgueiro, 2011).

Frozen semen is semen that collected from superior male, healthy, free from infectious animal diseases were diluted according to the procedure of production process. Processing of frozen semen in Indonesia only can be done by Artificial Insemination Centre (AI Center), namely Balai Besar Inseminasi Buatan (BBIB) Lembang in Bandung and BBIB Singosari in Malang. Frozen semen processing requires the expensive equipment. This happens because of the

difficulty of the freezing process and must be performed by people who are experts to handle. The implementation of frozen semen still has several problems, including delays in the procurement of liquid nitrogen, the limited containers, and the number of Post Thawing Mortality (PTM) is less than 35% with a pregnancy rate of 60% (Yusran et. al.,2001; Affandhy et.al.,2004). Frozen semen stored in liquid nitrogen bath at a temperature of -196°C in cryogenic containers, it makes dependence on liquid nitrogen which is expensive and difficult to obtain. Another problem is the chain length distribution of frozen semen from the AI Center until inseminator to implementation at the farmer (Situmorang, 2003).

Alternative technologies to avoid the problems of frozen semen is by using fresh semen. The fresh semen after collection and evaluation, that meets the required standards was extended to increase its volume and give many doses. Semen preservation involves the use of semen diluents or extenders that will nourish the spermatozoa and provide a good environment for their survival. The volume of extender added to the semen was worked out in such a manner that the resulting doses obtained from each ejaculate will contain a sufficient number. The quality of fresh semen is higher than frozen semen, according to Morel (1999), one million fresh semen comparable fertility with fifteen millions of frozen semen. However, the application of AI using fresh semen didn't implemented optimally yet, because there was no insemination gun tool that can be used for practically. The several special reproduction techniques were needed to insemination with fresh semen. Then provides valuable practical opportunities to the modern sheep and goat breeder to improve reproduction efficiency and to enhance genetic improvement.

The program of AI by using fresh semen can be applied with EI-GUN (Electrical Insemination Gun). EI-GUN is a tool of AI that has been modified

electrically to insemination with fresh semen. EI-GUN was created based on the lack of efficiency the AI at small ruminants (sheep or goat) using frozen semen. The advantages of EI-GUN are the process of AI becomes faster, economical and had a high success rate. EI-GUN has the electric system and portable, it was applicable in any area without dependence on liquid nitrogen.

MATERIAL AND METODHS

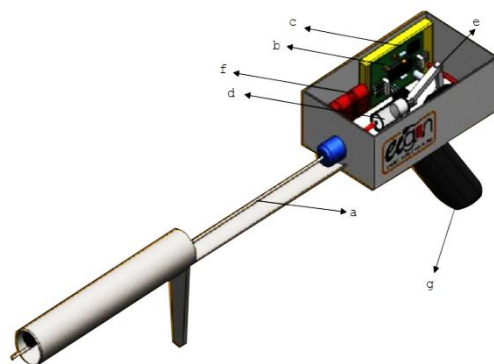
The material for produce EI-GUN has seven important parts. Those parts are a stylet, servo, system controlled, insemination pump, connecting rod, battery, and holder. The body of EI-GUN made from stainless steel, which has strength to keep the component inside the body, so it will work properly to maximize the result.

The material of this research was boer goat semen from one buck. Te buck came from Sumber Sekar Laboratory. The buck should be healthy, mature, and its semen doesn't collected for couple days before. Semen diluted using Andromed extender, and divide into 5 part. The equipments of this research are a set of Artificial Vagina (AV), a set of Microscope, testube, object glass, cover glass, ose, eosin-negrosin for staining, micro pipette, EI-GUN.

The methods of research were literature study, tool specification determination, designing EI-GUN, running test, semen evaluation passed EI-GUN and application on Goat.

RESULTS AND DISSCUSSIONS

Electrical Insemination Gun (EI-GUN) is the development of AI technology use fresh semen that has high fertility. The design of EI-GUN (Figure 1) works using the concept of sucking the semen and automatic pressure gave the servo on stylet (stick gun). Materials and components of EI-GUN based on Figure 1 below used in accordance with the standards food grade so that the fresh semen resulted in having a good quality.



a) stylet; b) servo; c) system controlled; d) insemiation pump; e) connecting rod; f) Battery; g) holder

Figure 1. Design of EI-GUN

EI-GUN has seven important parts, which supports each other in this operating system (Figure 1). The first is the stylet (a). The stylet is a small sized, small pipe with a length of 45 cm and a diameter of 4 mm, made from stainless steel which has a very small possibility to undergo corrosion. So it is safe for the spermatozoa.

The second part is the servo (b). Servo is a core part of this tool. The function of the servo is to suck and push the semen. The speed generated by the servo is 14-16 seconds/angle. The tool will produce semen slowly and static, in accordance with the standard procedure of doing the AI on goats.

The third part is the set of system controls (c) this section is an electro design that has the essential function. Consists of small components that were assembled to drive the servo with the source electricity from the battery. The technology used is microcontroller ATMEGA8. This section was stringed up with the servo.

The fourth part is the insemiation pump (d). This section is in the form of the vacuum flask that served as a holding tool to semen that has a volume of 5 ml.

The fifth part is the connecting rod(e). This section is the liaison between stylet with insemiation pump.

The sixth part is the battery (f). The battery on this tool serves as a power source this tool. The battery is a battery

with a capacity of 300 mAh LiPo type and voltage 6.0 V-5.0 V.

The last part is the holder (g). This section serves as a handle that is used to hold the tool in the right position in AI process.

Running Test

Design of EI-GUN (Figure 1) almost of component made from steel and one of them is electrical component. It is easy to kill the sperm cell when electrical short-circuit is happen. Insemiation pump had made from food grade plastic which will keep the semen get spared from electrical short-circuit. All of those component work properly and create a system to input 5ml semen and release 0.25ml semen. All this system has set to work semi-automatically.

Below is the specifications produced by EI-GUN that analysis to improve the tools.

Table 1. Specifications produced by EI-GUN

Specifications	Description
System controlled	Microcontroller ATMEGA8
Battery	LiPo 300 mAh 3.7 V – 16.0 V
Insemiation pump	Capacity 5 ml
Connecting rod	Gives a pump movement 2-3 cm
The servo movement	Produces 14-16 seconds/60°
The power button	EI-GUN switch on and off button
The Suck Button/ Red Button	Suck the semen as much as 5 ml
The Shoot Button/ Green Button	Release the semen as much as 0.25 ml

Table 1 shows that specification produced by EI-GUN was running well. The main controller of EI-GUN is from Microcontroller ATMEGA8, this electric system which drives the servo. The servo power use battery, the battery type is LiPo that has capacity 300 mAh and produces 3.7-16.0 voltage. The servo movement

produced 14-16 seconds/60o, its mean the tool can release the semen slowly and static in accordance with the standard procedure of AI in goats. The insemination pump collects the semen as much as 5 ml, its mean suitable with the function of suck button. The connecting rod gives the movement 2-3 cm, this tool a connection between the stylet with insemination pump All of the components be equipped with the power button, this part consists of a switch on and off.

Semen Quality Test on EI-GUN

Testing the quality of semen in the laboratory was used to know the quality of spermatozoa on the application of EI-GUN. The results of these observations were presented in Table 2.

Table 2. Data Analysis of Test Quality on Boer Goat Spermatozoa

No	Parameter	Before Applied	After applied EI-GUN
1	Semen volume	5 ml	5 ml
2	The motility of the spermatozoa	73%	70%

Table 2. showed that volume of semen as much as 5 ml in constant condition after passed from EI-GUN. Therefore, no semen that left inside the insemination pump or stylet. Servo arranged to move the connecting rod related to the insemination pump. The control system was connected to a suction and shoot button. When the suction button pressed, suction head moves back and perform suction step to suck the semen as much as 5 ml. EI-GUN had a plastic component of insemination pump. The aim was to reduce the temperature difference. Spermatozoa were really sensitive to the temperature change. It could be the insemination pump wich had gave the impact to the semen motility. There were sucking process wich had a pressure. This pressure might made the motility became low. In the other hand, this sucking process gave effect of speed momentum wich cause several shock movement.

The motility of spermatozoa (progressive movement) showed an ability of sperm to fertilize an ovum. Motility was influenced by several factors, including the maturation of sperm and sperm age. The use of fresh semen was expected to get a higher level of sperm motility. Based on the observation that the average sperm motility of Boer goat before applied into the EI-GUN is $\pm 73\%$ and after released from the EI-GUN to $\pm 70\%$ (decrease of 2-3%). The decline caused by several factors, including the condition of the semen in different temperatures. The mass motility was decrease due to several factor such as shock movement while handling, extreme temperature exposure, and long period of handling could be a causal of decreasing motility (Agarwal, 2011). Another possibility of this quality reduction was unsterile container (testube), it became toxic for spermatozoa and reduce the motility. Therefore, an extra element required in EI-GUN to maintain the temperature of the spermatozoa. Cell motility of spermatozoa still more than 70%, it has mean that the value on Indonesia National Standard (SNI).

The Implementation of EI-GUN on Female Goat

Spermatozoa quality test results used as the evaluation for implementation. The application of AI use EI-GUN exists in the Sumber Sekar laboratory. The implementation accompanied by the inseminator who is partners program of EI-GUN. The technique of AI on goats in accordance with the procedures, which have been, described previously (3.2.7). Figure 11 show the method to implementation the EI-GUN. The implementation use standart procedure to keep the safety of goat and inseminator. AI results can be seen after 2-3 months with pregnancy test.



Figure 2. AI use fresh semen on Kacang Goat

EI-GUN using electric system control in the operation and offers ease in discharging this insemination tools. The advantages of this tool include:

- AI fresh semen though the location of cattle is very remote or isolated to reach.
- By pressing the suction button 1 time, it will suck as much as 5 ml of semen.
- By pressing the shoot button 1 time will encourage as much 0.25 ml semen appropriate with AI standard size that was used to do.
- The electric system in the EI-GUN tool makes it easy for the farmer to use this tool.
- Material tools used are stainless steel, which has food grade standards.
- Portable and efficient tool invention.

CONCLUSIONS

1. Produce the design of EI-GUN tool with an electric and functional system for AI use fresh semen on goats.
 - The total length of body of EI-GUN is 60 cm with 2 main sections namely stylet which has length 45 cm and a body system control's length is 15 cm. As for the width of the body system control is 8 cm and height 4 cm.
 - The components of EI-GUN are a stylet, servo, batteries, connecting rod, insemination pump, system control, on-off switch, suction button, shoot button, body system control, and holder.
 - The working system by pressing the suction button once, insemination

pump will suck semen as much as 5 ml, but by pressing shoot button once, the semen comes out as much 0.25 ml appropriated with AI standard. This is very effective because, with one suck, it can be used for AI 20 times or 20 shots.

2. EI-GUN tool which has been produced proven to be applied to the partners for AI use fresh semen. It was supported by semen evaluation results that cell motility of spermatozoa is $\geq 70\%$ and still include in Indonesia National Standard (SNI).

UCAPAN TERIMAKASIH

Penelitian ini dibiayai melalui program PKM tahun 2015. Telah memenangkan medali emas untuk poster dan presentasi oral

DAFTAR PUSTAKA

- Affandhy, L., Situmorang, P., Rasyid, A., dan Pamungkas, D. 2004. Uji Fertilitas Semen Cair pada Induk Sapi-Peranakan Ongole pada Kondisi Peternakan Rakyat. Seminar Nasional Teknologi Peternakan dan Veteriner. 26 – 35.
- Agarwal, A., dan Said, T.M. 2011. Interpretation of Basic Semen Analysis and Advanced Semen Testing. *Journal of Agricultural Science* :15-22.
- Bonet, S., Casas, I., Holt, W.V., and Yeste, M., 2013. *Boar Reproduction. Fundamentals and New Biotechnological Trends*. New York. Springer.
- Djemali, M., Romdhani, B.S., Iniguez, L., and Inounu, I. 2009. Saving Threatened Native Breeds by Autonomous Production, The Involvement of Farmers Organization, Research and Policy Makers: The Case of The Sicilo-Sarde Breed in Tunisia, North Africa. *Livestock Science*. 120:213-217.
- Foote, R. H. 2000. *The History of Artificial Insemination*

- tion. Department of Animal Science, Cornell University, Ithaca, NY 14853-4801.
- Gordon, I. 1983. *Controlled Breeding in Farms Animals*. Pergamon Press.
- Hafez, E.S.E. dan Hafez, B. 2000. *Reproduction In Farm Animals*. 7th edition. Lippincott Williams and Wilkins. Maryland, USA.
- Herdis, M.S., dan Kusuma, I. 2001. *Inseminasi Buatan Teknologi Tepat Guna untuk Meningkatkan Populasi Ternak Akibat Krisis Ekonomi*. Badan Pengkajian dan Penerapan Teknologi. Jakarta. pp. 7-11.
- Inounu, I. 2014. *Upaya Meningkatkan Keberhasilan Inseminasi Buatan pada Ternak Ruminansia Kecil*. *Wartazoa*. 24 (4). 201-209.
- Mellado M., Valdez, R., Lara, L.M., dan Garcia, J.E. 2004. Risk Factors Involved in Conception, Abortion, and Kidding Rates of Goats Under Extensive Conditions. *Small Ruminant Research*. 55: 191-198.
- Mellado, M., Valdez, R., Garcia, J.E., Lopez, R., and Rodriguez, A, 2006. Factors Affecting The Reproductive Performance of Goats Under Intensive Conditions in a Hot Arid Environment. *Small Ruminant Research*. 63: 110-118.
- Minitub. 2001. *Certificate Andromed. Minitub Abfullund Labortechnik GmbH and Co KG*. Germany.
- Morel, D.M.C.G. 1999. *Equine Artificial Insemination*. Oxon: CAB1 Publishing.
- Nunes, J.F., and Salgueiro, C.C.M. 2011. Strategies to Improve The Reproductive Efficiency of Goats in Brazil. *Small Ruminant. Res* 98: 176-184.
- Pamungkas, F.A. 2009. *Potensi dan Kualitas Semen Kambing dalam Rangka Aplikasi Teknologi Inseminasi Buatan*. *Wartazoa*. 19 (1): 17-22.
- Partodihardjo, S. 1987. *Ilmu Reproduksi Hewan*. Jakarta: Mutiara Sumber Widya.
- Roca, J., J.A. Carrizosa, I. Compos, A. Lafuente, J.M. Vasquez and E. Martinez. 1997. Viability and Fertility of Unashed Murciano-Granadina Goat Spermatozoa Diluted in Tris-Egg Yolk Extender and Stored at 5°C. *Small Rum. Res*. 25: 147 – 153.
- Sariubang, M., dan Tambing, S.N. 2008. *Produktivitas Sapi Potong Hasil Inseminasi Buatan (IB)*. Dalam *Prosiding Seminar Nasional Teknologi Peternakan dan Veteriner 2008*.
- Situmorang, P. 2003. *Prospek Penggunaan Semen Dingin (Chilled Semen) dalam Usaha Meningkatkan Produksi Sapi Perah*. Bogor : Balai Penelitian Ternak.
- Suharyati, S. dan Hartono, M. 2013. *Peningkatan Kualitas Semen Kambing Boer dengan Pemberian Vitamin E dan Mineral Zn*. *Jurnal Kedokteran Hewan*. 7(2) : 91-93.
- Smith, P. A., Boland, M. P. and Gordon. 1978. Conception Rate in Ewes: Effect of Method of Breeding and Number of Inseminations. *J. Agric. Sci. Camb*. 91, 511-512.
- Toelihere, M.R. 1993. *Inseminasi Buatan pada Ternak*. Bandung: Angkasa.
- Tsuma, V.T, Khan, M.S., Okeyo, A.M. and Ibrahim, M.N.M. 2015. *A Training Manual on Artificial Insemination In Goats*. ILRI Manual 19. Nairobi, Kenya: International Livestock Research.
- Webb D.W. 2003. *Artificial Insemination in Cattle*. University of Florida, Gainesville. IFAS Extension, DS 58. Pp. 1-4.
- Yudi, Arifiantini, I., Purwantara, B., dan Yusuf, T.L. 2008. *Daya Tahan Semen Segar dan Kualitas Semen segar Kuda dengan Konsentrasi Spermatozoa Berbeda dalam Pen-*

gencerDimitripoulus yang Dimodifikasi. JITV.13(1). 35-42.

Yusran, M.A., Affandhy, L., dan Suyanto. 2001. Pengkajian Keragaan, Permasalahandan Alternatif Solusi Program IB Sapi Potong Di Jawa-Timur. Dalam: Prosiding.Seminar Nasional Teknologi Peternakan dan Veteriner 2001. Puslitbang.Peternakan, Bogor: 155- 167.