A New Disposable Injection Device for Dairy Cows

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Abstract

Since the climate in Taiwan is hot and humid, the reproductive performance of dairy cows in Taiwan usually decreases due to heat stress. This phenomenon causes the decline in pregnancy, birth and milk production of dairy cows, leading to a great economic loss in dairy industry. Previous studies have shown that mice with premature ovarian failure can restore their fertility by injecting cells into their ovaries. I suppose that the reproductive ability of dairy cows can be restored by similar techniques used in mice. In order to demonstrate this hypothesis, a specific injection device for cows is needed. Therefore, the goal of this project is to develop an ovary-specific cell injection device for dairy cows.

1 Introduction

The dairy cows in Taiwan are mainly Holstein cows, originating from the Netherlands and now distributing worldwide also. Holstein cows, characterized by intercalating black and white color on their skin, only produce milk after delivery. Therefore, these cows have to undergo repeated pregnancies and deliveries to produce milk as much as possible. Because the quality of their meat is not good enough, male cows are usually sacrificed when they are young. Only a few male cows are kept for breeding. By current biotechnology, cow sperms can be classified into X-chromosome or Y-chromosome carriers. It raises the probability of producing female dairy cows [1]. The key point of dairy industry depends on technology of dairy cow breeding and reproduction.

Taiwan is mainly located in the subtropical zone, thus the weather is often hot and humid. Typhoons usually attack Taiwan during summer and fall. In this kind of weather, dairy cows are prone to suffer from heat stress. This phenomenon decreases pregnancy rates, delivery rates and milk production of cows, causing economic losses to the dairy farmers [2]. From mouse studies, premature ovarian failure can be successfully treated by injecting specific cells into ovaries. This idea might also work on dairy cows with low reproductive ability. Therefore, the goal of this project is to develop a new ovary-specific injection device for dairy cows. By using this new device during rectal examination, specific cells or solutions can be injected into ovaries. Then whether low reproductive ability of dairy cows can be treated by this device can be investigated.

2 Design Concept

The current ovary-specific injection for dairy cows has two disadvantages. First of all, the efficacy is variable. It is not disposable, thus used repeatedly. Sometimes the needle is not sharp enough to pierce rectal wall and ovarian capsule due to repeated use. No effective management could check the quality of needles. Therefore, the success of injection cannot be guaranteed all the time. In addition, no sterilization procedure is done between each injection. This increases the risk of cross-infections between dairy cows. In order to avoid these disadvantages, the new device is designed to have a disposal needle module which is easy to assembly to and disassembly from the main body. The new device meets the requirements of convenience, good hygiene, safety, and reliability.

3 Technical Development

This new device will become a good tool to improve low reproductive ability of dairy cows by injecting cells to ovaries. This device uses the concepts of assembly, disassembly and disposable needles to fulfill the requirements for convenient, good hygiene, safety, and reliability.

4 Technological Competitiveness

The current device is integrally molded and the needle is reusable. It elevates the cost of device and causes user inconvenience. This new device will integrate the resources from the dairy farms in our university and the company in the southern Taiwan. I can also apply for patent to enhance the value of this device. In addition, this new device costs less and is operated easier in assembly and disassembly process. This device can inject cells to the ovary in a safe and fast manner. By this device, the reproductive disorders of dairy cows will be treated and the milk production will be improved during summer time.

According to the market value of dairy, female cows have to wait until the next estrous cycle if they cannot be successfully pregnant during this estrous cycle. The dairy cows will be sold as beef cattle if they fail to become pregnant within two consecutive estrous cycles. Compared to a successful pregnancy and mild production, dairy farmers will suffer from a greater economic loss from selling dairy cows as beef cattle only. If this new device can help to increase pregnancy rate of dairy cows, dairy farmers will benefit a lot.

5 R&D Result

According to design requirements, this device contains three modules: needle module, cell injection module, and cell container engaging module. Based on these three modules, I have designed four components, including disposal needle, cell injection tubing, shell of cell injection tubing, and engaging head of cell container. The 3D drawing of the device is shown in Figure 1. The real parts of the device can be seen in Figure 2 and Figure 3. After finishing the assembly and testing process, the interns of dairy farms in our university practice to use this device in dairy cows. The practicing process in dairy cows is shown in Figure 4 and Figure 5.

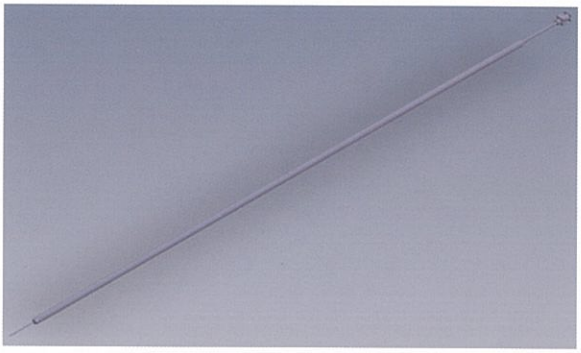

Fig. 1 The 3D drawing of the design device

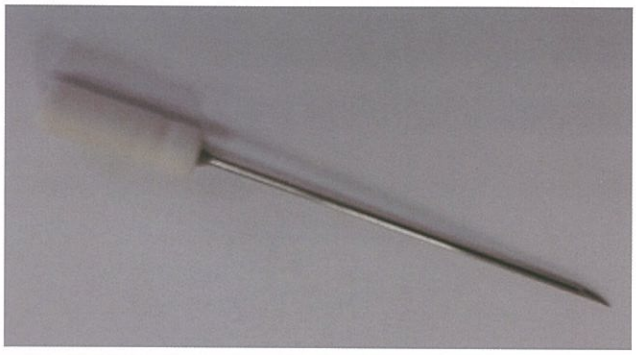

Fig. 2 The needle part of the design device

Fig. 3 The body part of the design device

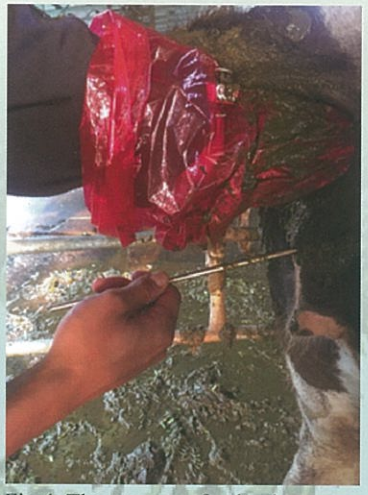

Fig.4 The process of animal experiment_1

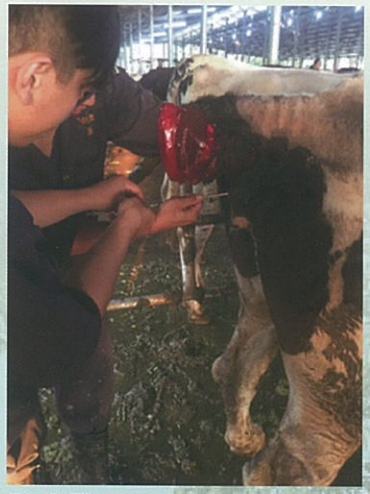

Fig.5 The process of animal experiment_2

By the practicing process, the new device can indeed avoid the drawbacks of current ones. The disposable needle module can reduce the risk of cross-infections and guarantee the success of injection. Therefore, this new device can be promoted by its convenience, good hygiene, security, and reliability. Next, this new device will be promoted to dairy farms in southern Taiwan, applied as a patent and potential technical transfer to a company. It will become a good model for industry-university cooperation.

References

[1] Wikipedia, Cattle, Website: https://en.wikipedia.org/wiki/Cattle

[2] Relieve Summer Heat Pressing in Cows and Pigs, 2009, Abroad report of Livestock Research Institute in Taiwan