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Assessment of the reproductive performance of dairy cows under smallholder production system

(Penilaian prestasi pembiakan lembu tenusu dalam sistem pengeluaran penternak kecil)

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Key words: reproductive performance, dairy cows, smallholder production system, milk-progesterone, radioimmunoassay

Abstract

The reproductive performance of dairy cows under smallholder production system from three regions in Johor and two regions in Melaka states was evaluated based on the progesterone concentration in one milk sampling [taken on the day of artificial insemination (AI)], two milk samplings (taken on the day of AI and day 10–12 after AI) and three milk samplings (taken on the day of AI, day 10–12 and day 22–24 after AI). Overall, 115, 107 and 59 cows had one, two and three milk samplings, respectively. The progesterone concentration in the milk samples was determined by radioimmunoassay (RIA). Cows were diagnosed for pregnancy through rectal palpation two to four months after AI.

Based on one milk sampling, 93% of the cows inseminated were in true oestrus, 2.6% were doubtful and 4.3% were not in oestrus. The progesterone concentrations from two milk samplings showed that 85.7% of the cows had ovulated, 1.9% had luteal cyst, 3.8% had short luteal phase or anovulation and 10.9% had reproductive status that cannot be confirmed. The three milk samplings followed by pregnancy diagnosis revealed that 54.2% of the cows were pregnant, 18.6% had either non-fertilization or early embryonic mortality, another 18.6% had either late embryonic mortality, luteal cyst or persistent corpus luteum (both frequencies contributed a reproductive wastage of 37.2%), 6.8% were in doubtful reproductive status and 1.7% incidence of AI on pregnant animal.

Altogether there were a total of 121 AI services for 115 cows in which 43 resulted in pregnancy giving an overall conception rate of 35.5% and 2.8 services per conception. By milk-progesterone RIA, the accuracy of early pregnancy and early non-pregnancy diagnosis (day 22–24 after AI) was 75% and 100%, respectively.

The study showed that there was a high occurrence of true oestrus and ovulation in dairy cows under smallholder production system but the conception rate obtained was low due to the high occurrence of reproductive wastage.

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Introduction

Low conception rate from artificial insemination (AI) in cattle has always been the major reason for dairy farmers not adopting AI as a routine breeding technique in this country. Dairy farmers are more convinced with using bulls to impregnate their cows. Hence, bulls are used widely in dairy smallholders replacing AI in breeding. Other than the low conception rate, some farmers had difficulties in getting the AI services more due to logistic and communication problems.

The low conception rate can be due to several factors which include those related to the cow, management and environment, and the interaction of these factors. It has always been presumed that cow that is being bred is on true oestrus, ovulated and has a functional corpus luteum to maintain pregnancy. However, there are instances where cows being bred are not in oestrus, not ovulating or conceived but experience early or late embryonic mortality. All these reproductive events play a vital role in affecting the fertility of the cow and their occurrence will influence the conception rate. The extent of occurrence of these reproductive events needs to be known so that appropriate measures can be adopted to improve the fertility.

The objective of this study was to assess the reproductive status of dairy cows (occurrence of true oestrus, ovulation, conceptions, embryonic mortality and persistent corpus luteum) under smallholder production system by milk-progesterone radioimmunoassay.

Materials and methods

Milk samples of cows of first to fifth parities from three regions in the states of Johor and two regions in Melaka were collected on the day of AI, day 10–12 after AI and day 22–24 after AI using 10 mL tube containing one sodium azide tablet as preservative. The sample was taken from the pail containing the composite milk after hand or machine milking was completed, chilled in ice cubes and subsequently centrifuged for 15 min at 2300 x g at room temperature to remove the fat. The fat-free milk was stored at –21 °C until analysed for progesterone concentration (P_4).

The P_4 in the fat-free milk was determined by solid-phase radioimunoassay (RIA) using kit with antibody pre-coated tubes supplied by Animal Production and Health Section of International Atomic Energy Agency. The procedures of the assay were as described in the manual provided by the agency (Progesterone RIA Pre-Coated Tube Method, Assay Protocol Version 2.0, January 1993). Labelled Iodine^{125}-Progesterone was used as isotope tracer and gamma counter (Series E 5005 Cobra; Packard Instrument Company) was used to count the radioactivity of the tracer in the standard, quality control and unknown samples. The intra- and inter-assay coefficients of variations were 3.7% and 10.7%, respectively. Cows were checked for pregnancy through rectal palpation 2–4 months after AI.

Cows were categorized according to their reproductive status based on the P_4 values using the guidelines as described in Garcia (1996). From the guidelines, P_4 levels from undetectable to <1 nmol/litre, 1–3 nmol/litre and >3 nmol/litre were designated as low, intermediate and high concentrations, respectively.

The one milk sampling (on the day of AI) was used to verify whether the animal was in true oestrus and not inseminated during the luteal phase (i.e. incorrect timing, high progesterone values), two milk samplings (on the day of AI and on day 10–12 after AI) to verify whether the animal was cycling and had ovulated, and three milk samplings (on the day of AI, day 10–12 and day 22–24 after AI) plus pregnancy diagnosis to verify whether the animal had conceived, lost the embryo, inseminated while already pregnant or inseminated when acyclic. On the whole, 115, 107 and 59 cows had one, two and three milk samplings, respectively.

The extent of occurrence of the various reproductive events was measured in percentage, as this was an assessment study.

Results and discussion

Based on P_4 from one milk sampling, 93% of the cows presented for AI were in true oestrus or AI was performed outside the luteal phase *(Table 1)*. Proportion of cows categorized as not in oestrus or an indicative that AI was done too early or too late relative to oestrus accounted for 2.6%. The proportion of cows not in oestrus or bred during the luteal phase was 4.3%.

The proportion of cows with ovulatory oestrus was 85.7% *(Table 2)* and cows with anovulation or short luteal phase accounted for 3.8%. Percentage of cows with luteal cyst was 1.9% and proportion of cows whose reproductive status cannot be confirmed (required other clinical data for proper interpretation) accounted for 10.9%.

The reproductive status of cows based on three milk samplings is shown in *Table 3*. From a total of 59 inseminated cows, 54.2% were pregnant, 18.6% had either fertilization failure or early embryonic mortality and another 18.6% had either late embryonic mortality or persistent corpus luteam or luteal cyst resulting in reproductive wastage of 37.2%. Incidence of AI on pregnant cow was 1.7% and cows whose reproductive status could not be confirmed accounted for 6.8%. Altogether there were a total of 121 AI services involving 115 cows in which 43 resulted in pregnancy giving an overall conception rate (CR) of 35.5% and 2.8 services per conception.

From *Table 3*, 33 of 44 cows with high progesterone values on day 22–24 after AI were confirmed pregnant after pregnancy diagnosis giving a 75% accuracy of early pregnancy diagnosis. All the 11 cows with low progesterone values on day 22–24 after AI were confirmed not pregnant giving a 100% accuracy of early non-pregnancy diagnosis by using milk progesterone RIA.

This study showed that the high proportion of cows with low level of progesterone on day of AI indicates that most of the cows presented for AI were in true oestrus, i.e., cows inseminated were not in the luteal phase. This suggested that the majority of farmers had the skill or experience in oestrus detection and they used the skill to correctly detect cows in

Table 1. Reproductive status of cows and frequency of occurrence based on progesterone concentrations in milk samples taken on the day of AI (n = 115)

Milk progesterone concentrations	Reproductive status	Percentage
Low (<1 nmol/litre)	In oestrus	93.0
Intermediate (1–3 nmol/litre)	Probably not in oestrus	2.6
High (>3 nmol/litre)	Not in oestrus	4.3

Table 2. Reproductive status of cows based on progesterone concentrations in milk samples taken on the day of AI (day 0) and day 10–12 after AI (n = 107)

Milk progesterone concentrations		Reproductive status	Percentage
Day 0	Day 10–12		
Low	High	Ovulatory oestrus	85.7
Low	Low	Anoestrus, anovulation or short luteal phase	3.8
High	High	Luteal cyst	1.9
*	*	Cannot be confirmed (required other clinical data for proper interpretation)	10.9

*At least one of the samples showed an intermediate value (1–3 nmol/litre)

Table 3. Reproductive status based on progesterone concentrations in milk samples taken on day 0, day 10–12 and day 22–24 after AI followed by pregnancy diagnosis (n = 59)

Milk progesterone concentrations			Pregnancy diagnosis	Reproductive status	Percentage
Day 0	Day 10–12	Day 22–24			
Low	High	High	Positive	Pregnant	54.2
Low	High	Low	Negative	Non-fertilization, early embryonic mortality, post AI anoestrus	18.6
Low	High	High	Negative	Late embryonic mortality (>16 day), luteal cyst, persistent CL	18.6
High	High	High	Positive	AI on pregnant animal	1.7
*	*	*	Positive/ Negative	Cannot be confirmed (required other clinical data for proper interpretation)	6.8

*At least one of the samples showed an intermediate value (1–3 nmol/litre)

heat. However, there were still instances where cows were wrongly detected in oestrus as evidenced in cows presented for AI with high progesterone values or cows that were doubtful but still bred. The occurrence in both cases (7%), however, was substantially lower when compared to 20% occurrence of AI done during the luteal phase reported in other study (Chantaraprateep 1994).

The high proportion of cows with ovulated oestrus suggested that many of the cows under smallholder dairy had normal ovarian function, an indication of the well being of the animals. The low proportion of cows not ovulating or having short luteal phase or luteal cyst reflected a normal frequency of the occurrence. The occurrence of these ovarian disorders reported in other studies was around 12% (Mongiardino and De Vinals 2001; Shamsuddin et al. 2001).

The overall CR obtained in this study was low (35.5%) compared to that obtained in Myanmar (63.3%; Hla et al. 2001) or in Vietnam (68.4%; Chung et al. 2001) but comparable to that obtained in Indonesia (37%; Toleng et al. 2001). However, a lower CR was reported in Pakistan (27.3%; Garcia et al. 2001) and a much lower CR was reported in Cuba (15.1%; Garcia et al. 2001).

The low CR obtained in the present study appears to be due to the high occurrence of reproductive wastage. It was reported that reproductive wastage caused by embryonic mortality after natural mating or AI accounts for the majority of reproductive failures in cattle with a mortality rate of up to 40% of all fertilized eggs (Jainudeen and Hafez 2000).

Several factors have been associated in influencing the occurrence of embryonic mortality and these include chromosomal aberrations, nutrition, environmental factors, infection, genetics, endocrine and immunological states of the animal (Jainudeen and Hafez 2000). It is possible that some of these factors could have exerted their influence in causing the high incidence of reproductive wastage in cows under the smallholder dairy system. Similar level of reproductive wastage (38.2%) had also been reported in other study (Mongiardino and De Vinals 2001) but a lower percentage of occurrence (21.3% and 14.7%) was reported by Chung et al. (2001) and by Hla et al. (2001).

The 100% accuracy of early non-pregnancy diagnosis through milk progesterone RIA was similar to that reported in other studies (Chung et al. 2001; Mongiardino and De Vinals 2001;

Shamsuddin et al. 2001) but the 75% accuracy in the early pregnancy diagnosis in the present study was lower than the 80–95% accuracy range reported in those studies. However, the accuracy percentage is more influenced by the number of cows becoming pregnant and the percentage is higher with increased number of pregnant cows.

Monitoring the milk progesterone on the day of AI, day 10–12 after AI and day 22–24 after AI will provide farmers with information on the actual reproductive status of the cows. Alerting farmers on cows with high progesterone values on the day of AI will help them to improve their oestrus detection system and to avoid performing AI on cows with false oestrus. If the progesterone values in all the three samples are low it signifies that the cow has inactive ovaries with the possibility of having follicular cyst. The farmer or the veterinarian can then adopt an appropriate therapeutic treatment such as using GnRH (gonadotropin releasing hormone) or PMSG (pregnant mare serum) to stimulate inactive ovaries or HCG (human chorionic gonadotropin) to treat follicular cyst (Jainudeen and Hafez 2000).

On the other hand, high progesterone values in all the three samples indicates that the cow may have persistent corpus luteum, luteal cyst or the cow is pregnant at the time of AI. Therefore before attempting any treatment, the cow must be diagnosed through rectal palpation to make sure that it is not pregnant and prostaglandin may be applied to destroy the corpus luteum or luteal cyst of the non-pregnant cow.

Early pregnancy diagnosis based on progesterone concentration on day 22–24 after AI will enable the farmer to know whether the cow is or not pregnant. If it is not pregnant, then the farmer should observe the cow carefully and have it bred in the next oestrus. Hence, progesterone monitoring will allow the farmer to identify non-pregnant cow earlier and avoid delay in getting the animal pregnant.

The presence of progesterone concentrations with intermediate values in some of the milk samples could be due to abnormal oestrus cycles, milk degeneration (due to improper handling) or some inaccuracies occurred in running the assay. However, the number of milk samples with the intermediate values was few.

From the study, it is concluded that there was a high occurrence of true and ovulatory oestrus in cows under smallholder dairy but the high occurrence of ovulation did not result in high conception rate due to high reproductive wastage. It can be regarded that ovarian dysfunction was not a major cause for the low conception rate in dairy cattle bred by AI in this country and factors related to management, AI services and bull fertility need to be investigated for the low conception rate.

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Abstrak

Prestasi pembiakan lembu tenusu betina di tiga kawasan di Johor dan dua kawasan di Melaka dikaji berdasarkan konsentrasi progesteron di dalam satu pensampelan susu [diambil pada hari permanian beradas (AI) dilakukan], dua pensampelan susu (diambil pada hari AI dan hari ke-10–12 selepas AI) dan tiga pensampelan susu (diambil pada hari AI, hari ke-10–12 dan hari ke-22–24 selepas AI). Secara keseluruhannya, satu, dua dan tiga sampel susu telah diambil masing-masing daripada 115, 107 dan 59 ekor lembu. Konsentrasi progesteron di dalam sampel susu ditentukan melalui teknik radioimunoasai. Pengesahan bunting dilakukan secara meraba rasa di dalam rektal dua hingga empat bulan selepas AI.

Berdasarkan satu pensampelan susu, 93% daripada bilangan lembu yang dilakukan AI berada dalam keadaan estrus, 2.6% dalam keadaan estrus diragukan dan 4.3% tidak estrus. Kandungan progesteron di dalam dua pensampelan susu menunjukkan bahawa 85.7% lembu yang estrus berovulasi, 1.9% mempunyai sista luteum, 3.8% mengalami fasa luteum pendek atau tidak berovulasi dan 10.9% tidak dapat dipastikan prestasi pembiakannya.

Berdasarkan tiga pensampelan susu diikuti dengan pengesahan bunting, 54.2% lembu disahkan bunting, 18.6% tidak mengalami persenyawaan atau kematian janin di peringkat awal, 18.6% lagi sama ada mengalami kematian janin di peringkat lewat kebuntingan atau sista luteum (kedua-dua kekerapan ini menyumbang kepada 37.2% pembaziran pembiakan), 6.8% tidak dapat dipastikan kedudukan pembiakannya dan 1.7% insiden AI pada lembu yang telah pun bunting.

Secara keseluruhannya, daripada sejumlah 121 bilangan AI yang dilakukan pada 115 ekor lembu, 43 menjadi bunting dengan kadar konsepsi 35.5% dan memerlukan 2.8 AI untuk satu kebuntingan. Melalui teknik radioimunoasai, ketepatan pengesahan bunting pada hari ke-22–24 selepas AI ialah 75% manakala pengesahan tidak bunting pada hari berkenaan ialah 100%.

Kajian ini menunjukkan bahawa bilangan lembu tenusu yang betul berestrus dan berovulasi dalam sistem pengeluaran penternak kecil adalah tinggi tetapi kadar kebuntingan yang diperoleh adalah rendah disebabkan kekerapan pembaziran pembiakan yang tinggi.

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