Evaluation of Changing Daily Milking Frequency on Milk Yield and Total Solids from Boran Breeds Crossed with Holstein Frisians at Hawassa, South Ethiopia

By

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ABSTRACT

The study was conducted at Hawassa University dairy farm for three consecutive weeks with the objective to evaluate the effect of changing milking frequency from 2X to 3X daily on yield and total solids of milk using half udder technique. Five cows (2nd and greater lactation) were selected from the farm. Their udder was divided diagonally and assigned randomly to 2X and 3X milking treatments. During the experiment all cows were managed alike and fed roughage free choice and concentrate feeds controlled. The results of the study indicated that, the quarters milked 3X daily produced significantly (P<0.05) more milk yield (12.5%) than that of 2X daily, and there was no significant difference (P<0.05) between the treatments in ash and dry matter percentage, although DM and ash percentages for the quarters milked 3X daily were numerically lower. The amount of total solids in 3X milking was increased by about 8.28 kg due to the increased yield. Therefore, it can be concluded that 3X milking is highly productive mainly in terms of yield, however, the management and production systems of the farm have to be improved to maintain the production advantage.

Key words: Cow, Milking Frequency, Milk Yield, Total Solids.

INTRODUCTION

Milk provides a complete diet with all the essential nutrients for the newborn calf. However, as a result of continuous breed improvement, proper nutrition, and management the milk yield of the modern dairy cow is many times that needed for its offspring. Certainly, milk has become a valuable commodity to man, both in nutritional and economical sense (Stelwagen, 2001).

Milk production costs have risen dramatically in recent years and dairy producers are forced to find ways of increasing their net income. Methods most often used to increase milk production are to change herd size and type besides to applying improved management activities (Stelwagen and Knight, 1997). Besides, changing the frequency of milking is another method that can be used to increase milk yield with a function of the number of mammary milk secreting cells and their metabolic activity and thus increase income (Goodwin et al., 1996). Increasing the frequency of milk removal increases milk production in cattle as it does in many species (Stelwagen, 2001).

The immediate response for the rise of milk yield due to increasing milking frequency is related to the removal of a chemical inhibitor of secretion (Donald et al., 1985). If there is frequent removal of milk intra-mammary pressure will decreased, which subsequently increase milk secretion rates. On the other hand the increased yield in the short term is produced by raising the activity of pre-existing milk-secreting tissue in the longer term; however, increased milking frequency stimulates the growth of mammary tissue.

In machine and robotic milking systems various research reports proved that, increase milking frequency have an increasing effect on milk yield i.e. more frequent milking is commonly practiced to increase milk yield on commercial dairy farms and with the number of farms with robotic milking systems rapidly increasing (Lind et al., 2000). Generally cows are milked twice daily (2X), but increasing milking frequency to three times a day (3X) or even more often increases milk yield by 10 to 20% (Erdman and Varner, 1995; Jurjanz et al., 1993).

Using traditional, hand milking, system the optimum milking frequency has not yet been determined, but it can be assumed that it is from two to four times a day. In Ethiopia, although, labor is relatively cheap, the usual
adopted milking frequency is 2X per day with in 9 to 10 hours interval in the day time. Therefore, this study was conducted to evaluate the effect of increased milking frequency to 3X daily on the yield and the total solid contents of the milk produced using traditional (manual) milking system.

MATERIALS AND METHODS

Description of study Area

The experiment was conducted at Hawassa university dairy farm, which is located 275 km away from Addis Ababa. The area has an altitude of 1600 m.a.s.l and receives an average annual rainfall of >950 mm and average minimum and maximum temperature of 10°C and 30°C, respectively, which is highly conducive for dairy production.

Experimental animals and their management

The cows available in the farm were composed of both pure exotic breed (Holstein), and their crosses with Borena breeds. The exotic brood levels of the latter have been up-graded to about 80% or more. In the farm hay and silage constitute the majority of the feed provided to the lactating cows. The cows were kept in a loose house where they were provided with the roughage feeds Ad libitum. At the milking times, they were directed into the milking room at which they were given some concentrate mix and were milked. During the experiment, the farm’s usual routine management practices were followed except the change in milking times.

Arrangement of experimental treatments

To run the experiment five (5) milking cows, which were healthy especially, no mastitis problem and their four quarters of the udder normally functioning were selected. All cows were at their 2nd, 3rd or 4th lactation and 5 to 6 weeks after calving. The experiment was conducted using half udder techniques as follows. The four quarters of each cow were grouped in to two, i.e., groups I: Right-fore (RF) and Left-Hind (LH), and group II: Left-Fore (LF) and Right-Hind (RH). The two quarter groups of each cow were then assigned randomly to either 2X or 3X daily milking treatments. The milking times were at 6:00, 12:00 & 18:00; the quarters receiving two times (2X) daily milking being milked at 6:00 & 18:00 hours only. The trial was conducted for about three consecutive weeks.

Data collection and Statistical Analysis

During the experiment, the milk obtained from the quarters milked 2X and 3X daily was recorded separately at each milking time. At the same time representative milk samples (about 50ml) were taken from the two groups and bulked over the experimental period. The samples were stored in a deep freezer pending for further chemical analysis. The dry matter content of the samples was determined; the ash content was analyzed by using the deride sample in a muffle furnace. Moreover, the total solid content was estimated from the average milk yield and dry matter percentage of the samples.

The milk yield, dry matter and the ash percentage values were described using descriptive statistics with the statistical software (SAS, 1999). Moreover, the presence of significant difference between the two treatments at P<0.05 was detected using paired t-test.

RESULT AND DISCUSSION

Milk yield

From the daily milk yield records for the quarters milked twice and three times daily, the average milk yield was analyzed. After the dry matter (DM) and ash concentrations of half udder milk from each cow were determined, total solids and ash production were also estimated. In all the study parameters (Table 1) considered, differences were observed between the quarters milked differently. However, the paired t-test mean comparison showed the presence of a significant differences (P<0.05) in milk yield only. The differences in total solids production, dry matter and ash concentrations remained insignificant.
Table 1: The mean values for milk yield, total solids, DM and ash% obtained from the quarter milked 2X and 3X daily for 21 days.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>2X</th>
<th>3X</th>
<th>SN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk yield (L)</td>
<td>159</td>
<td>179</td>
<td>*</td>
</tr>
<tr>
<td>Total solids (kg)</td>
<td>14.77</td>
<td>18.42</td>
<td>NS</td>
</tr>
<tr>
<td>DM concentration (%)</td>
<td>10.79</td>
<td>10.334</td>
<td>NS</td>
</tr>
<tr>
<td>Ash concentration (%)</td>
<td>0.741</td>
<td>0.72</td>
<td>NS</td>
</tr>
</tbody>
</table>

2X= Two times milking; 3X= Three times milking; SN= Significant level; *=P<0.05; NS= Not significant; L= Litre.

The significant increase in milk production from the quarters milked 3X daily could be due to several factors. However, the more realistic reason for the increased production could be related to decreased udder pressure as a result of more frequent removal of milk from the udder cisterns, which is thought to initiate milk secretion. Depeters et al. (1985) reported that emptying the udder 3X daily might permit rate of milk secretion to reach maximum and increase production.

According to Stelwagen (2001), the acute response to frequent milking may be the result of increased milk secreting cell activity whereas the long term response may be due to an increased cell number. Besides, Wall and McFadden (2008) speculated that frequent milking increases milk yield via an increase in mammary cell number and/or milk secreting activity.

The presence of increased production with 3X daily over 2X daily milking was reported by different researchers. In the study conducted by stimulating robotic milking, Phillips (1996) reported that 3X daily milking produced 10 to 15% more milk than 2X. In this study 12.6% more milk was obtained with 3X daily milking using the traditional hand milking, which is in agreement with the work of Phillips (1996). VanRaden et al. (1999) indicated factors of 12-14% are used to adjust 3X milking records to 2X equivalence. Moreover, Cows milked 3X generally produce about 15% more milk than those milked 2X, and four times daily (4X) milking increases yield by a further 7%, relative to 3X (McFadden and Wall, 2010).

Depeters et al. (1985) also reported that cows milked 3X daily produced 13 & 17% more milk over the entire lactation than cows milked 2X. This result was obtained by using 54 experimental cows within 44 weeks of lactation. The results obtained from the previous researches mentioned above appeared to be in line with the present report. However, unlike the previous reports, in the present trial, the fewer the number of experimental animals involved and the shorter the duration of the experiment could contribute to the slight variations observed between the previous and the present reports.

As it is shown in the graph (Fig 1) the milk form 3X milked quarters is superior to that of 2X daily milked quarters in all the experimental cows considered. The cows had different milk production potential per day under the existing management condition. But as far as milking frequency was concerned, regardless of the individual cow’s performance, the milk production between the two treatments followed the same trend, 3X daily being superior in all cases.

![Fig 1: The mean daily milk yield of the two quarter groups milked 2X and 3X daily during the experiment.](www.gjournals.org)
Total Solids Estimation

In order to examine whether the increase in milk production was due to increased secretion of nutrients in the mammary gland (milk secreting cells) the total solids production in the two treatments during the experimental period was estimated. This was done by multiplying the dry matter concentrations by the milk yields of the respective records. The total solids production analyzed remained to be higher (18.43 kg) in the case of three times daily milking than 2X (16.77 kg) daily milking. However, this difference was not statistically significant (P>0.05). When presented in percentages, the rise in total solids secretion was about 9.9%. Milk yield is inversely proportional to the concentration or percentage of major constituents especially fat test. In line with this result, Barnes et al. (1990) reported that the increase of milk production is associated with a decrease of the milk constituents. Reports on the effects of frequent milking on milk composition and SCC have been inconsistent (McFadden and Wall, 2010); however, a decrease in fat percentage was reported in association to higher milking frequency and increased milk yield (Smith et al., 2002).

In the present trial the increase in milk yield with 3X daily milking might have reduced the fact and possibly the concentrations of other major constituents that have resulted in reduced DM percentage. Since the total solids production was estimated by multiplying the DM percentage by the amount of the respective milk yield, this must have contributed to the absence of statistical significance in the total solids production between the two treatments.

<table>
<thead>
<tr>
<th>Cow’s ID</th>
<th>Milk yield (L)</th>
<th>DM (%)</th>
<th>Total solids (kg)</th>
<th>Milk yield (L)</th>
<th>DM (%)</th>
<th>Total solids (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>151</td>
<td>217</td>
<td>10.305</td>
<td>22.37</td>
<td>233.5</td>
<td>10.56</td>
<td>24.66</td>
</tr>
<tr>
<td>121</td>
<td>116.65</td>
<td>10.933</td>
<td>12.75</td>
<td>132.97</td>
<td>10.865</td>
<td>14.45</td>
</tr>
<tr>
<td>102</td>
<td>159.84</td>
<td>10.705</td>
<td>16.1</td>
<td>197.9</td>
<td>9.94</td>
<td>19.67</td>
</tr>
<tr>
<td>119</td>
<td>157.7</td>
<td>11.123</td>
<td>17.54</td>
<td>165.43</td>
<td>10.61</td>
<td>17.52</td>
</tr>
<tr>
<td>114</td>
<td>143.15</td>
<td>10.547</td>
<td>15.1</td>
<td>163.43</td>
<td>9.695</td>
<td>15.8</td>
</tr>
</tbody>
</table>

ID= Id number of cows; DM = Dry matter ; L=Litre

As shown in the result (Table 2), the DM percentage of milk harvested form 2X milking was higher than that of 3X milking, but because of the higher milk yield in case of 3X milking, the total solids production of the latter was higher by about 8.3 kg on average.

Dry Matter and Ash Concentration

The dry matter and ash concentrations determined for the quarters milked twice daily varied from 10.31 to 11.55%, and 0.599 to 0.876%, respectively. The comparative values for three times daily milking ranged from 9.7 to 10.9% and 0.648 to 0.777%, respectively. From the results obtained it can be observed that the milk obtained from the quarters milked three times daily had lower DM concentrations, than that obtained from twice milked quarters.

Like the milk yield, the difference in DM concentration was not statistically significant (P>0.05). It is well established that milk yield is inversely proportional to the concentrations or percentages of major constituents especially fat (Eckles et al., 1979; Barnes et al., 1990). Therefore, the present finding is in agreement with the already established trend of variation in total solid concentrations. Fat is the major constituent of milk solids which varies greatly by factors affecting the composition of milk. Milking frequency being the only factor in this experiment, it can expect that the variation in total solid concentration between the two treatments could mainly be due to differences in fat percentage.

The dry matter percentages of 2X (Fig 2) increase slightly, the bar graph representing it increased over that of 3X groups with all experimental cows, except in the 1st cow, which appears to show similar DM concentrations. From the group, the difference in DM concentrations appeared to be wider, when there was high daily milk production. This is in accordance with the established fact that dry matter concentrations decreases as the yield increased.
**Ash (Mineral) Estimation**

After the water in milk has been driven off and the residue burnt, a nearly white ash will be left. This ash contains different mineral substances. The percentage of the ash produced mainly depends upon the amount of dry matter, which will be incinerated. Species varies considerably. As Van den Berg (1988) indicated the ash content of milk of ruminants is mostly higher than that of non-ruminants.

**CONCLUSION AND RECOMMENDATION**

The present result emphasizes on possible benefits of 3X milking to increase milk production without apparent effects on animal’s performance. The significant increase in yield using 3X milking daily in this trial could be due to decreased udder pressure and stimulation of the milk secretion cells which results in a higher rate of milk production in the mammary gland. The result of the present trial was more or less similar to the results reported by different researches. The only difference was that it mainly depended on half udder technique using traditional milking system, with small number of animals and shorter duration. While the difference between the two treatments in milk yield was significant (P<0.05), the total solids, dry matter and the ash percentage parameters showed no significant (P>0.05) difference between the means.
Therefore, it is recommended that 3X milking is highly productive mainly in terms of yield, however, the management and the production systems of the farm have to be improved to maintain the production advantage. Better nutrition including improved forage quality maybe necessary to maintain responses to 3X milking to its maximum and minimize body weight loss during lactation.

ACKNOWLEDGEMENTS

I am very grateful to Hawassa University for the financial support of this study. Special appreciations also go to the university's Dairy farm managers, milkmen and to the dairy laboratory staffs for facilitating different supports required during the conduct of the study.

REFERENCES