

# The Correlation Between Some Characteristics of Dairy Bull Semen and Conception Rate

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The accurate evaluation of freshly drawn and stored bull semen before use is of prime importance in artificial insemination. The detection before use and discarding of semen samples likely to result in poor conception rates is most important in securing maximum efficiency. The physical and chemical characteristics which have been commonly proposed for the evaluation of semen are pH, concentration, motility, viability in storage, percentage of abnormal sperm, glycolysis rate, respiration rate, reduction tests, resistance to various shock treatments, percentage of live sperm, etc. This paper reports a study of the correlation between the first five of the characteristics listed above and the conception rate of the semen as used in the University of Missouri Dairy Herd.

## MATERIALS AND METHODS

The semen studied was largely from University of Missouri bulls of the Holstein-Friesian, Guernsey and Jersey breeds. Cows inseminated were nearly all in the University of Missouri herd, but a few cows and bulls in outside herds have been included in the data. Semen from twenty-three bulls was studied. The bulls studied represented all phases of fertility from practically sterile to highly fertile. The bulls ranged from fifteen months to thirteen years of age.

All inseminations were made by cervical deposition by the use of a speculum as described by Herman and Ragsdale (4). Pregnancy determinations have been supported in most cases by calvings, and in others by manual examinations for presence of fetus or failure of cow to return to heat within 90 days after insemination. The data cover the years 1940 to 1942 and the early part of 1943. Insemination of cows which never conceived or were known to have malfunction of the ovaries or other reproductive trouble were omitted from the study.

The methods used in examination of the semen have been described previously (5). These were simple tests which could be done satisfactorily with little technical skill. The rating of motility from 0 to 5 lacks somewhat in precision, and further study of accurately counting the motile sperm shows that a small number of very active spermatozoa may make the semen appear as good in motility as a larger number of slowly moving sperm. Since the vigor of motion as well as the amount is an important test of fertility (2, 7), the rating method may be of great value in spite of its error in estimating the actual number of sperm which are motile. Actual counts have shown that the previously estimated percentage of motile sperm for the different ratings was too high. Semen of 5 motility has about 80 per cent or more progressively motile sperm; 4 motility, 70 to 85 per cent; 3 motility, 45 to 75 per cent; 2 motility, 20 to 50 per cent; and 1 motility is usually below 25 per cent of progressively motile sperm.

Since two or more cows were seldom inseminated with any one sample of semen, the data were grouped to facilitate correlation analysis. All inseminations were tabulated in class interval groups of the semen characteristic as to whether or not they resulted in conception, and the percentage of samples resulting in conception was calculated for each group. The coefficients of linear correlation,  $r$ , were then determined for the various semen characteristics and conception rate.

#### RESULTS

The results secured are presented graphically in figure 1 for all of the characteristics studied except pH. The importance of pH readings was in doubt early in the period covered, hence the pH of all samples was not determined as a routine procedure. The pH of semen used for 205 inseminations was recorded, however. These were grouped in classes of 0.2 pH unit interval from pH 5.8 to 7.4. The correlation coefficient,  $r$ , for pH and conception rate was  $-0.18$  which indicated that there certainly was not a correlation between the two.

The percentage of abnormally shaped sperm in semen used in 525 inseminations was tabulated in groups at intervals of 3 per cent from 0 to 30 per cent. As shown by the chart (fig. 1) and the correlation coefficient of  $-0.12$  there was no correlation between conception rate and percentage of abnormal spermatozoa in the range studied. Bulls producing extremely large numbers of abnormally shaped sperm, however, may be low in fertility (5).

The concentration of sperm in semen used in 559 inseminations was tabulated in groups at intervals of 200 per mm.<sup>3</sup> from 200 to 2000. As shown in figure 1 there was a slight tendency for the more concentrated semen to produce a larger percentage of conceptions. The correlation coefficient, 0.63, was just short of significance, since an  $r$  of 0.666 is required (3) for the expression of a significant correlation within a probability of 0.05. The concentration of sperm was, therefore, not an important factor in the determination of conception rate.

Semen used in 475 inseminations was tabulated as to the length of time a motility rating as good as 2 was maintained in the undiluted semen during storage at 40° F. Daily motility ratings of the stored semen were made; so the samples were grouped at intervals of 24 hours up to 192 hours. Forty-one per cent of inseminations from semen that kept a motility rating of 2 for less than one day after use produced conceptions. As viability of the semen increased the conception rate increased until 68 per cent of inseminations with the most viable semen group resulted in conception. The correlation coefficient, 0.84, showed that there was a highly significant linear correlation between viability of the sperm in storage and their ability to produce pregnancy.

The motility ratings of semen used in 565 inseminations were tabulated according to the fertility of the semen. As shown in figure 1, plotting the motility ratings against conception rate did not indicate a linear correlation.

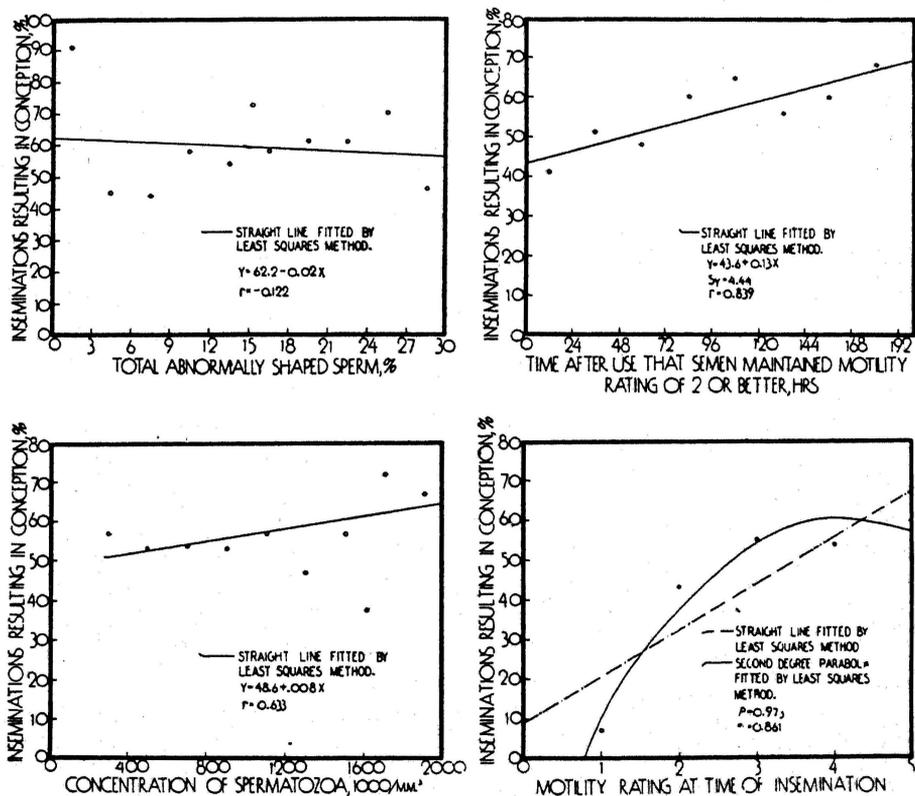


FIG. 1. The correlation between conception rate and semen quality as expressed by motility estimation, viability, concentration of sperm, and abnormal morphology of sperm.

Conception rate from semen of 1 motility was very poor. Semen that was 2 motility was not very satisfactory since only 43 per cent of such inseminations resulted in conception. Semen of 3 motility was correspondingly

better than semen of 2 motility as 2 had been better than 1. Conception rate of semen which was rated 4 and 5, however, was not significantly different from that of semen rated only 3, although semen rated 5 motility did give the best conception rate. The relation between motility rating and conception rate was therefore curvilinear. Conception rate increased as motility increased up to the 3 rating, and thereafter increased motility did not result in important increases in conception rate. The index of correlation,  $\rho$ , should therefore be used to measure the degree of correlation between the two. The index of correlation, 0.97, revealed that there was a significant curvilinear correlation between motility rating and conception rate.

#### DISCUSSION

This evaluation of five commonly used methods of determining semen quality has revealed some useful information for the practitioner. According to the results of this study there is little practical value in making routine pH determinations, abnormality counts, or determining the concentration of sperm. The information furnished by these determinations was not correlated significantly with rate of conception. Therefore, the rejection of a sample of semen because it is slightly abnormal in any of the three characteristics does not seem justified. The only reason for rejecting samples which are very high in pH or abnormalities or very low in concentration should be the extent to which such items are correlated with longevity and motility of the sperm. This problem has not been treated in this study. If samples are of acceptable motility and viability, it does not seem reasonable to reject them on the basis of pH and concentration, especially in view of the fact that the semen may be diluted many times with a buffered protective mixture. Semen that is very high in abnormal sperm usually does not have good motility or viability; but if it does have good motility and viability it will probably give good breeding efficiency.

The fine correlations shown between viability and conception rate are of more theoretical interest than practical interest because such information is not obtained until after use of the semen. This correlation can be used as a guide, however, in the development of other methods of semen evaluation. The high correlation of any test with viability should indicate its correlation with semen fertility. Beck and Salisbury (1) have used short-time high-temperature survival tests in this manner. Knowledge of the probable survival time of highly motile semen is important for selection of semen which must be stored as well as for the maintenance of good conception rates.

The curvilinear relationship between conception rate and motility rating of the semen at the time of insemination will be of special interest in the use of stored semen. Semen which is below a rating of 3 cannot be used with much confidence. Even though many pregnancies have resulted from semen of lower motility the chances of conception are so reduced that such practice may be worthwhile only in the case of very valuable sires. The data also

indicate that practically as good results may be expected from semen of 3 and 4 motility as from the highest rating. These observations are in agreement with those of Lasley (6) who found no correlation between motility rating above 3 and the fertility of the semen. He also observed that there was not a significant difference in the fertility of semen containing from 55 to 95 per cent live sperm, but semen which contained only 20 per cent of live sperm was infertile. It therefore seems safe to conclude that semen should be 3 motility or better if good breeding efficiency is to be maintained. In terms of progressively motile spermatozoa, there should be about 45 per cent or more. This study has again demonstrated the value of the motility rating for detecting semen likely to result in poor breeding efficiency. Further study of the value of accurately determining the percentage of progressively motile sperm with reference to its correlation with viability is in progress.

A study has been made of the correlation between semen characteristics and conception rate in the University of Missouri dairy herd. The correlation between conception rate and pH, abnormal sperm, and concentration of sperm was found to be non-significant. A highly significant linear correlation was found between conception rate and viability of the sperm. A significant curvilinear relationship between motility and conception rate was found. The difference in conception rate between semen rated 3 motility, which is usually 45 per cent or more progressively motile sperm, and higher grades of motility was very slight.

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