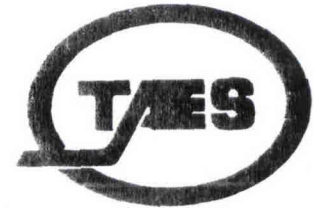# PUBLICATIONS

# 1983

# Nutritional Influence on Reproductive Efficiency in Beef Cows

## Research Center

TECHNICAL REPORT | NO. 83-1

CHAPTER 6

POSTPARTUM NUTRIENT INTAKE AND BODY CONDITION: EFFECT ON
PITUITARY FUNCTION AND ONSET OF ESTRUS IN BEEF CATTLE

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Summary

From calving through first estrus, 30 Brangus females were equally assigned to one of three diets to study the effect of postpartum nutrient intake and body condition on the ability of the pituitary to release luteinizing hormone (LH) and on the postpartum interval to estrus (PPI). The postpartum diets were calculated to achieve a 1) low (90% of the NRC recommendations, 2) maintenance (100% of the NRC recommendations), or 3) high (110% of the NRC recommendations) level of nutrient intake. The females were group-fed within a treatment, calves were allowed to suckle ad libitum. Cow weight, body condition score, and calf weight were recorded 24 h after calving, day 20 postpartum and at first behavioral estrus. On day 21 postpartum, blood samples were collected via jugular cannulae at 15 min intervals for 4 h followed by a 100-µg im injection of gonadotropin-releasing hormone (GnRH) and continued sampling at 15 min intervals for an additional 6 h to determine serum LH.

Although there was a significant decrease in PPI with increasing levels of nutrient intake (low = 57.5 ± 8.8 d; maintenance = 40.3 ± 6.6 d; high = 34.7 ± 5.1 d), there were no differences in any of the observed LH parameters due to treatment. There were, however, marked differences in both the PPI and LH parameters when the data were analyzed on the basis of ability to maintain body condition, regardless of calculated dietary treatments. Cows that maintained body condition (MBC) had a shorter

PPI (MBC, 31.7 ± 2.8 d vs lost (LBC) 60.0 ± 7.5 d; P<.01), were able to release more endogenous LH (MBC, .83 ± .09 ng vs LBC, .61 ± .04 ng; P<.025), had a higher GnRH-induced peak LH concentration (MBC, 58.99 ± 11.15 ng vs LBC, 38.86 ± 8.37 ng; P<.10), exhibited a greater GnRH-induced LH surge (P<.001) and had greater release curve areas for the endogenous (MBC, 124.6 ± 13.3 units vs LBC, 91.7 ± 5.6 units; P<.025), GnRH-induced (MBC, 4370.8 ± 699.5 units vs LBC, 3039.7 ± 683.3 units; P<.10) and total (MBC, 4510.7 ± 706.7 units vs LBC, 3141.9 ± 684.7 units; P<.10) LH release. Results from this study suggest that females maintaining body condition following parturition, regardless of calculated nutrient requirements, have an enhanced pituitary function and reproductive potential.

(KEYWORDS: Postpartum, nutrient intake, body condition, LH)

## Introduction

A prolonged postpartum anestrous period in the beef cow is of major economic importance in terms of cow productivity. Numerous workers have attempted to link postpartum reproductive performance to nutritional status (for review, see Dunn and Kaltenbach, 1980). Although there appears to be general agreement that cows in good body condition at calving will return to estrus earlier postpartum than cows in poor body condition at calving, there is some controversy regarding optimal nutritional conditions for prompt return to estrous cyclicity and, indeed, regarding nutritional effects on the endocrine patterns of the postpartum female. In high producing dairy cows, Butler et al. (1981) concluded that energy balance during the first 20 days of lactation was important in determining the onset of ovarian activity following parturition. However, measurements of blood glucose levels have been reported to

be either inversely (Kellogg and Miller, 1977) or positively (Patil and Deshpande, 1979) correlated with the postpartum interval. On the basis of calculated nutrient requirements, some workers have reported a positive effect of increased dietary nutrient levels on reproductive potential, including enhanced pituitary (Beal et al., 1978; Lishman et al., 1979; Jordan and Swanson, 1979; Moss et al., 1982) and ovarian (Wiltbank et al., 1962; Wiltbank et al., 1964) function. Other workers, however, have found no consistent relationship between calculated dietary nutrient intake and ovarian (Lishman et al., 1979; Carstairs et al., 1980) or pituitary (Hill et al., 1970; Dunn et al., 1974; Spitzer et al., 1978; Haresign, 1981) activity. In studies that have attempted to increase metabolically available nutrients by altering rumen fermentation patterns (Randel and Rhodes, 1980; Mason and Randel, 1981; Randel et al., 1982) or by providing energy substrates post-ruminally (Rutter et al., 1982), there does appear to be a consistent enhancing effect on reproductive potential. The general assumption in many of these studies has been that the metabolic response will be similar among individual animals within a given level of dietary nutrient intake, and endocrine measurements have been averaged among all animals within a treatment. This assumption, however, ignores differences in body energy reserves and thus what may be limiting to one animal may be an excess to another within the same treatment group. It may, in fact, be more important to recognize whether or not a female must mobilize body reserves to meet production demands, particularly in the early postpartum period, regardless of what her calculated requirements are.

Therefore, the objectives of this study were to determine if

10% incremental changes in the level of postpartum dietary nutrient intake, which should induce changes in metabolically available nutrients, would affect 1) the ability of the pituitary to release luteinizing hormone (LH) before and after a gonadotropin-releasing hormone (GnRH) challenge, and 2) the duration of postpartum anestrus in Brangus females maintained in good body condition before calving.

## Materials and Methods

Prior to calving, 21 mature Brangus fall-calving cows and nine first-calf Brangus heifers were maintained on coastal bermudagrass (IFN 1-00-703) pasture. Animal weight and body condition score (1 = very thin, 10 = very fat) were recorded an average of 62 d prior to calving (range 23 to 143 d prepartum), within 24 h after calving, at 20 d postpartum, and at first observed standing estrus. Based on calving date, parity and sex of calf, the females were equally assigned to one of the following dietary treatments:

1) Low: contained 90% of the NRC (1976) recommendations for metabolizable energy (ME) and digestible protein (DP) for an approximately 450 kg mature lactating beef cow with average milking ability.

2) Maintenance: contained 100% of the NRC recommendations for ME and DP.

3) High: contained 110% of the NRC recommendations for ME and DP.

The 10% incremental changes were chosen based on previous reports of a 3-6% increase in metabolically available energy by the addition of monensin to the diet (Raun et al., 1976; Richardson et al., 1976; Chalupa et al., 1980) and based on the enhanced pituitary response observed in heifers receiving abomasal infusion of propionate at 9%

of the dietary digestible energy intake (Rutter et al., 1982). Within treatment, the females were group-fed a diet consisting of a corn:cottonseed meal concentrate plus coastal bermudagrass hay (table 1) from parturition to first observed behavioral estrus. Calves were allowed to suckle ad libitum and were allowed access to creep feed in an attempt to minimize consumption of the dams' experimental diet. Sterile marker bulls were maintained with each treatment group throughout the trial to aid in estrus detection.

On day 20 postpartum, the cow was fitted with an indwelling jugular cannula and placed in a separate pen with her calf (figure 1). At approximately 2200 h on the day of cannulation, the calf was separated from the dam until approximately 0600 h the following morning when the cow was fed her experimental diet to insure uniformity of the suckling stimulus prior to the sampling period. At approximately 0730 h, the cow was put into a chute for sampling purposes, and the calf was allowed to roam the area around the chute to minimize cow anxiety. The calf was not allowed to suckle the dam during the sampling period. Starting at approximately 0800 h on day 21 postpartum, blood samples were collected via the jugular cannula at 15 min intervals for 4 h in an attempt to characterize any endogenous pulsatile LH release. At 5 min after the 16th blood sample was drawn, the cow was injected im with 100 μg GnRH[5]. The 17th blood sample was collected 10 min after the GnRH injection, and subsequent blood samples were drawn at 15 min intervals thereafter for an additional 6 h. Blood samples were

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[5]Beckman Synthetic Peptides, Palo Alto, California.

allowed to clot, were refrigerated at 4 C until centrifuged to harvest the serum within 48 h following collection, and were stored at -20 C until assayed for LH using a modification of the double antibody radioimmunoassay (RIA) reported by Golter et al. (1973) and validated in this laboratory. The cow and calf were returned to their respective treatment group immediately following the sampling period where they remained until the cow was observed in behavioral estrus or until day 90 postpartum if the cow failed to exhibit estrus.

LH Assay. Rabbit anti-bovine LH, RABLH #5[6], was used as the first antibody, and sheep anti-rabbit gamma globulin (P4)[7] was used as the precipitating second antibody. Highly purified bovine LH (2.5 mg of LER-1072-2)[8] was iodinated with 1 mCi $^{125}$I[9] and diluted with 1% eggwhite/phosphate buffered saline (pH 7.0) to achieve a final working concentration of approximately 40,000 cpm/100 μl. Prior to assaying the experimental serum samples, the optimal concentrations for the first and the second antibody to be used in the RIA were determined for this laboratory. In the first trial assay, the optimum second antibody concentration appeared to be the 1:40 dilution which gave 13.8% and 18.6% binding in the

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[6] Supplied by J. J. Reeves, Washington State University, Pullman, Washington.

[7] Antibodies, Inc., LaJolla, California.

[8] Supplied by L. E. Reichert, Albany Medical College, Albany, New York.

[9] ICN, Irving, California.

absence of cold LH (NIH-LH-B9; biological potency, .70 NIH-LH-S1 units mg)[10] with a 1:50,000 and a 1:25,000 dilution of the first antibody, respectively (figure 2). To further confirm the optimum concentration of the first antibody, a second trial was run with complete standard curves, ranging from .05 ng b-LH to 20.0 ng b-LH, with two concentrations of the first antibody (1:25,000 and 1:50,000) and a 1:40 dilution of the second antibody. Both concentrations of the first antibody gave parallel binding curves (figure 3) with 30.8% of the total counts bound by a 1:50,000 dilution of the first antibody in the absence of cold LH and 37.1% of the total counts bound by a 1:25,000 dilution of the first antibody in the absence of cold LH with nonspecific binding of 2.6% and 2.8%, respectively. The experimental samples were assayed with a 1:50,000 dilution of the first antibody and a 1:40 dilution of the second antibody with another iodination of 2.5 mg LER-1072-2 which resulted in approximately 25,000 cpm/100 μl. The 1:50,000 dilution of the first antibody in the experimental run was identical to the binding curve plotted for the 1:50,000 dilution of the first antibody in the second trial run, bound 41.8% of the total counts in the absence of cold LH, and had 3.4% nonspecific binding with an intra-assay coefficient of variation (calculated on the basis of five ovariectomized pooled serum samples assayed in duplicate) of 4.2%. All experimental samples were assayed in the same LH run.

Statistical Analysis. All physical measurements were first analyzed by one-way analysis of variance (Steel and Torrie, 1960) with

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[10]Supplied by the National Institute of Health, Bethesda, Maryland.

dietary nutrient level as the main effect. When it became apparent that dietary nutrient level was not accounting for the variation in PPI and due to the fact that all animals within a dietary treatment group did not have similar metabolic responses, the animals were reclassified on the basis of whether or not body condition was lost or maintained during the PPI. Proportional data were then analyzed by Chi-square (Steel and Torrie, 1960). Pre- and post-GnRH serum LH concentrations were analyzed separately between dietary nutrient levels and between condition score status by factorial analysis of variance (Steel and Torrie, 1960). Specific LH curve characteristics, including time to the GnRH-induced LH peak, peak LH concentration, mean LH release both before and after GnRH injection, area (Stein, 1967) under the pre-GnRH serum LH release, area under the GnRH-induced LH curve, and area under the total LH release pattern were also analyzed by one-way analysis of variance with nutrient level or condition score status as main effects. Where applicable, a paired t-test (Steel and Torrie, 1960) was performed for comparisons between cow vs heifer response and for response comparisons between loss vs maintenance of body condition.

## Results

Despite the calculated differences in postpartum nutrient intake between the three dietary treatment groups, there was no apparent difference in cow weights (table 2) or body condition score (table 3) due to treatment. Although mature cows were heavier (P<.005) and were carrying more body condition (P<.005) over all dietary treatments than were first-calf heifers, there was no difference in PPI (table 4) between cows and heifers. It is felt that the lack of difference in PPI between cows and heifers is due

to the low number of heifers (9) used in this study and is not meant as a contradiction to numerous reports which indicate a poorer postpartum reproductive performance in heifers, particularly on a restricted diet (Laster et al., 1973; Bellows et al., 1982). When differences between cows and heifers were not detected, again probably due to the low number of heifers, cow and heifer data were pooled. When PPI was averaged within dietary treatment (table 4), there was a decrease in PPI with increasing level of dietary nutrient intake (P<.01). If females were classified according to whether or not they were able to maintain body condition following calving, irrespective of assigned dietary nutrient level, there was a dramatic decrease in the PPI in females that maintained body condition compared with females that lost body condition (maintained = 31.7 ± 2.8d, lost = 60.0 ± 7.5d; P<.005). Eighty-eight percent of the females that were able to maintain body condition following parturition had been observed in standing estrus within 42 d compared to only 36% of the females that were not able to maintain body condition (P<.01) following parturition (figure 4). Calves from dams that lost body condition were heavier (P<.025) and older at the time of their dam's first estrus (table 5), but had lower average daily weight gains (P<.10) than did calves from dams that maintained body condition.

Over all dietary treatments, there was no difference between cows and heifers in the amount of endogenous LH release, in the GnRH-induced LH surge, in peak LH concentrations, nor in the areas under the endogenous, GnRH-induced or total (endogenous + GnRH-induced) LH release (table 6). When LH concentrations were averaged for all females within a dietary treatment group, there was

no significant difference in mean LH release prior to the GnRH
challenge (table 6), in the GnRH-induced LH surge (figure 7), in the
peak GnRH-induced LH concentrations (table 6), nor in the areas
under the endogenous, GnRH-induced or total LH release (table 6)
between the three levels of dietary nutrient intake.

There were, however, marked differences in the LH parameters
between females that lost and females that maintained body condition
following calving, regardless of the calculated dietary treatments.
Females that maintained body condition after parturition were able
to release more (P<.025) endogenous LH (table 7, figure 5) and more
(P<.001) LH in response to exogenous GnRH challenge (figure 6), had
higher (P<.10) peak GnRH-induced LH concentrations (table 7), and
had greater release curve areas for the endogenous (P<.025),
GnRH-induced (P<.10), and total (P<.10) LH release (table 7) when
compared to females that lost body condition after calving.

## Discussion

Results from this study show that increasing dietary nutrient
intake did decrease the PPI in Brangus cattle, which agrees with
other reports (for review, see Dunn and Kaltenbach, 1980). Although
the level of dietary nutrient intake helped establish the lost vs
maintained body condition categories, 4 of 11 females in the 90% NRC
treatment group were able to maintain body condition on a diet that
was calculated to below maintenance, while 4 of 10 in the 100% NRC
group and 3 of 9 in the 110% NRC group were unable to maintain body
condition on a diet that was calculated to be at or above
requirements for maintenance and lactation. Since this study was
conducted under a group-feeding situation, there is the possibility
that the females who were able to maintain body condition in the low

nutrient intake group were exhibiting dominant behavior and were consuming more than their calculated share of the diet. Although this type of behavior was not grossly apparent, it does point to a problem in group-feeding experiments, particularly if changes in individual animal response to a given dietary treatment are not taken into account.

Females that were able to maintain body condition after calving, regardless of calculated nutrient intake levels, had an approximately 30-day shorter PPI than did females that lost body condition. Although we found no difference in postpartum body weights, our results do agree with those reported by Cantrell et al. (1982) who indicated a shorter PPI in cows maintaining post-calving weight. None of the cattle used in this study were thin prior to or at calving and were not considered to be under nutritional stress before the start of the dietary treatments, which would have biased our results (Wiltbank et al., 1962). Therefore, the loss or maintenance of body condition through the PPI must have been affected by the magnitude of metabolic demands of an individual female. Loss or maintenance of dam body condition could not be accounted for by changes in calf weights or gains during the PPI. The greater calf weights at first estrus from females losing body condition reflects the older age of those calves at the time the dam was observed in heat. The lower ADG from parturition to first estrus in those calves from dams which lost body condition may reflect possible decreased milk production over an extended period of nutrient restriction in the dams.

Although increasing dietary nutrient level decreased the PPI, there was no apparent change in pituitary function, as measured by

both endogenous and stimulated LH release, between dietary treatments. Pituitary function, however, was enhanced in females that maintained body condition following parturition. Serum LH concentrations presented in this study were comparable to basal (Forrest et al., 1980a; Forrest et al., 1980b; Dunlap et al., 1981) and GnRH-induced peak (Kesler et al., 1977; Irvin et al., 1981) LH concentrations reported for suckled beef cows at two to three weeks postpartum. The apparent pulsatile nature of endogenous LH release seen in females that maintained body condition is primarily due to one heifer in the 100% NRC treatment group that was exhibiting a pulsatile pattern of LH release. None of the other females showed any discernible pattern of pulsatile LH release prior to GnRH injection, and excluding data from this heifer did not change the significantly higher basal LH release observed in females that maintained body condition after calving. The changes observed in pituitary function in this study are in agreement with Lishman et al. (1979) and Jordan and Swanson (1979) who reported a decreased pituitary responsiveness to GnRH in postpartum cows receiving inadequate dietary energy and protein. They do not, however, agree with the results of Hill et al. (1970) and Spitzer et al. (1978) who reported no difference in LH concentrations in normally cycling heifers receiving restricted nutrient intakes and of Dunn et al. (1974) who reported higher peak LH concentrations in energy restricted cows. Comparisons in circulating LH levels and in pituitary responsiveness between postpartum and normally cycling cows, however, may be misleading due to the possibility that different mechanism(s) control the onset of estrous cyclicity in the postpartum cow vs the maintenance of cylicity. In addition, the

enhanced pituitary function reported in this study was only apparent when animals were grouped on the basis of body condition changes, regardless of prescribed nutrient intake.

This study demonstrates that whether or not a cow loses or maintains body condition following parturition is more dependent upon what her individual metabolic requirements are than what the calculated NRC values are. Dairy cows typically experience a period of negative energy balance during early lactation because they cannot consume enough feed to meet nutrient requirements, particularly for glucose (Baird, 1981). If glucose is limiting in the lactating cow, then maternal reserves must be mobilized to meet the deficit (Hardwick et al., 1963; Bergman, 1973) and other metabolities must be used as a source of carbon for biosynthesis and as a source of metabolic energy (Bartley and Black, 1966). Use of amino acids for glucose synthesis is not only metabolically less efficient than is the use of propionate as a glucose precursor (Gill et al., 1981), but may also decrease protein available for other metabolic processes (Heitmann and Bergman, 1980). Therefore, loss of body condition due to individual metabolic demands in the postpartum lactating female may well reflect a decreased nutrient availability to specific reproductive tissues. Hayashi et al. (1978) demonstrated an absolute requirement of a rat pituitary cell line (GH$_3$) for insulin and Sen et al. (1979) reported the GnRH-induced LH release from rat pituitary cells is an energy-dependent process. If nutrients are limiting in the postpartm cow, which would be reflected in mobilization of maternal body reserves, then increasing nutrient availability to the reproductive organs could account for the enhanced pituitary function observed in those

cows which were able to maintain body condition. Although not measured in this study, increased substrate availability to the ovary may also affect gonadotropin release via enhanced ovarian steroid production, as suggested by Rone et al. (1982).

It can be concluded from this study that females who maintain body condition following calving have a shorter PPI and a greater endogenous and GnRH-induced LH release than do cows who lose body condition, regardless of calculated dietary nutrient levels. These results also suggest that perhaps some of the previously reported conflicting results on the effect of periparturient nutritional status on the endocrine patterns associated with the postpartum period may need to be reexamined on the basis of mobilization of body reserves rather than on average weight changes or calculated nutrient requirements.

Table 1:   TREATMENT DIETS[a].

| Item | Treatment Group | | |
| --- | --- | --- | --- |
| | Low | Maintenance | High |
| Feedstuff (IFN) | | | |
| Coastal Bermudagrass Hay (1-00-703) | 9.8 kg/d | 9.8 kg/d | 9.8 kg/d |
| Corn (4-02-931) | .454 kg/d | .994 kg/d | 1.544 kg/d |
| Cottonseed Meal (5-01-621) | .454 kg/d | .454 kg/d | .454 kg/d |
| Nutrients | | | |
| Metabolizable Energy (% NRC recommendations) | 16.32 Mcal/d (90.2%) | 18.10 Mcal/d (100.0%) | 19.91 Mcal/d (110.0%) |
| Digestible Protein (% NRC recommendations) | .462 kg/d (92.4%) | .502 kg/d (100.4%) | .542 kg/d (108.4%) |

[a]Dry matter basis, for a 450 kg mature lactating beef cow during the first 3-4 months postpartum with average milking ability.

Table 2.  DAM WEIGHTS

| Group | n | Precalving Weight (kg)[a] | Calving Weight (kg)[b] | Day 20 Postpartum Weight (kg)[c] | 1st Estrus Weight (kg)[d] |
|---|---|---|---|---|---|
| Low | 11 | 497.7 ± 12.3 | 448.1 ± 9.0 | 454.3 ± 15.2 | 424.0 ± 16.8 |
| Maintenance | 10 | 528.2 ± 19.2 | 477.0 ± 18.6 | 481.8 ± 19.5 | 460.4 ± 26.5 |
| High | 9 | 503.5 ± 16.3 | 450.0 ± 16.8 | 459.7 ± 21.4 | 448.5 ± 17.8 |
| All Cows | 21 | 527.6 ± 9.8* | 476.3 ± 8.6* | 489.0 ± 10.1* | 463.3 ± 13.0* |
| All Heifers | 9 | 467.7 ± 12.6 | 416.4 ± 12.9 | 416.4 ± 15.6 | 397.5 ± 16.8 |

[a]Precalving weights not different between dietary treatments, P>.10.

[b]Calving weights not different between dietary treatments, P>.10.

[c]Day 20 postpartum weights not different between dietary treatments, P>.10; one cow in Low and one cow in Maintenance were observed in estrus before Day 20 postpartum and, therefore, their data are not included in these means.

[d]1st estrus weight not different between dietary treatments, P>.10.

* Cows heavier than heifers, P<.005.

Table 4. POSTPARTUM INTERVAL TO 1ST ESTRUS

| Group | n | Days from Calving to 1st Estrus |
|---|---|---|
| Dietary Treatment: | | |
| Low | 11 | $57.5 \pm 8.8^{c}$ |
| Maintenance | 10 | $40.3 \pm 6.6^{b}$ |
| High | 9 | $34.7 \pm 5.1^{a}$ |
| Parity: | | |
| All Cows | 21 | $43.4 \pm 5.4^{*}$ |
| All Heifers | 9 | $48.3 \pm 8.3^{*}$ |
| Body Condition: | | |
| Lost Body Condition | 14 | $60.0 \pm 7.5^{d}$ |
| Maintained Body Condition | 16 | $31.7 \pm 2.8^{e}$ |

[a,b,c] Means differ, P<.01.

[d,e] Means differ, P<.005.

[*] Cows not different from heifers, P>.10.

Table 5.  EFFECT OF DAM CONDITION ON CALF WEIGHTS

| Dam Group | Calving Weight (kg) | Day 20 Postpartum Weight (kg) | 1st Estrus Weight (kg) | Calf ADG from Calving to Day 20 Postpartum (kg) | Calf ADG from Calving to 1st Estrus (kg) |
|---|---|---|---|---|---|
| Lost Body Condition | 32.4 ± 1.5 | 48.4 ± 2.5 | 73.7 ± 6.6[b] | .76 ± .06 | .69 ± .09[c] |
| Maintained Body Condition | 30.7 ± 1.9 | 49.4 ± 1.9 | 57.6 ± 2.4[a] | .85 ± .06 | .84 ± .05[d] |

[a,b]Means differ, P<.025.

[c,d]Means differ, P<.10.

Table 6. EFFECT OF PARITY AND DIETARY NUTRIENT LEVEL ON LH RELEASE[a]

| Group | Pre-GnRH LH (ng/ml) | Peak GnRH LH (ng/ml) | Basal | Area Under the LH Curve GnRH-Induced | Total |
|---|---|---|---|---|---|
| **Dietary Treatment:** | | | | | |
| Low | .67 ± .05 | 51.95 ± 9.8 | 100.4 ± 7.1 | 4018.0 ± 827.2 | 4131.3 ± 828.9 |
| Maintenance | .83 ± .13 | 47.70 ± 13.07 | 123.7 ± 19.2 | 3730.7 ± 940.1 | 3869.0 ± 953.5 |
| High | .66 ± .06 | 46.67 ± 15.79 | 98.5 ± 8.4 | 3282.5 ± 874.9 | 3391.6 ± 878.2 |
| **Parity:** | | | | | |
| Cows | .75 ± .07 | 47.68 ± 8.31 | 112.2 ± 9.7 | 3441.9 ± 523.2 | 3566.6 ± 529.0 |
| Heifers | .66 ± .09 | 51.56 ± 14.17 | 99.6 ± 13.0 | 4261.2 ± 1109.5 | 4374.5 ± 1115.8 |

[a]No difference (P>.10) in any LH measurements between dietary treatments or between parity groups.

Table 7.  EFFECT OF BODY CONDITION ON LH MEASUREMENTS.

| LH Parameter | n | Females that Lost Body Condition | Females that Maintained Body Condition |
|---|---|---|---|
| Pre-GnRH LH level (ng/ml) | 28 | .61 ± .04** | .83 ± .09*** |
| Time to the GnRH-induced LH peak (min) | 28 | 130.0 ± 4.7 | 127.9 ± 5.4 |
| Peak GnRH-induced LH level (ng/ml) | 28 | 38.86 ± 8.37* | 58.99 ± 11.15** |
| Area under endogenous LH release (arbitrary units) | 28 | 91.71 ± 5.64** | 124.61 ± 13.27*** |
| Area under the GnRH-induced LH release (arbitrary units) | 28 | 3039.71 ± 683.32* | 4370.75 ± 699.48** |
| Area under the total LH release (arbitrary units) | 28 | 3141.93 ± 684.73* | 4510.69 ± 706.67** |

*,** Means within same row differ, P<.10.

**,*** Means within same row differ, P<.025.
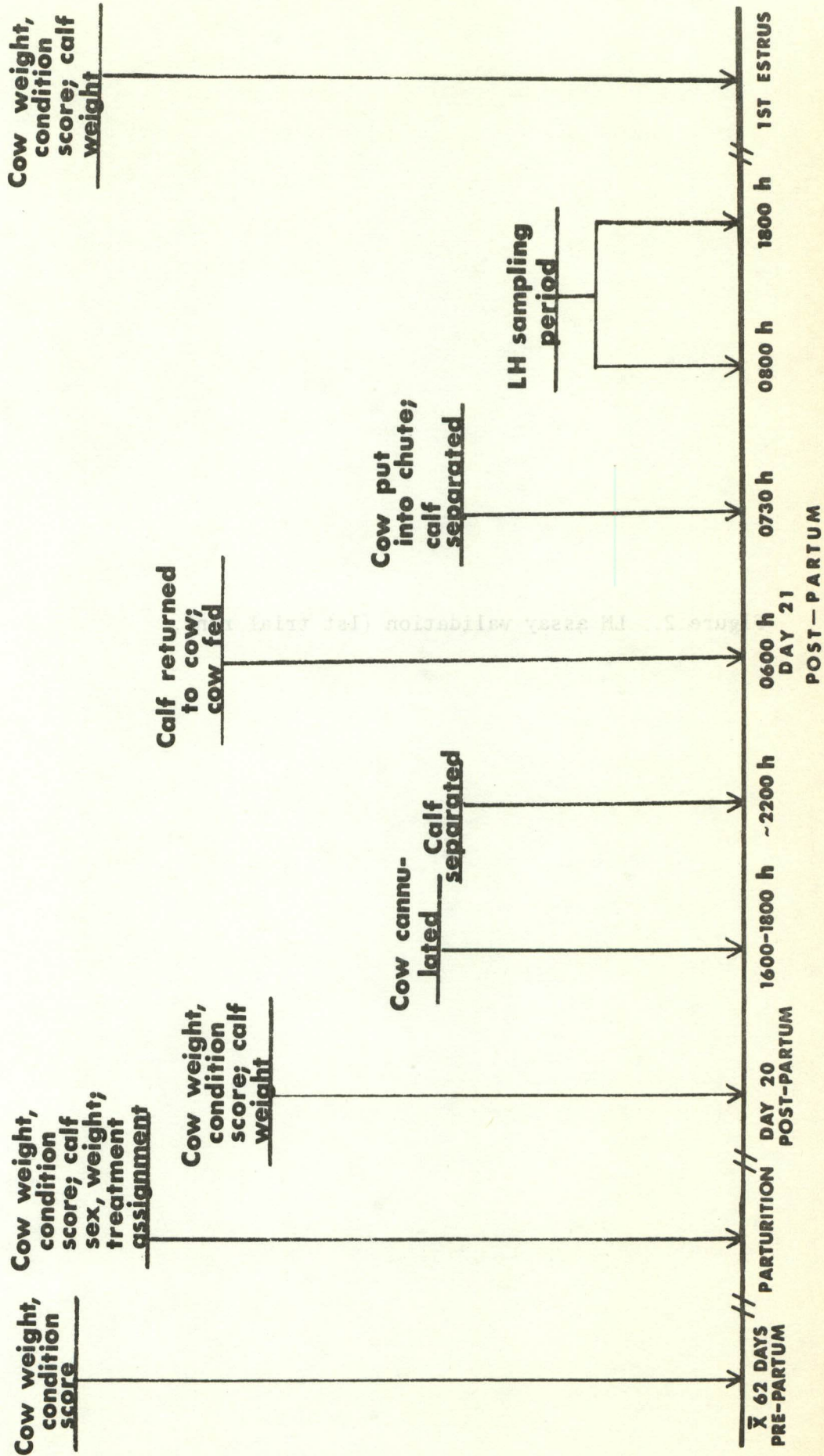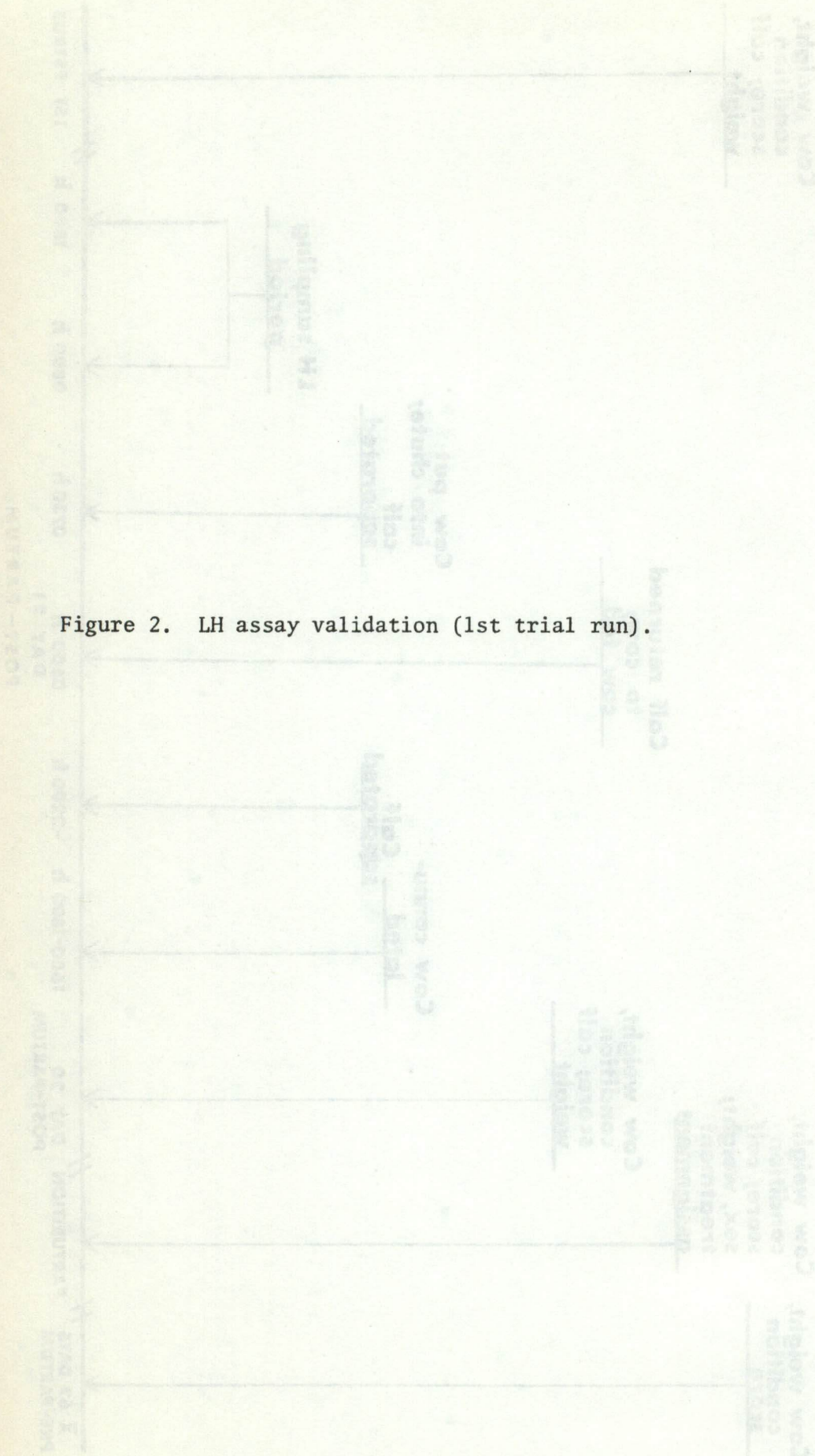
Figure 1.  Experimental data collection.

Cow weight, condition score; calf weight

1ST ESTRUS

1800 h

LH sampling period

0800 h

Cow put into chute; calf separated

0730 h

Calf returned to cow; cow fed

0600 h
DAY 21
POST-PARTUM

Cow cannu-lated

Calf separated

~2200 h

1600-1800 h

Cow weight, condition score; calf weight

DAY 20 POST-PARTUM

Cow weight, condition score; calf sex, weight; treatment assignment

Cow weight, condition score

PARTURITION

$\bar{X}$ 62 DAYS PRE-PARTUM

POST-PARTUM

Figure 2. LH assay validation (1st trial ...)

Figure 2.   LH assay validation (1st trial run).
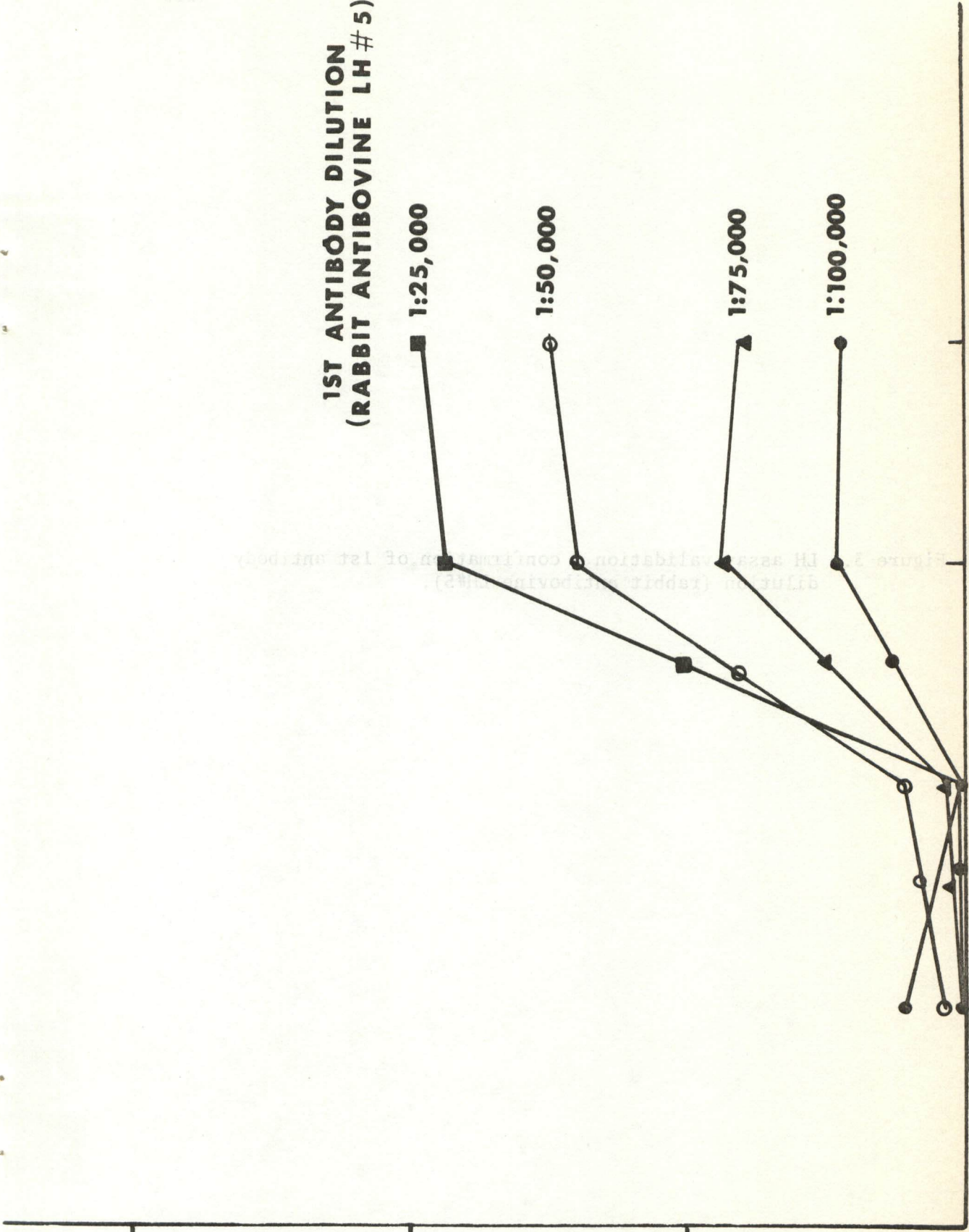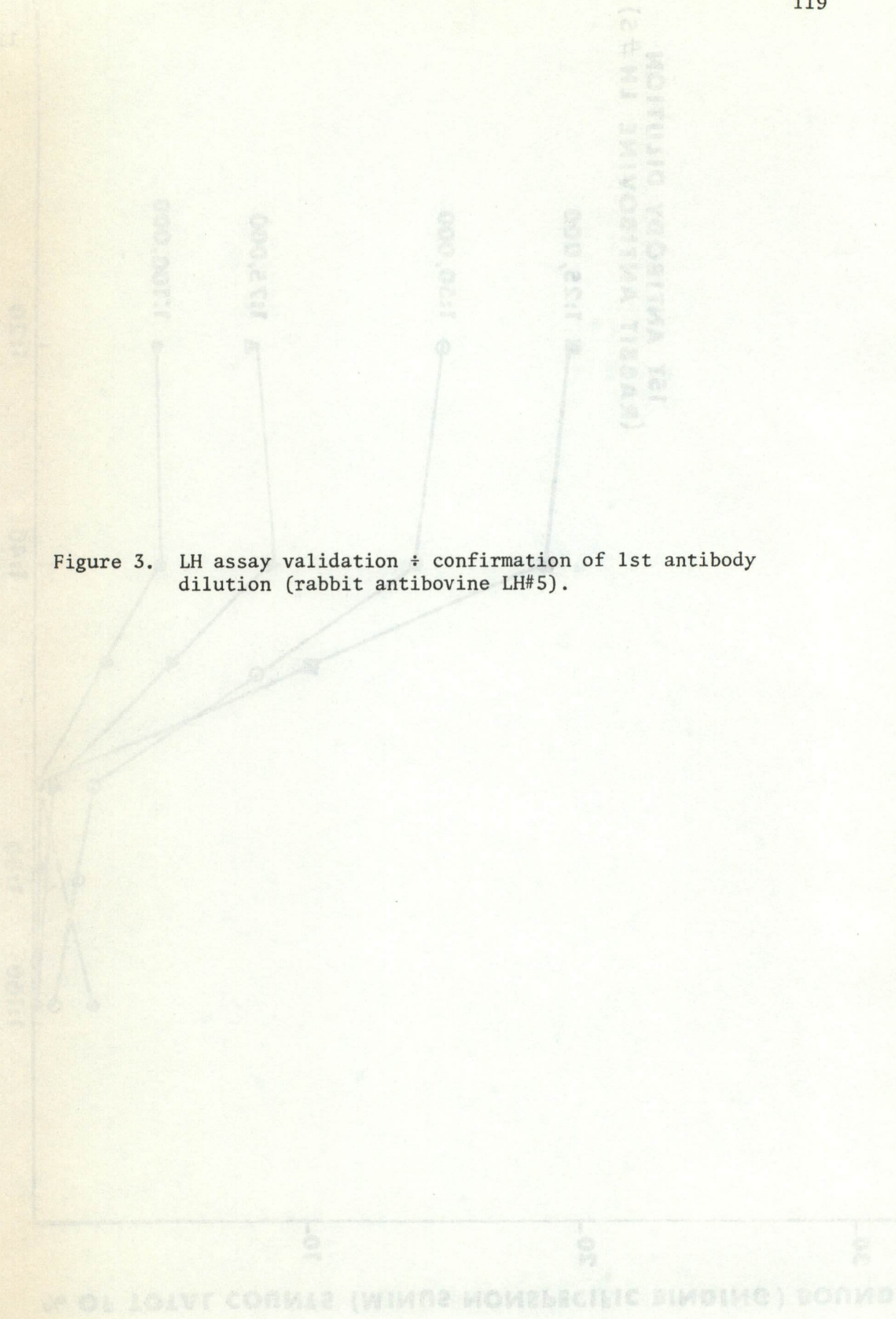
Figure 3. LH assay validation confirmation of 1st antibody dilution (rabbit antibovine LH#5).

Figure 3.   LH assay validation ÷ confirmation of 1st antibody
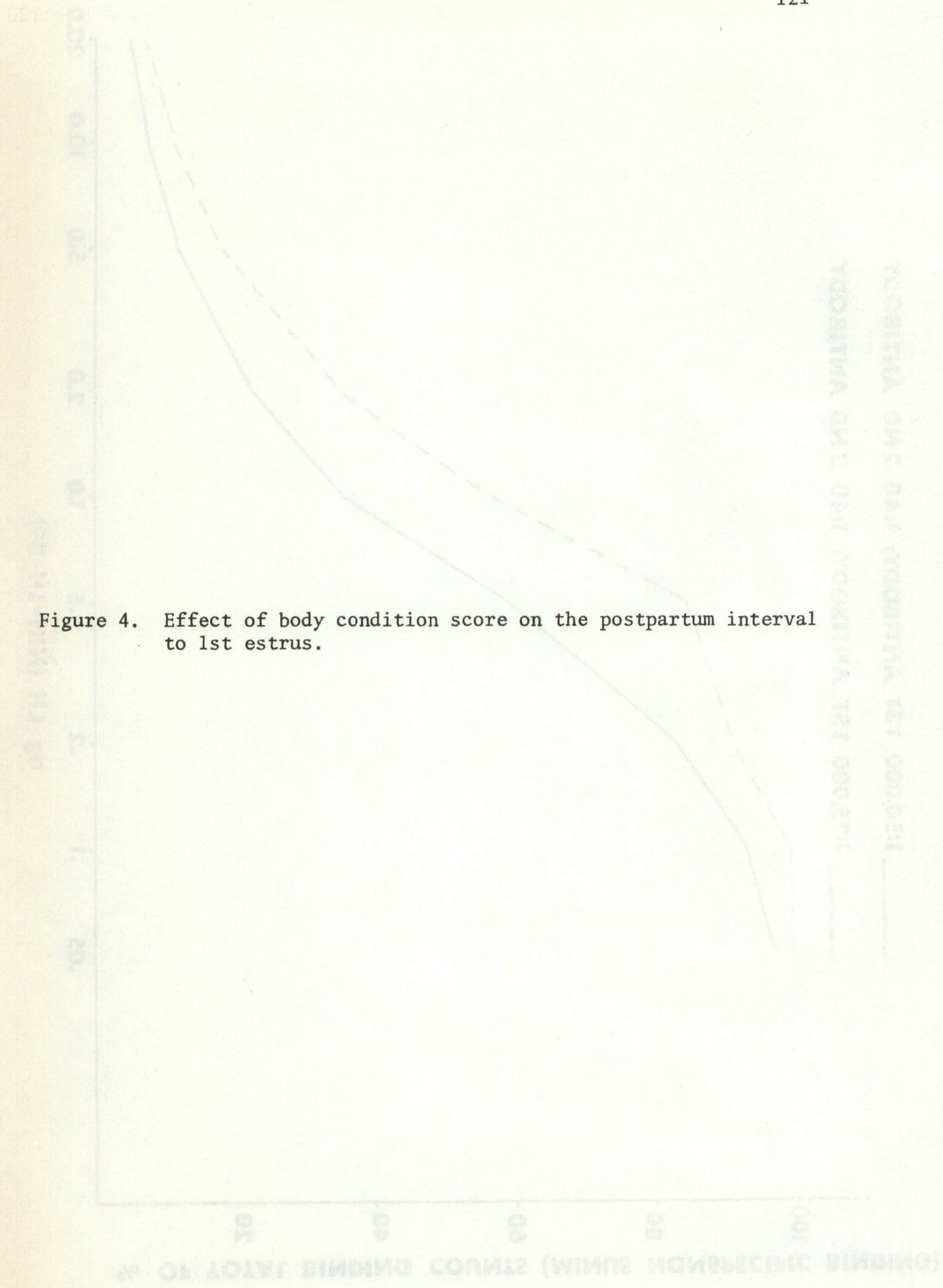dilution (rabbit antibovine LH#5).
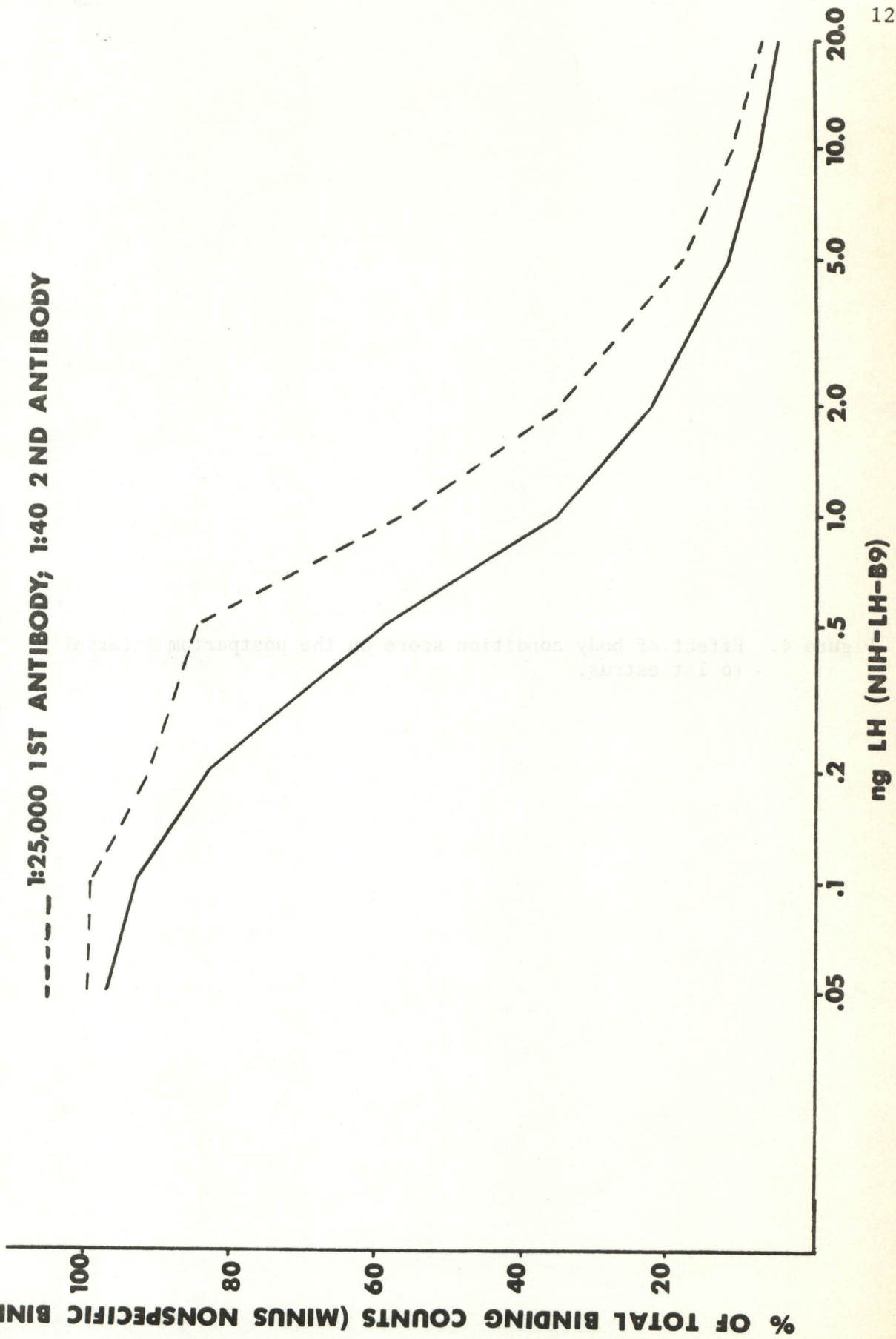
Figure 4. Effect of body condition score on the postpartum interval to 1st estrus.
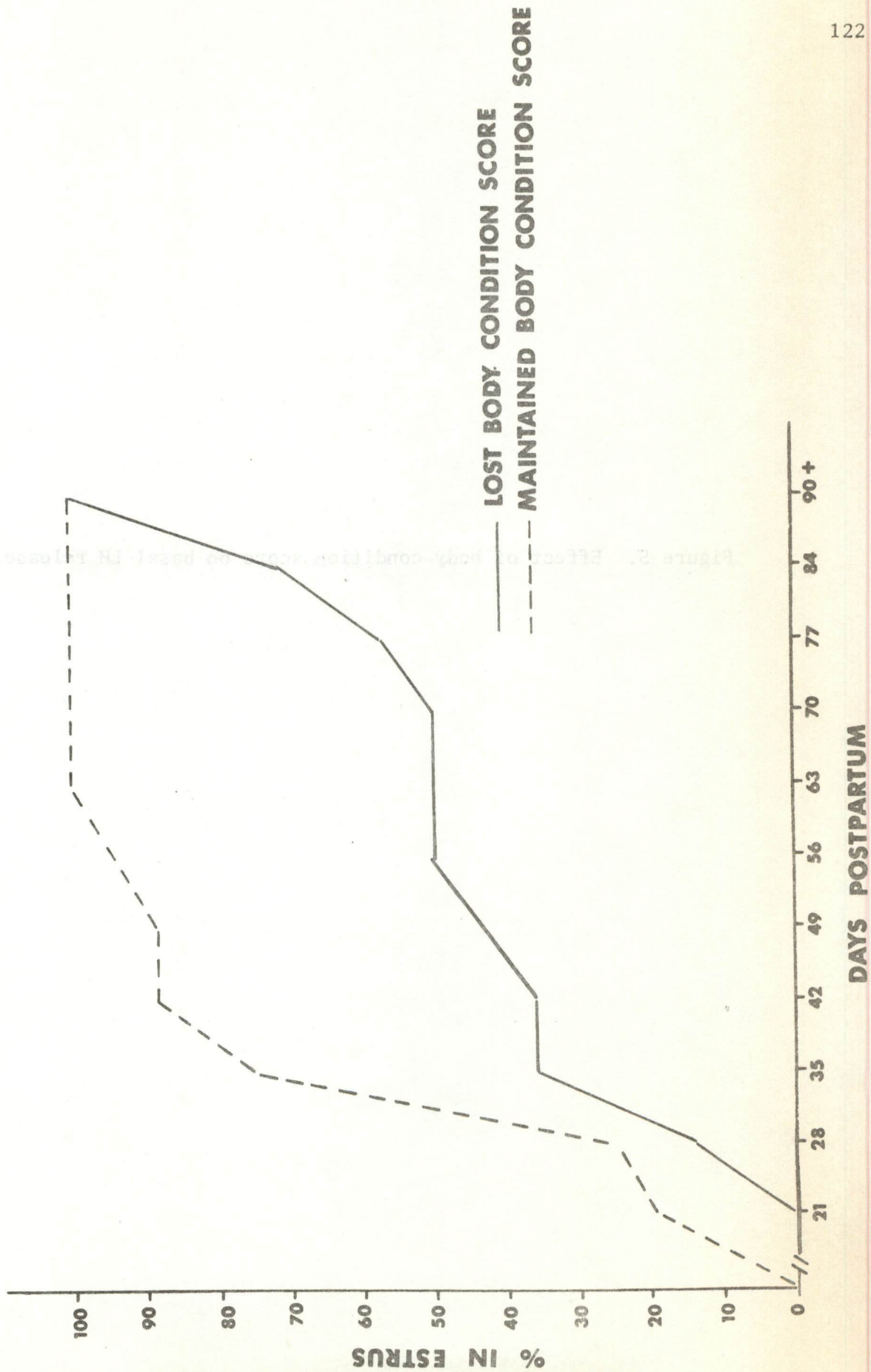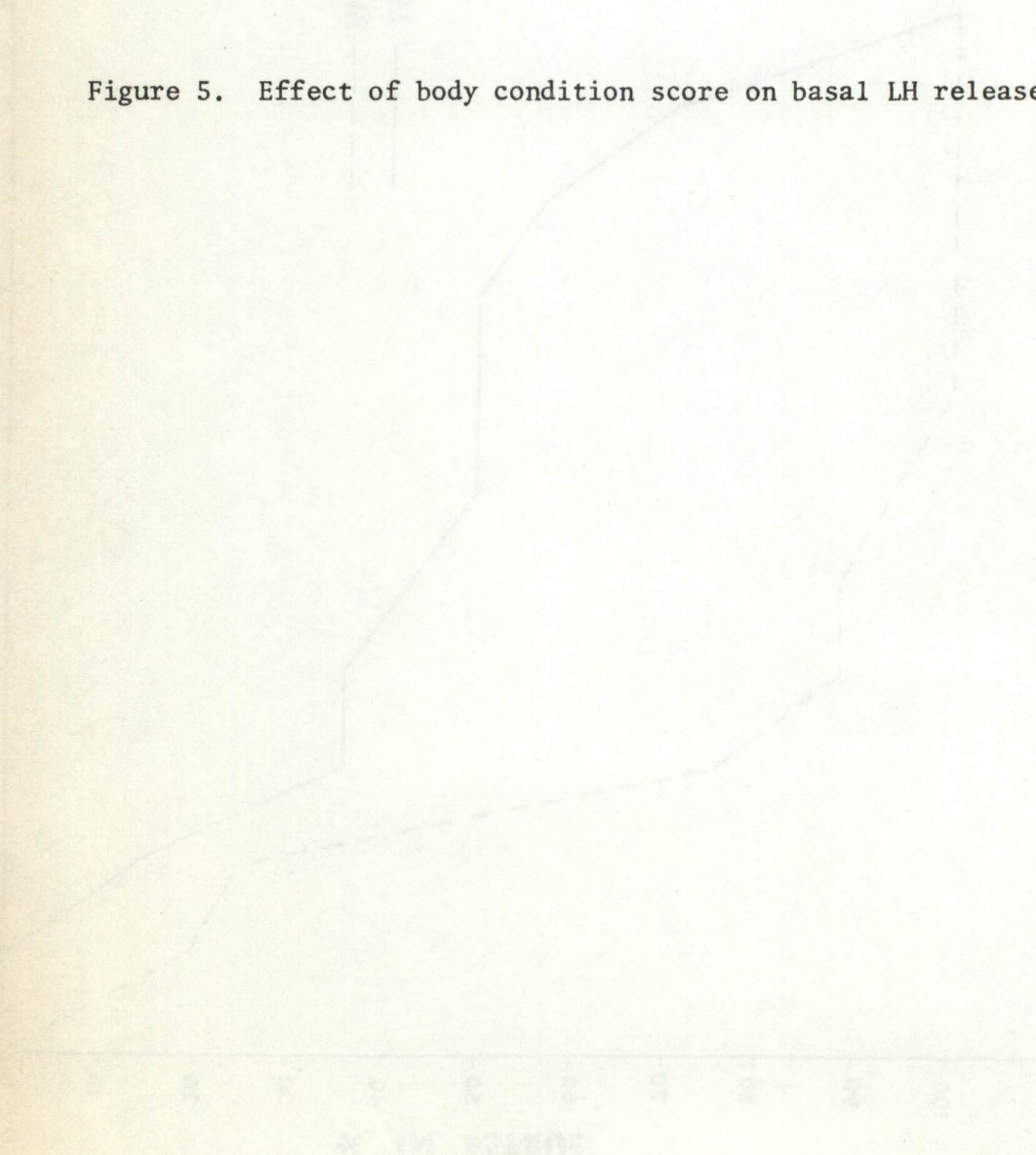
Figure 5. Effect of body condition score on postpartum LH release.

Figure 5.  Effect of body condition score on basal LH release.

Figure 5. Effect of body condition score on the GnRH-induced
LH release.

The chart shows:

LOST CONDITION SCORE
MAINTAINED CONDITION SCORE

TREATMENT: P < .001
TIME: P > .10
TRT X TIME: P > .10

Y-axis: ng p-LH (NIH-LH-B9)/ml

X-axis: TIME (MIN)
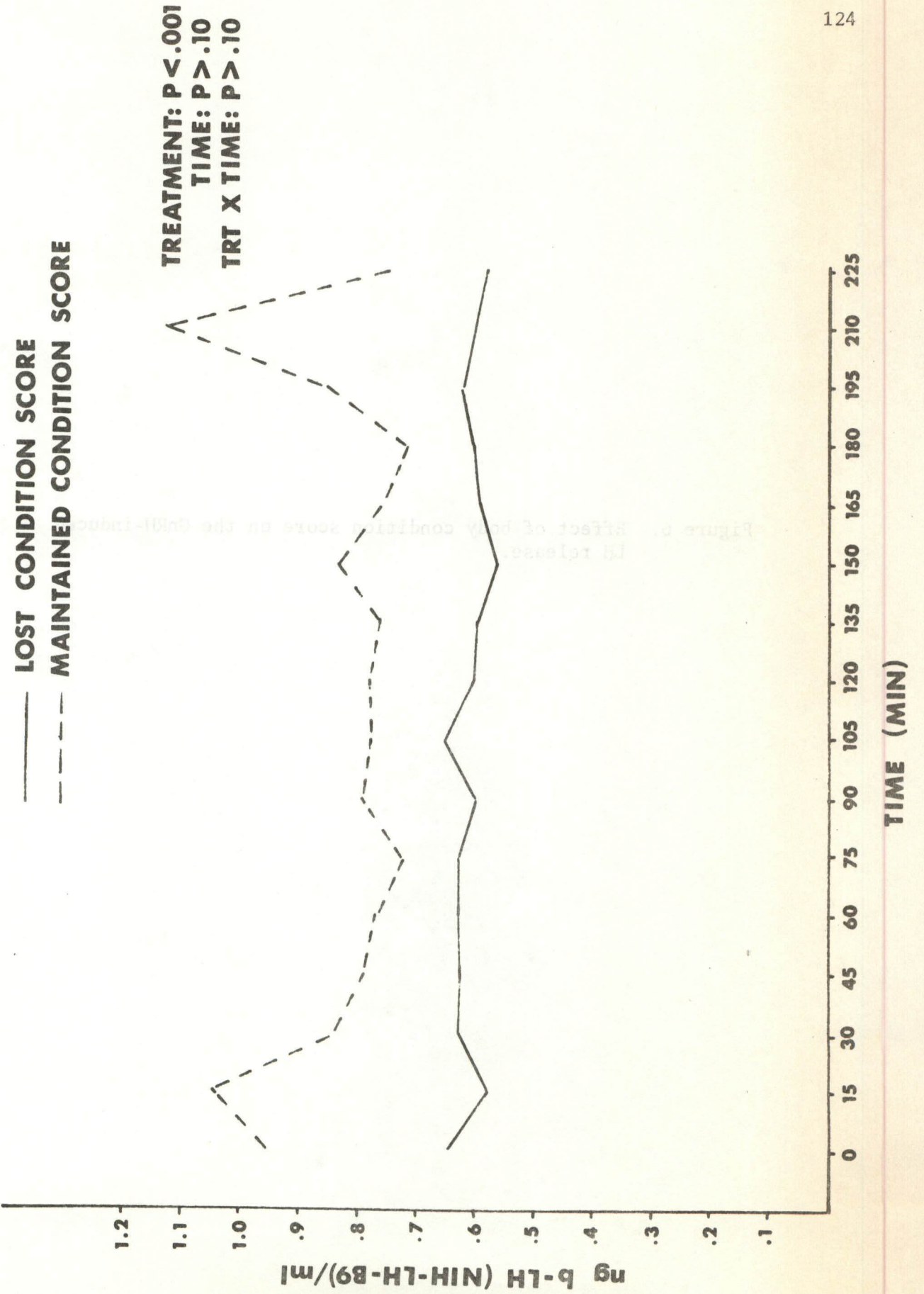
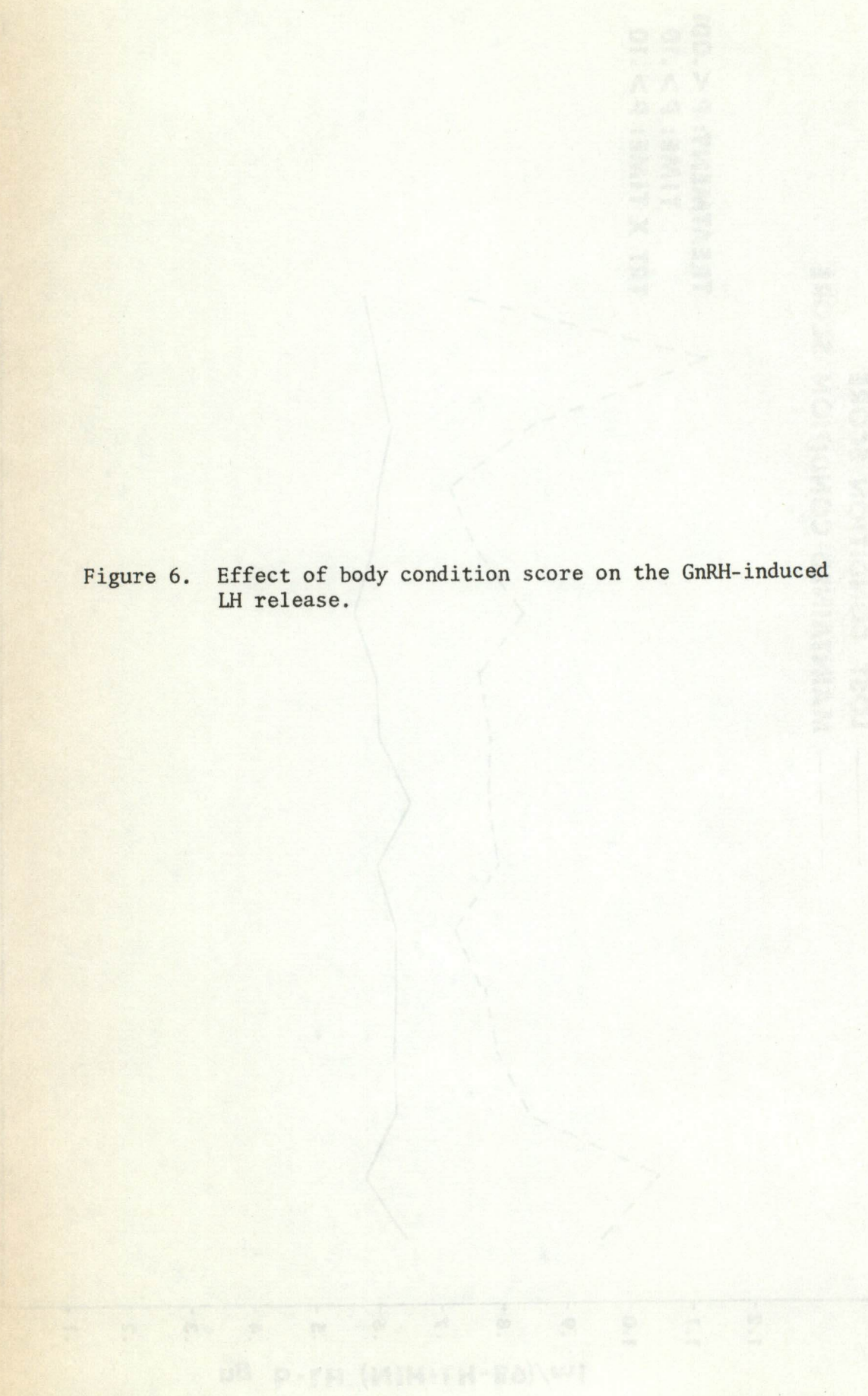Figure 6.  Effect of body condition score on the GnRH-induced LH release.

Figure 7. Effect of dietary energy level on GnRH-induced LH release.
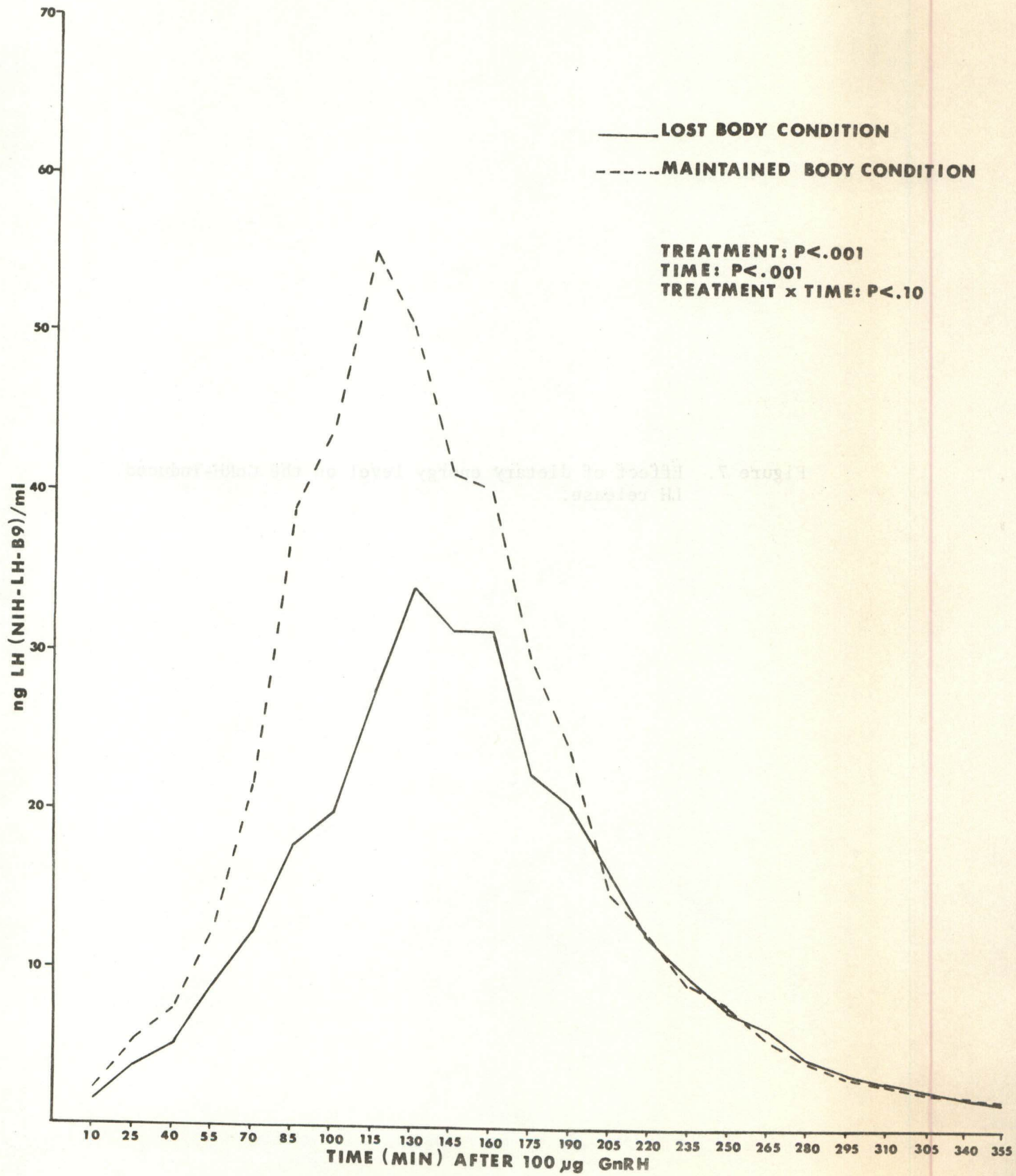
Figure 7.  Effect of dietary energy level on the GnRH-induced LH release.

90% NRC FOR ME

100% NRC FOR ME

110% NRC FOR ME

TREATMENT: P>.10
TIME: P<.001
TREATMENT×TIME:P>.10

TIME (MIN) AFTER 100 µg GnRH

ng LH (NIH-LH-B9)/ml

10   20   30   40

10  25  40  55  70  85  100  115  130  145  160  175  180  205  220  235  250  265  280  295  310  325  340  355
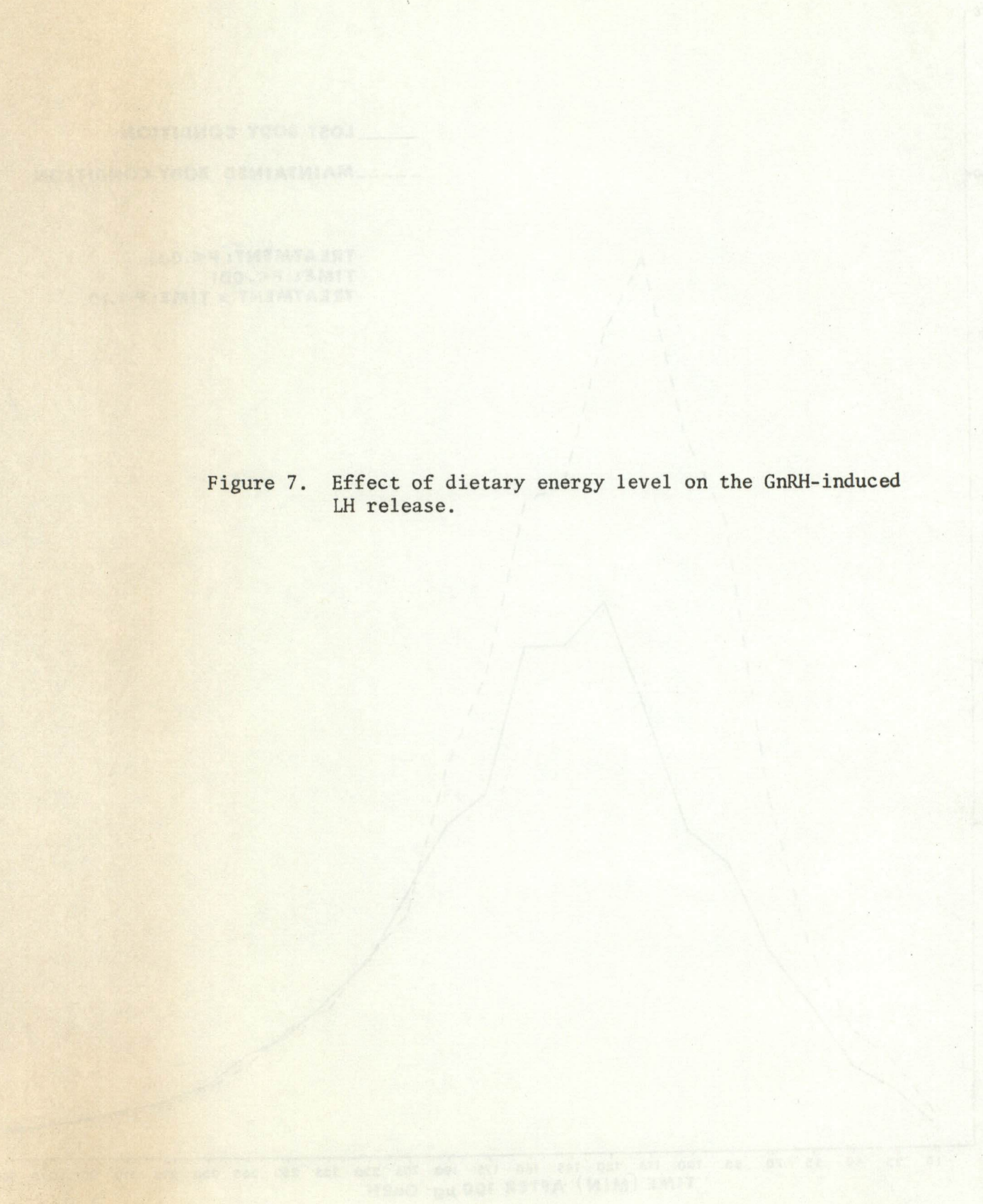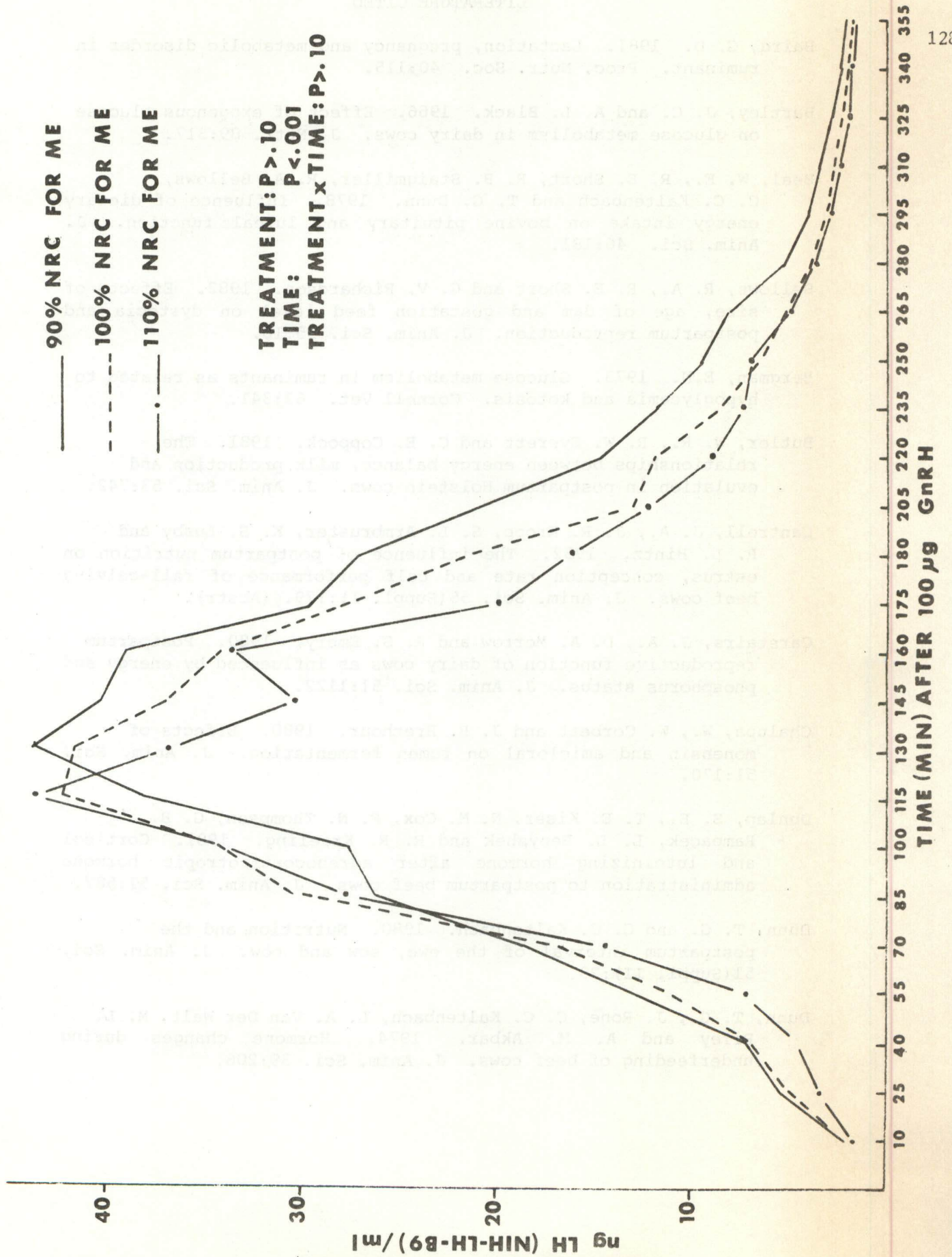
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