The Effect of Mineral Buffers on Milk Yield, Milk Components and Heat Tolerance In Lactating Dairy Cows

by

Debora Charles

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Dr. C. E. Coppock

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ABSTRACT

Twelve Holstein and eight Jersey cows in mid-lactation were blocked in groups of four based on breed and parity, and assigned randomly to four treatments in a ten week continuous feeding trial. Treatments were four concentrate formulations to provide: a) .5% NaCl; b) .72% $NaHCO_3$; c) .5% NaCl + .72% $NaHCO_3$; d) 1.44% $NaHCO_3$ in the total diet dry matter. Rye grass hay was fed ad libitum once daily on a group basis. Milk yield was recorded at the a.m. and p.m. milking three times per week and samples were taken for analysis of milk fat, protein and total solids. The objectives of this study were to measure the responses of milk yield and composition to different dietary levels of sodium, chloride and bicarbonate during hot weather. The four sodium supplements imposed as treatments had no detectable effects on milk yield and composition in Holsteins and Jerseys in mid-lactation.

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INTRODUCTION

Milk protein, as one of the highest quality proteins available, has long been valuable as a part of the human diet. Today, 22% of the total protein consumed in the United States is a milk protein (2,9). Although milk protein is increasing in importance, fat content is also important because farmers get paid on the basis of milk fat percentage. The importance of both protein and fat content has prompted many dairymen and researchers to begin measuring levels of fat and protein. Graphic analysis shows that during June, July and August there is a large decrease in the protein level, with a similar drop occurring in fat content. These depressions coincide with the highest ambient temperature (8).

Many factors affect the protein and fat content of milk. The type of feed used has an effect on fat content, as does the processing of feed. For example, a high concentrate and low fiber diet (<15%) induces a depression in milk fat percentage, but this kind of diet reduces metabolic heat production (11, 7). Another depressing factor on milk fat test is hot weather, which simultaneously depresses feed intake, yield and percentages of fat and protein. So, the problems of milk component percentage reductions in hot weather may be the effect of both temperature and low fiber levels (3).

Michigan researchers (6) proposed the use of sodium bicarbonate to maintain milk fat percentage in diets that have caused depressed milk fat levels (5). An important question which arises with the use

of sodium bicarbonate is what to do about sodium chloride. Apparently, the cow can tolerate large excesses of both sodium and chloride, so little harm occurs when both salts are fed. Since sodium, chloride and and bicarbonates are the principle ions in extracellular fluid, it seems that varying levels of each might increase the buffering capacity of the blood. This in turn, might be beneficial to cattle in hot weather. Even so, many diets for cattle appear to be formulated with excessive levels of chloride because of the routine addition of sodium chloride to diets that do not need a chloride supplement (4). Consequently, when feeding sodium and bicarbonate, it would be easy to omit sodium chloride without concern for the possibility of a sodium deficiency. Unfortunately, chloride requirements of lactating cows have not been established.

Although cows tolerate large excesses of both sodium and chloride, there are valid reasons to minimize the overfeeding of these elements. Excess consumption of salt may increase the water intake, bedding requirements, urine output and transfer these elements to the soil. Both sodium and chloride in high concentrations are toxic to plants and present practical problems in areas with saline soils. There is also a cost factor to consider because nutrients fed in excess waste money (1).

At this time, there is little, if anything known about the effects of low dietary chloride on heat tolerance and milk component percentages, but because of known physiological relationships, those effects should be examined. The overall objective of this research is to study the effect of mineral buffers on milk component yield and heat tolerance

in lactating dairy cows by measuring their responses to differences in dietary levels of sodium, chloride and bicarbonate. This paper will cover only the results on milk yield and composition.

MATERIALS AND METHODS

Twleve Holstein and eight Jersey cows in their first half of lactation were blocked in groups of four based on breed and parity and assigned randomly to 4 treatments in a 10-week trial beginning June 8. The first 2 weeks served as an adjustment period to the control diet, the next 2 weeks as a standardization period and the last 6 weeks as a comparison period.

Treatments were 4 concentrate forumlations to provide added sodium salts in the total diet dry matter of: a) .5% NaCl; b) .72% $NaHCO_3$; c) .5% NaCl + .72% $HaHCO_3$; and d) 1.44% $NaHCO_3$. The concentrate mixtures were offered individually in two equal feedings daily to Holsteins at 1 kg per 2 kg of milk produced and to Jerseys at 1.5 kg per kg of milk produced. Concentrate allowances were calculated weekly based on the previous week's milk production. Rye grass hay was offered ad libitum once daily on a group basis. Cows were housed in a freestall barn open to a paddock except for 30 minutes twice daily, when they were brought into a stanchion barn at 0000 and 1200 hours for feeding of concentrate with subsequent milking in a side-open parlor.

Milk production was recorded on Sunday, Tuesday and Thursday of each week and aliquot samples were taken at each milking and composited on a daily basis for analysis of milk fat, protein and total solids. Milk fat was analyzed by a Foss Milk-O-Tester, milk protein by acid

orange dye (10), and total solids by oven drying at 100°C for 4 hours.

RESULTS AND DISCUSSION

Conclusions of this paper will be limited to a discussion on the effect of treatments on milk yield and milk components. After the statistical analysis for the areas dealing with heat tolerance are completed, these will be included in a final paper. Each graph is divided into a standardization period and an experimental period. The standardization period provided data from all of the cows fed the control diet. Differences present during the standardization period will be used to adjust statistically, data obtained in the experimental period. Each point on the figures represents a mean of 15 observations.

The graph on milk yield (Figure 1) does not follow the usual pattern expected for milk yield in cows beyond the peak of lactation. The amount of milk produced decreases as cows progress in their lactation. Data in Figure 1 show very little decrease from June 22 to the end of the experiment, and in some cases a slight increase occurred. The slight depression and the increase can partially be explained by the fact that the experiment started on June 22, probably some days after the cows had become accustomed to the heat. Also, the cows might have been helped by our choosing an extremely palatable feed that all groups ate readily which helped keep production high. Although production stayed high, it is impossible to conclude that this was due to the varying levels of sodium, chloride or bicarbonate because all treatment groups had basically the same level production curves, regardless of the minerals fed.

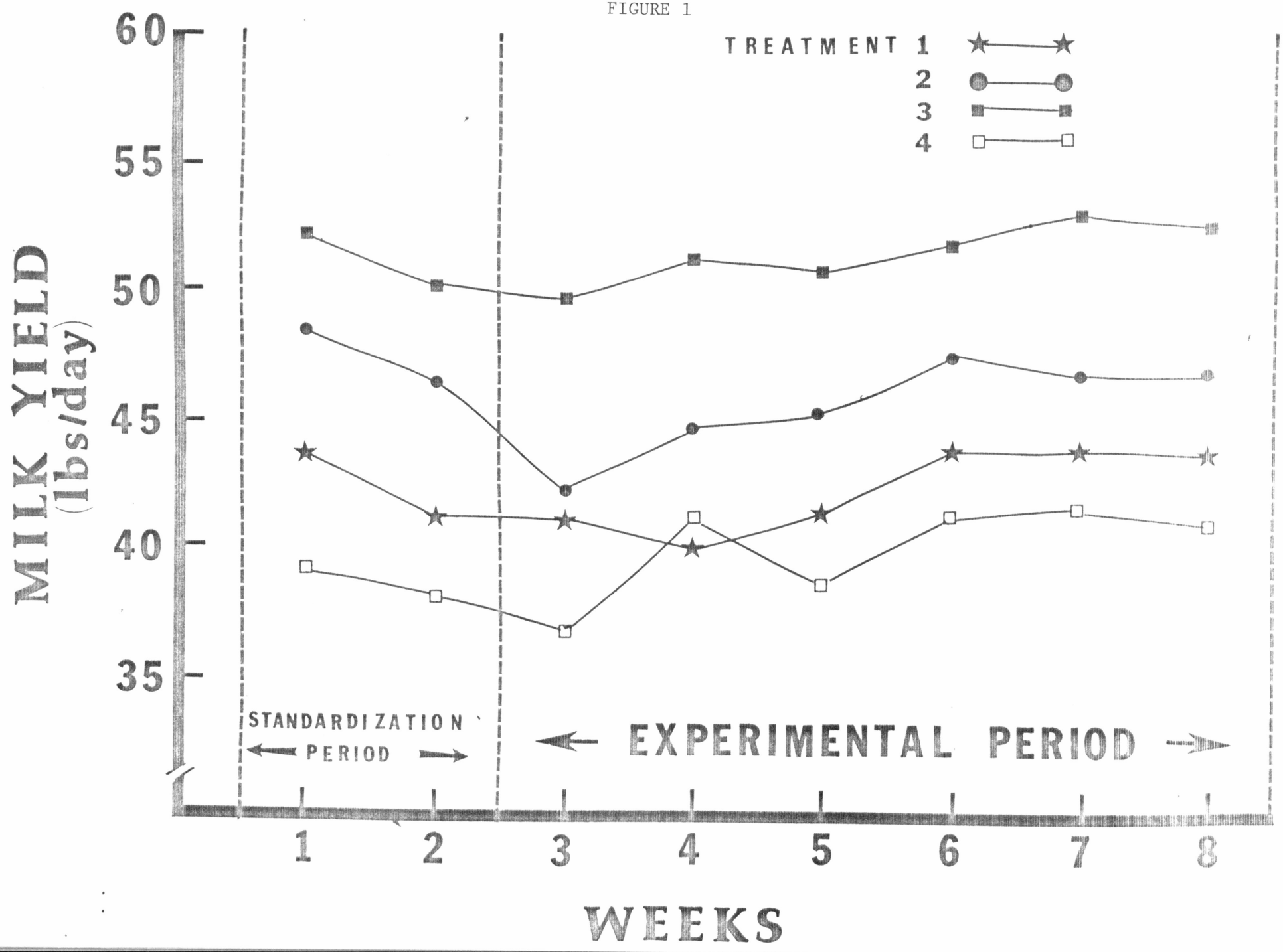
Milk protein percentage (Figure 2), in accord with our graph,

should increase as the animal's lactation period progresses. Milk fat (Figure 3), similar to protein, increased slightly as expected but showed a large degree of fluctuation. The graph of total solids (Figure 4) showed an increase in the manner that was expected with advancing lactation. It is important to understand that though each treatment group, as shown graphically, had a positive response, it cannot be said that this was due to the different diets fed because all responded similarly. Each treatment group increased in production regardless of the varying levels of sodium, chloride and bicarbonate. From analysis of feeds and water, it appears that large excesses of both sodium and chloride were present in the basal diet before addition of any sodium salts. Therefore, further work is needed with carefully selected ingredients and a different water supply that will allow the study of a larger variation of sodium and chloride ratios in the experimental diets that do not greatly exceed the nutrient requirements for sodium and chloride.

CONCLUSION

The four sodium supplements used in this study had no detectable effects on milk yield or composition in Holstein and Jersey cows in mid-lactation in hot weather. The significance of this study is that where ample chloride is present in the basal diet, there is no advantage to including sodium chloride when sodium bicarbonate is added. This will not only reduce diet costs, but reduce environmental contamination of both sodium and chloride.

FIGURE 1


TREATMENT 1
2
3
4
MILK YIELD
(lbs/day)
60
55
50
45
40
35
STANDARDIZATION
PERIOD
EXPERIMENTAL PERIOD
1
2
3
4
5
6
7
8
WEEKS

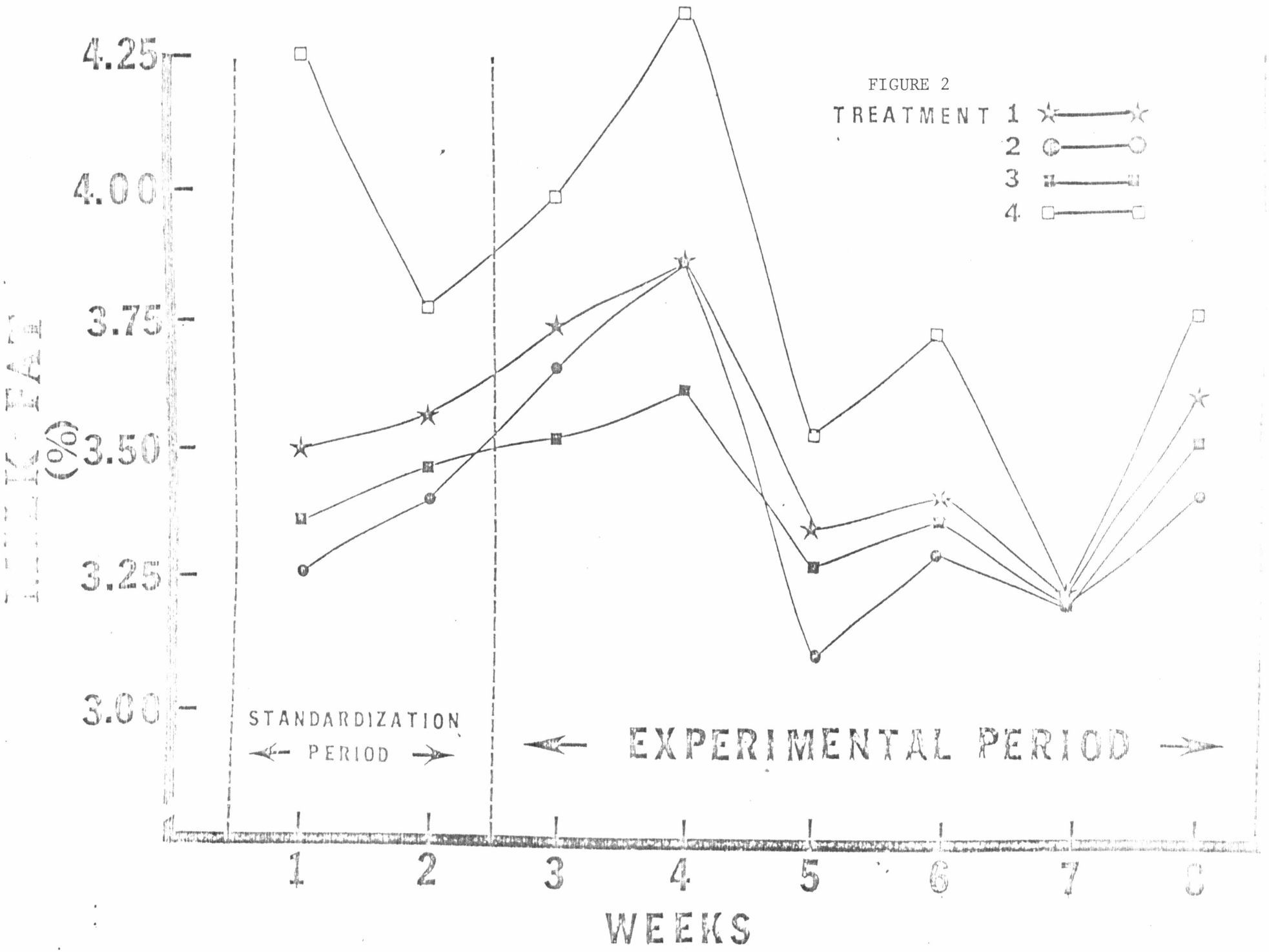


FIGURE 2
TREATMENT 1
2
3
4
4.25
4.00
3.75
3.50
3.25
3.00
(%)
STANDARDIZATION
PERIOD
EXPERIMENTAL PERIOD
1
2
3
4
5
6
7
8
WEEKS

FIGURE 4

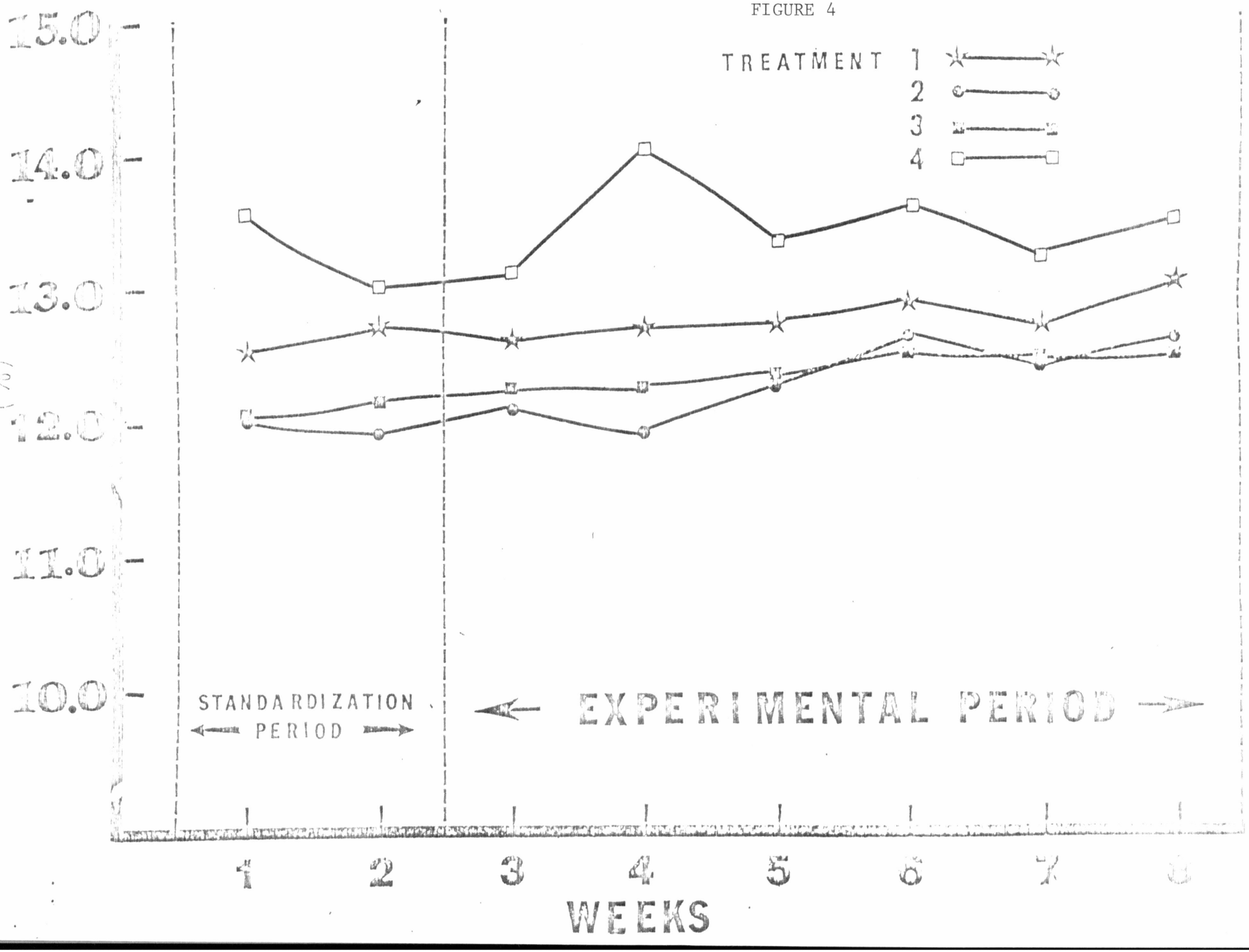
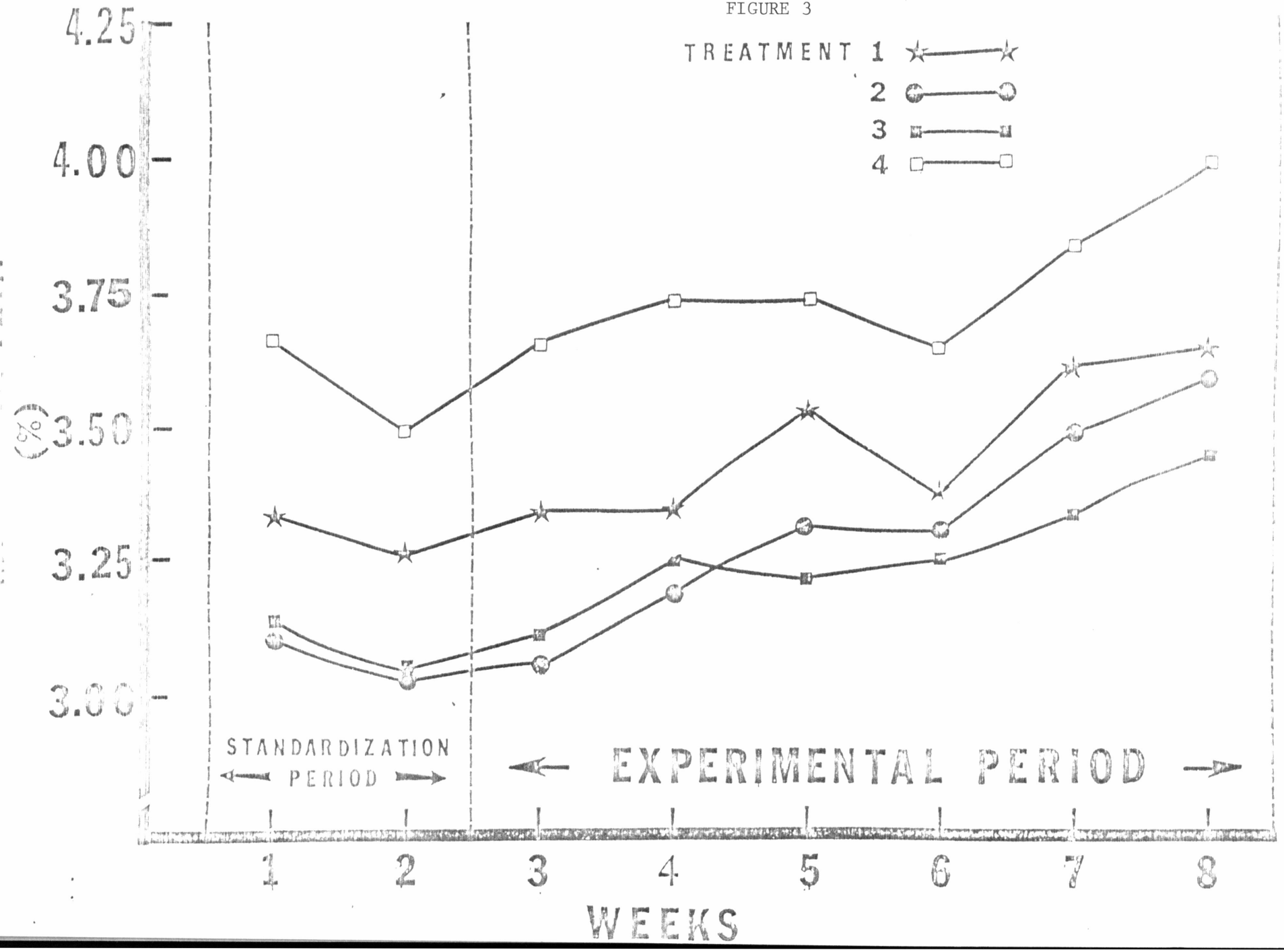

15.0
14.0
13.0
12.0
11.0
10.0
TREATMENT 1
2
3
4
STANDARDIZATION PERIOD
EXPERIMENTAL PERIOD
1
2
3
4
5
6
7
8
WEEKS

FIGURE 3


TREATMENT 1
2
3
4
4.25
4.00
3.75
3.50
3.25
(%)
STANDARDIZATION PERIOD
EXPERIMENTAL PERIOD
1
2
3
4
5
6
7
8
WEEKS

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