

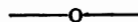
OKLAHOMA  
AGRICULTURAL AND MECHANICAL COLLEGE  
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# STUDIES IN NUTRITION

By  
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## *Studies in Nutrition* <sup>(1)</sup>

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1. Nutritional Value of the Grain Sorghums.
2. The effect of Ensilage on the Vitamine Content of the Grain Sorghums.
3. The Nutritive Value of Milk from Stover-fed and Silage-fed Cows.
4. The Nutritive Value of Milk as Affected by Heat.

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### THE NUTRITIONAL VALUE OF THE GRAIN SORGHUMS

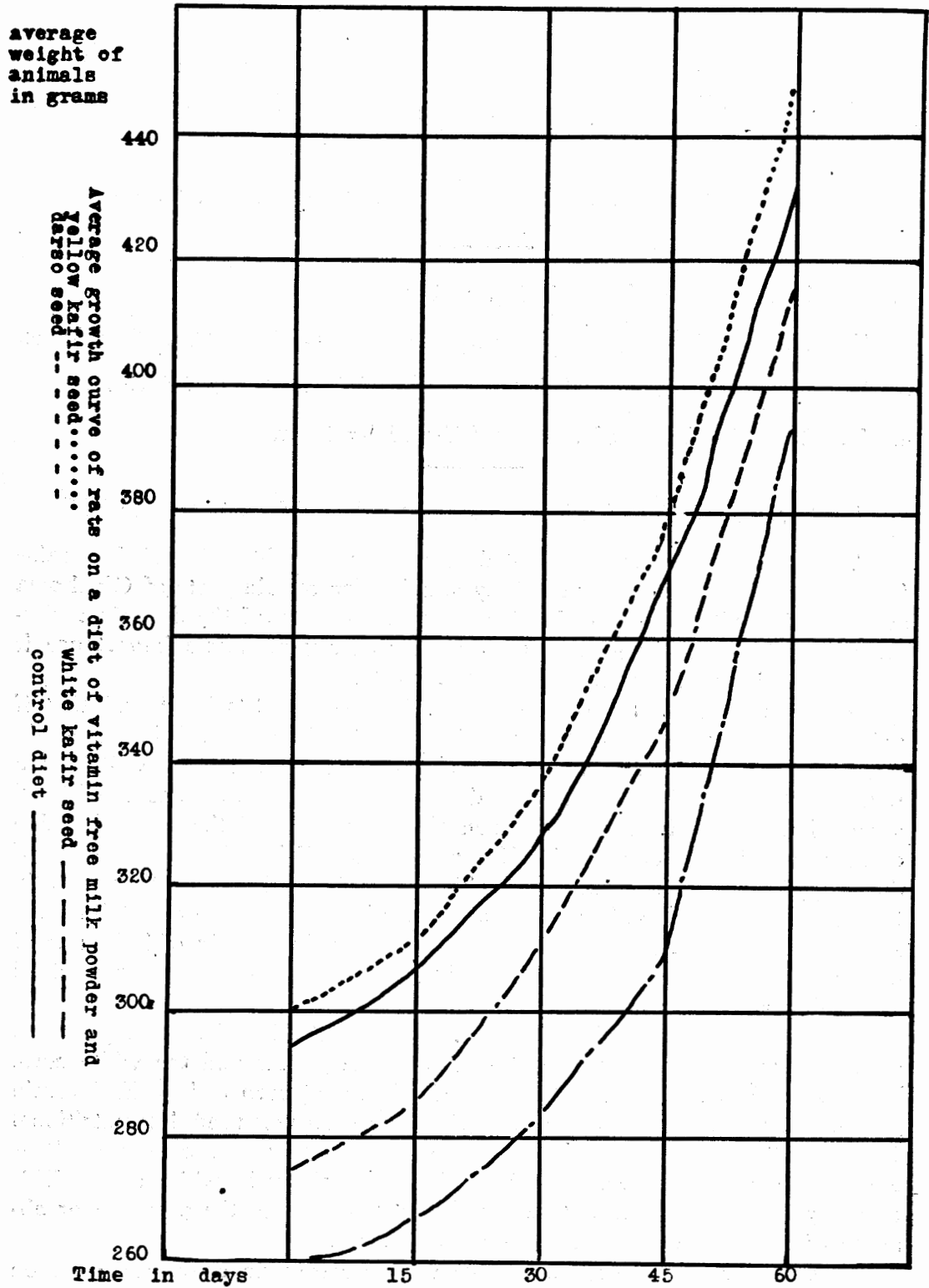
The grain sorghums are adapted to regions of light and sufficient rainfall, and for this reason are peculiarly suitable for certain parts of Oklahoma and are among its most valuable farm crops. In view of the drought resisting properties of these grains and their increasing economic importance it seems desirable to study their nutritional value.

Albert G. Hogan (1) of the Kansas Experiment Station found that if animals were fed a diet, all the protein of which is derived from the grain sorghums, such a diet always results in nutritional failure. It is well known that different proteins are not equal in nutritional value. The nutritional value of a protein is dependent upon the proportion of the various amino acids of which it is composed. If a protein is deficient in one or more of the essential amino acids and incapable of continuously supporting growth, but is supplemented with a small amount of another protein rich in such amino acids, normal growth will ensue. Neither the protein of kafir nor of corn will support growth in animals, but if the proteins of milk are added to the diet normal growth will take place.

Recently H. Steenbock and P. W. Bontwell (2) found that there was a difference between the nutritional values of the yellow and the white corn. When animals were fed a diet composed of ground corn and purified casein growth took place at the normal rate if yellow corn was used, but nutritional failure resulted with white corn. It is concluded that yellow corn contains a dietary constituent necessary, but which is lacking in white corn. This they say is not due to any difference in protein, but to the presence or absence of the so-called accessory food substances.

If corn varies in nutritional value with variation in color, the question presents itself, if such is also the case with the grain sorghums. In order to bring out the limitations in the nutritional values of the grain sorghums,

(1). These studies were undertaken at the suggestion of the Director, Dr. C. T. Dowell.



several groups of young white rats were fed on these grains. Each pen contained four animals. One pen was fed on yellow milo, a second pen on darso which is red in color, a third pen on white kafir, and a fourth pen was used for control observations. Each pen received its one kind of grain sorghum throughout the experiment. All the animals were fed the grain sorghum seed only, for a month, by this time growth had ceased in the animals, their weight becoming stationary. This is explained by the fact that as previously stated the protein of the grain sorghums does not support growth. Vitamine free milk powder was then added to the diet of each pen, including the controls, and the control pen received other foods, such as fresh milk and vegetables. The milk powder used was extracted with alcohol, ether, and acetic acid, and then heated in order to prevent the admission of any so-called vitamins to the diet except those contained in the seed of the grain sorghums. This milk powder was proven vitamine free by experiment. This vitamine free milk powder was found to supply the necessary amino acids for growth. The diet now consisted of grain sorghum seed 90 gms., milk powder 15 gms. (containing 7 gms. protein), and 3 gms. of salt mixture (3).

The animals had free access to this diet for two months, and the increase in weight of each pen was carefully noted. The increase in weight of each pen is shown graphically in the accompanying chart. It will be noted that the growth in each pen, including the control pen, is nearly the same. From this it would seem that the nutritional value of the three color types grain sorghums are equal in value, and that they all contain a sufficient quantity of the so-called growth accessory substances. At the end of the two months, all the animals were again placed on a diet composed exclusively of the grain sorghums. A very slight increase in weight, or even a decline was shown during the next fifteen days.

From the results of this experiment we conclude that the seed of the grain sorghums will support life in the albino rat, and the three color types studied, the yellow, the red and the white, all contain a sufficient amount of the food accessory substances, and they do not differ in nutritional value. The nutritional failure when the diet is composed of the grain sorghums only is due to the protein which from the standpoint of nutrition, is incomplete.

These results were later confirmed by G. N. Blackshaw, in the Rhodesia Agri. Journal. 20-451-60; 20-178-82.

1. A. G. Hogan *Jo. Bio. Chem.*, XXXIII-51.
2. H. Steenbock & P. W. Bontwell. *Jo. Bio. Chem.*, XLI-83.
3. E. B. Haxt, J. G. Halfin & H. Steenbock. *Jo. Bio. Chem.*, XLIII-422.

### THE NUTRITIVE VALUE OF MILK FROM STOVER-FED AND SILAGE-FED COWS

The nutritive value of milk from the standpoint of vitamine content has been shown to depend upon the feed consumed by the cow. (1) This value is greatest when the cows are on green pasture. Some dairymen never put their cows on pasture, but depend upon silage as a succulent. It occurred to the writers to test the desirability of this practice by comparing the nutritive value of milk from cows fed on stover with that from cows having silage in their ration.

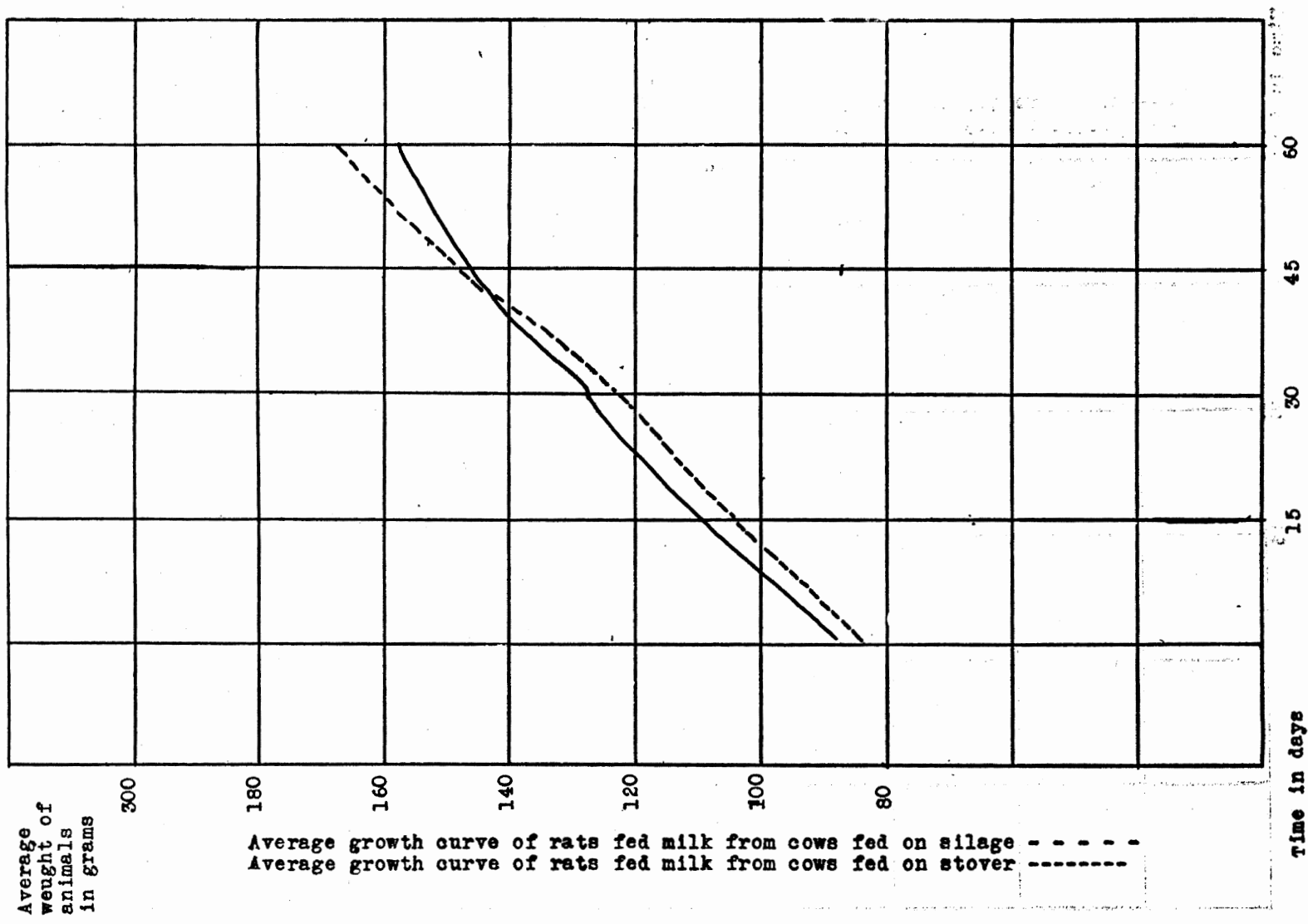
To compare the nutritive value of milk from cows fed silage, with milk from cows fed stover, two cows giving milk of similar composition were selected for the comparison and fed a grain ration of oats 4 parts, wheat middlings 3 parts, corn chops 2 parts, and cotton seed meal one part, in addition to which one cow received kafir silage of good grade, the other dry kafir stover.

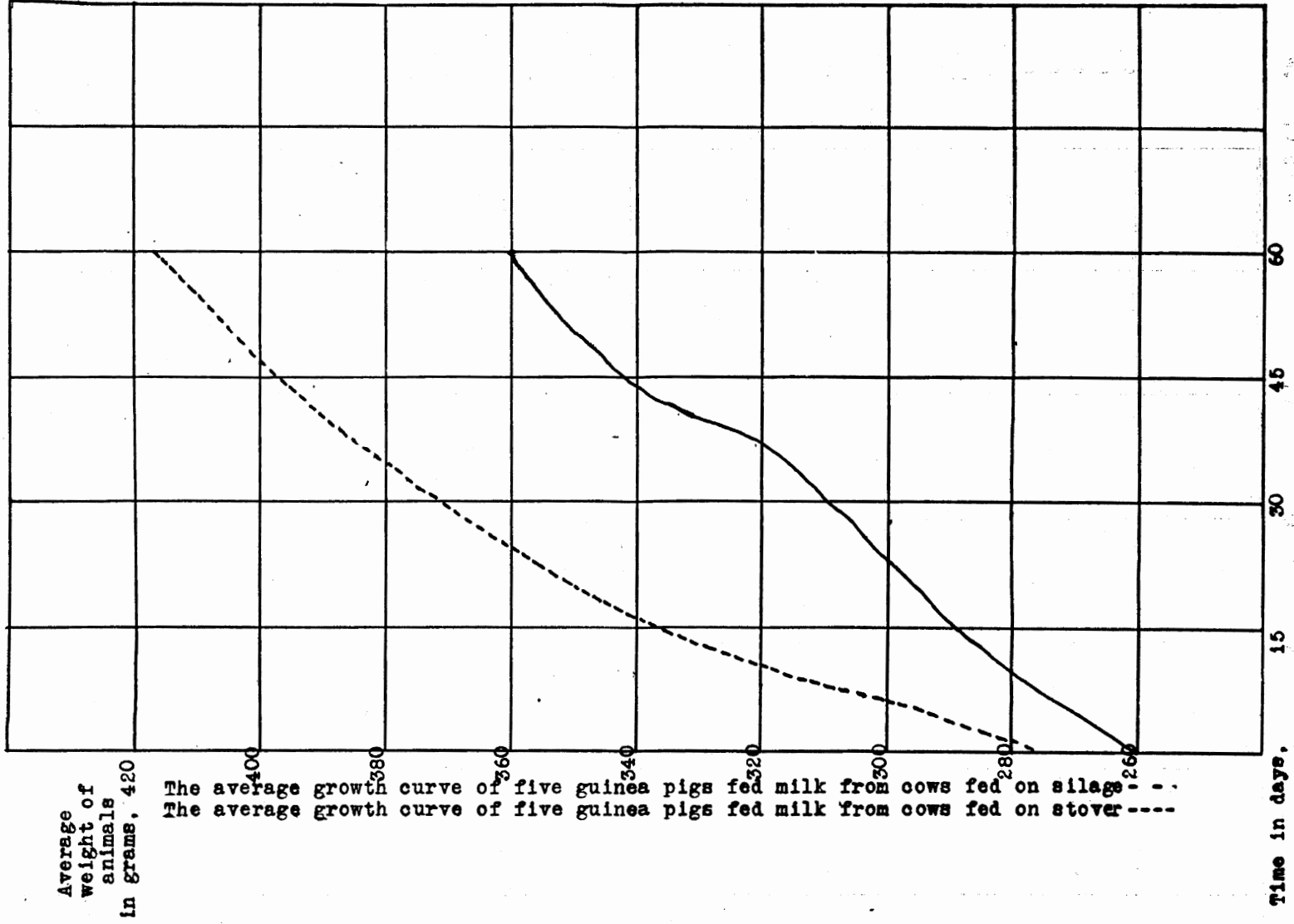
Eight young rats and eight young guinea pigs were fed on a diet proven free of vitamins, consisting of a poor grade alfalfa flour 27 parts, oatmeal 67 parts and a salt mixture 2 parts, this mixture was then autoclaved. In addition to this diet four of the rats and four of the guinea pigs were given milk from the cow fed silage, the remaining four rats and guinea pigs were given milk from the cow fed stover. Of the milk assigned each rat or guinea pig received daily 10 percent of its own weight. This diet was continued for 60 days, each animal was kept in a separate cage and weighed from time to time. Figure on page 7 presents the growth curves of the eight rats and figure on page 8 that of the eight guinea pigs.

The object was to note any difference in the nutritive values of the milk from cows fed silage and that from those fed dry stover. From the growth of the animals as shown by the accompanying charts it is evident that the milk obtained from the silage fed cow is superior to that obtained from the one fed the dry stover.

The animals were in good health during the experiment and showed no indication of suffering from any disease associated with a lack of vitamins, no symptoms of scurvy, eye disease, or any nervous disorder. It is apparent that 10 per cent of the body weight of fresh whole milk furnishes sufficient vitamins for young rats and guinea pigs, and that milk from silage fed cows is superior in nutritive value to that from cows fed on dry stover.

(1) R. Adams Dutcher, C. H. Eckler, C. D. Dahle, W. W. Meade and C. G. Schaefer—*Jo. Bio. Chem.*, XIV-119.  
C. Kennedy and R. A. Dutcher—*Jo. Bio. Chem.*, L-399-359.







**THE EFFECT OF ENSILING ON THE VITAMINE CONTENT  
OF THE GRAIN SORGHUMS**

H. Steenbock and P. W. Bontwell (1) find that ensiling does not destroy the vitamins A or B, in alfalfa. N. R. Ellis, H. Steenbock and E. B. Hart (2) find that the fermentation processes involved in the making of sour kraut from cabbage and silage from corn result in the destruction of the antiscorbutic factor, known as Vitamine C.

In connection with other experiments it was decided to determine whether the grain which had undergone the ensiling process still possessed nutritive value comparable to that of dried grain. Mother rats with litters one week old, were placed on a diet as in experiment No. 1, excepting that white kafir seed which for three months had been subjected to the ensiling process, was the grain used in the ration. This ensiled grain was obtained by sifting out the grain from white kafir silage from one of the station silos. It was then air dried, ground and mixed with the vitamine free milk powder and salt mixture. The animals were fed the same as in experiment No. 1. The weight of the young was found at regular intervals of 5 days. When the young were 25 days old the mothers were removed. All of the litters were healthy and in good condition throughout the experiment. No disorder attributable to a lack of vitamins could be noted. The young animals were kept on this diet for two months. Their average growth is graphically shown by chart on following page.

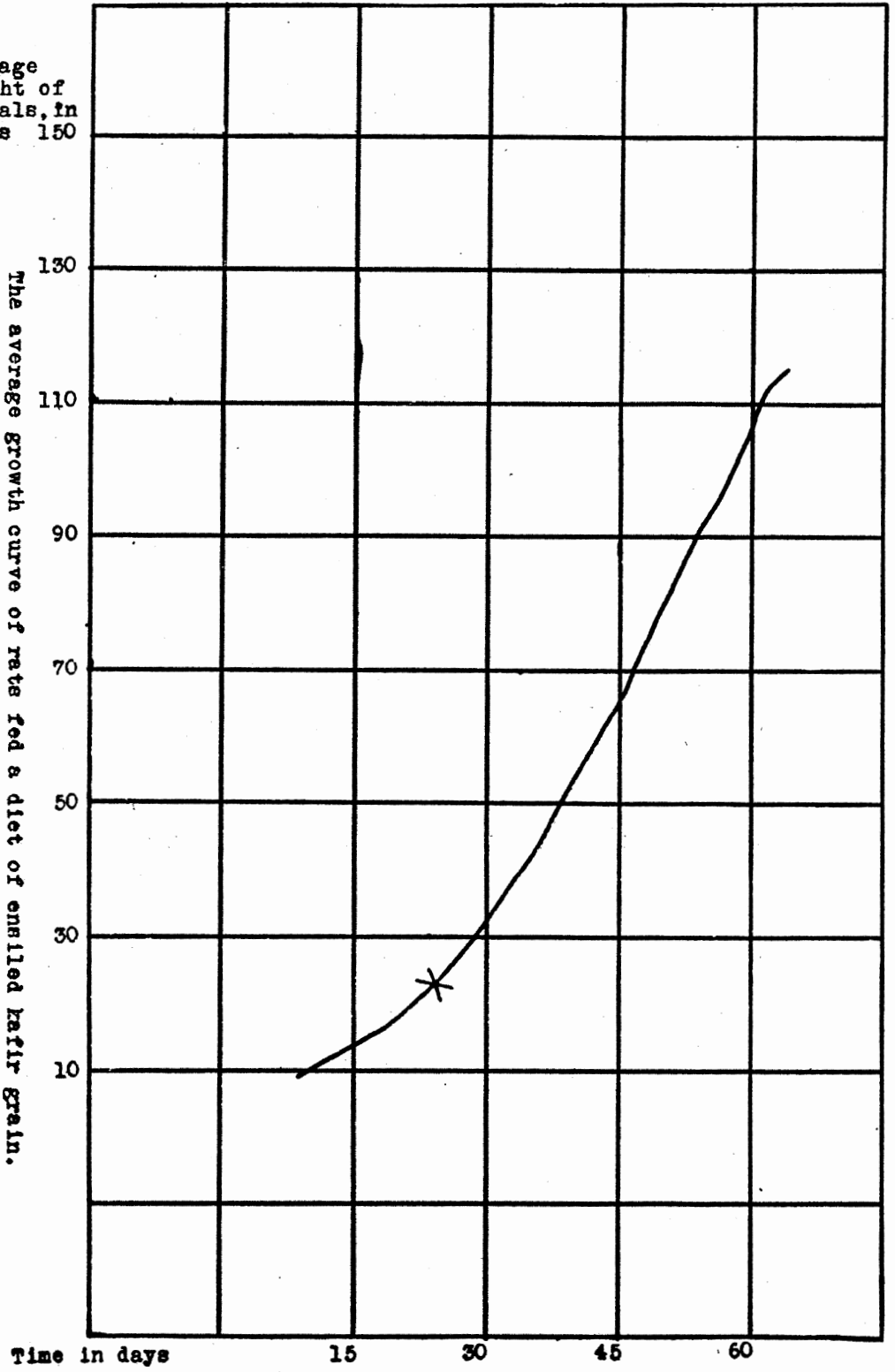
The animals varied but little in growth which was approximately normal. It is evident that the ensiling process does not impair the nutritive value of the grain.

(1) H. Steenbock and P. W. Bontwell. *Jo. Bio. Chem.*, XLI-163.

(2) N. R. Ellis, H. Steenbock and E. B. Hart. *Jo. Bio. Chem.*, XLVI-367.

Average weight of animals, in grams 150

The average growth curve of rats fed a diet of emulged kafir grain.  
Mother rats were removed from young at X.



## THE NUTRITIVE VALUE OF MILK AS AFFECTED BY HEAT

Nearly all the studies regarding the influence of pasteurization of milk have been made as regarding vitamine C, with the result that some workers, (1), (2), (3) and (4), agree that the use of milk which has been heated may result in scurvy. Other investigators, (5), (6), (7), (8), (9) and (10), on the contrary, argue that heat treatment does not affect the so-called vitamins, and that pasteurized milk or even dried milk is as nutritive and furnishes as complete protection against scurvy as raw milk. Even better results were obtained with dried milk, showing that the dilution of the food-stuff is of some importance.

It has been shown that milk alone is not the ideal food for the later stages of life, although a complete food for the first two-thirds of the growth period. Evidently we are not fully informed as to the nutritive value of milk. As a contribution to the knowledge of the subject the writers conducted some experiments on the effect on pasteurizing milk, which we offer as additional data.

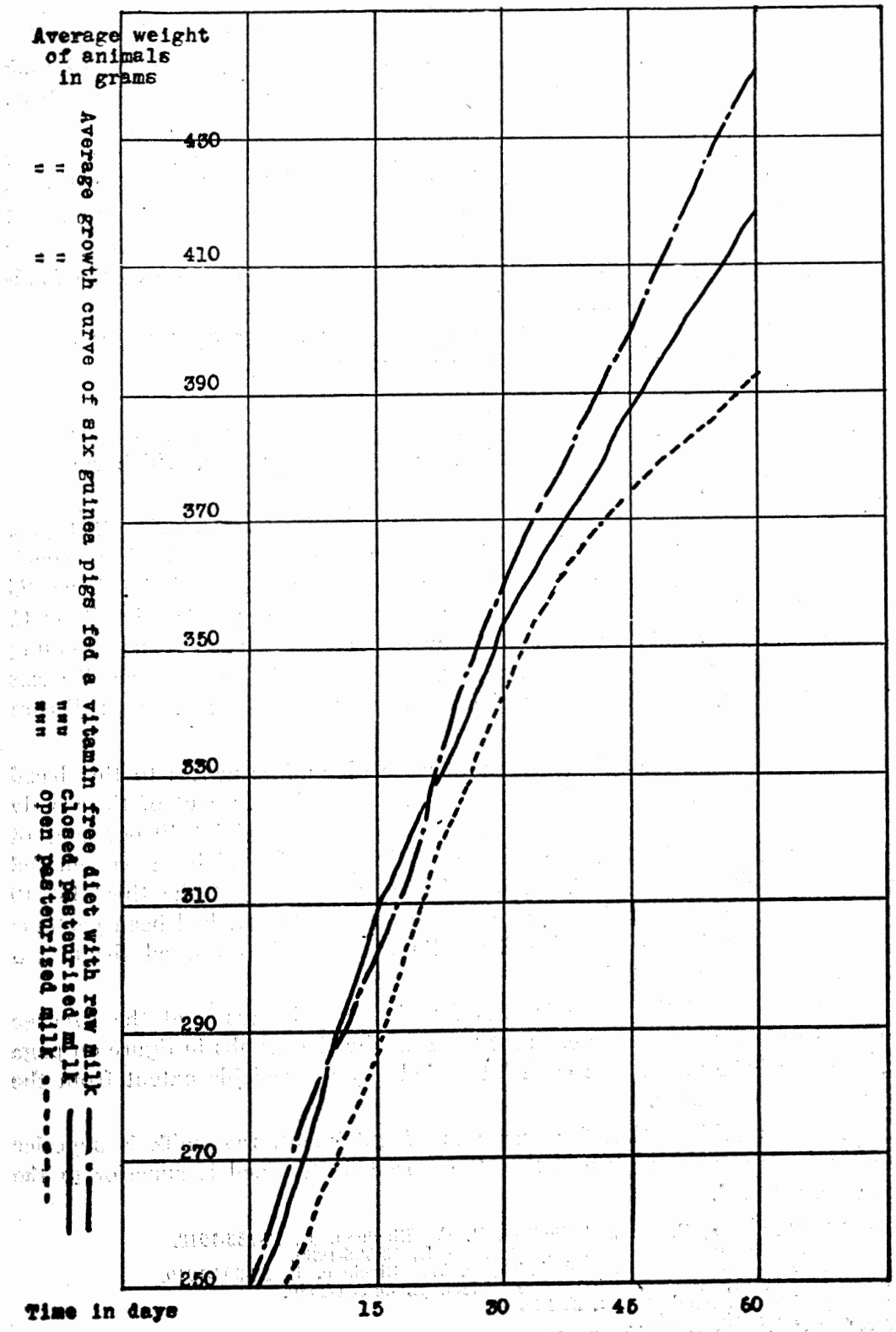
Three lots each of six young guinea pigs, weighing from 225 to 250 gms. each, were fed a basal ration found vitamine free by other feeding experiments, consisting of rolled oats 72 parts, a poor grade of alfalfa flour, 25 parts, and a salt mixture 3 parts. This ration was then autoclaved at 130° C, for four hours then dried at the temperature of 150° C. for four hours. Young guinea pigs fed this ration, with water, developed scurvy and eye diseases in 10 to 13 days. Young rats on the same diet developed a nervous disease and eye disease in two weeks.

The guinea pigs in this experiment were given free access to this basal ration, besides which those of the first lot received 10 per cent of their body weight of mixed raw milk each day, those of the second lot 10 per cent of their body weight of the same milk excepting that it had been pasteurized in a closed bottle at 145° F. for 20 minutes, and those of the third lot 10 per cent of their weight of the same milk excepting that it had been pasteurized in an open bottle at 145° F. for 20 minutes, then poured through a cooler, thus being aerated.

The weight of the animals was found every 5 days, and the average growth of the six animals in each lot is shown by the graphs in figure on page 12. None of the animals in each lot varied any appreciable extent from the average growth curve.

It seems evident that for purposes of nutriment, raw milk is superior to closed pasteurized milk and that the closed pasteurized is superior to the open pasteurized.

- (1) Chick, H., Hume, E. M., and Shelton, R. F. *Biochem. J.*, 12-133-1918.
- (2) Barnes, R. E., and Hume, R. M. *Biochem. J.*, 13-306-1920.
- (3) Hart, E. E., Steenbock, H., and Smith, D. W. *Biochem. J.*, 38-305-1919.
- (4) Daniels, A. L., and Laughlin, R. *Biochem. J.*, 44-381-1920.
- (5) Winfield, *Govt. Food Report*, 24-189.
- (6) Naish, *Pediatrics*, 26-247.
- (7) Hess, A. F., and Unger, L. J. *Biochem. J.*, 38-393-1919.
- (8) Cotts, *Govt. Food Report*, 24-1.
- (9) Johnson, J. M., *Pub. Health Report*, U. S. 36, 1921, No. 34.
- (10) Johnson, J. M., and Hooper, C. W., *Pub. Health Reports*, U. S. 36, 1921, No. 34.



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