THE EFFECT OF PROTEIN QUALITY ON GROWTH IN THE MINK AND RAT

ABSTRACT

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by

Lorne Charles Seier

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EXPERIMENT I

THE EVALUATION OF TWO DRY PROTEIN SOURCES IN RATIONS FOR YOUNG GROWING MINK

By Lorne Charles Seier

Forty-five male Sapphire kits were allotted to three treatment groups. After a two week adjustment period the kits were started on test. The control ration was a standard growing ration composed of horse meat 10%, chicken by-products 15%, raw cereal 25%, and frozen fish 50%. The protein substitutes were herring meal and soybean meal which replaced the frozen fish on an equivalent dry matter basis.

Average final weights in kilograms taken on November 7th were 1.78, 1.87, 1.92 kg. for the soybean meal, herring meal, and control treatment respectively. The differences in final weights were not statistically significant. The test period was divided into three stages; (1) growing before furring (August 1st to 29th); (2) growing and furring (August 30th to October 17th); and (3) maintenance (October 17th to November 7th). The growth rates for these three periods in grams per day were: for the control treatment 15.2 (Period I), 6.1 (Period II), 0.8 (Period III); herring treatment 18.0 (Period I), 6.7 (Period II), -2.6 (Period III); soybean treatment 11.8 (Period I), 7.8 (Period II), -0.7 (Period III).

Digestibility trials were carried out during each period. Dry matter and energy digestibility were significantly higher ($P < .05$) for the herring and control treated kits when compared to the soybean meal treated kits. There was no significant difference ($P > .05$) in nitrogen balance among treatments.

Skin biopsies were taken at pelting time to compare fur density. Average fur densities expressed as hair per pore were 19.6, 20.6, and 19.5 for the soybean, herring, and control treated kits, respectively.

EXPERIMENT II

THE EFFECT OF PROTEIN QUALITY AND QUANTITY ON HAIR GROWTH IN THE RAT

Sixty male weanling albino rats, approximately 3 weeks of age were allotted to six treatment groups. A 3 x 2 factorial experiment with three qualities of protein, egg albumen, casein supplemented with methionine and casein unsupplemented, and two levels of protein 20 per cent and 10 per cent, was initiated. The 20 per cent egg treatment was discarded due to egg white injury and the experiment was then analysed as a random design. The hair on the rats was shaved from their backs so that the hair cycles could be observed. The rats were fed ad libitum, and feed consumption and body weight recorded weekly.

The average length of the hair cycle in days was significant ($P < .05$) for treatments and for the 20% vs 10% orthogonal contrast, the values being SC 20% - 30.3; E 10% - 31.1; C 20% - 33.0; SC 10% - 35.0; C 10% - 40.1. Body growth, expressed as grams of gain per day was significant ($P < .05$) for each comparison and followed the same order of treatment effect as the hair cycle lengths with values of 3.61; 3.30; 2.88; 2.16; and 1.20 respectively.

Skin biopsies were taken after the second regrowth of hair and the hair densities, expressed as number of hair per follicular unit, were C 20% - 2.11; SC 20% - 2.06; SC 10% - 1.86; E 10% - 1.66; C 10% - 1.60. Treatment effects and the 20% vs 10% contrast were significant ($P < .05$). Hair diameters were measured and expressed as the ratio of the primary follicle diameters to the secondary follicle diameters. The values were E 10% - 1.44; SC 20% - 1.39; C 20% - 1.37; SC 10% - 1.33; C 10% - 1.29, and were not significantly different from each other. These data suggest that when protein is restricted body growth and hair growth are restricted proportionately.

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INTRODUCTION

The mink industry, as part of the agriculture industry in general, is plagued by rising costs combined with constant or lowering returns. The response to these economic pressures has been the amalgamation of many of the small ranches into larger and more efficient units. In addition the principal ingredients of the diet for mink have changed from horse meat to scrap fish and poultry by-products.

Reduction in feed price should not sacrifice quality, but rather be those feeds which result in the most economical production of quality mink pelts. Fish and poultry by-products have in many instances replaced horse meat; however, all these products are expensive and not continually available, as well as requiring refrigeration. The trend today is away from fresh ingredients such as meat, fish, and packing house offal from livestock and poultry, and towards such dried foodstuffs as fish meal, blood meal, cereal grains, and soybean oil meal. These dry feeds represent economic savings in that no refrigeration is required, spoilage and the possibility of food poisoning is reduced, labor for ration preparation is reduced, and supplies are readily available and may be lower in price than fresh ration ingredients.

To evaluate these new diet ingredients, certain criteria must be established which relate to the performance of mink. Most research to date has used the standards established for farm animals, such as body growth or weight, body size or body length. With mink this is not necessarily adequate, as the pelt and not the carcass is the saleable product. Mink should not be pelted before the fur is prime, which is generally near the end of November, whereas, maximum body weight is reached sometime in October.

Since the pelt is the saleable product, a criterion for evaluating the dietary effect on furring would seem desirable. The basic question of what makes hair grow also warrants investigation.

The evaluation of pelt quality is very complex. However, a measurement of hair density is fairly readily obtained, and could possibly be one of the criteria used to evaluate the economic value of pelt quality, along with color and texture.

As protein sources change by the introduction of dry rations and hair is mainly protein, varying sources of protein were investigated with respect to the growth, digestibility, and effect on hair growth of growing mink. Hair density as a measure of the effect of diet on pelt quality, was the criterion used to evaluate hair growth.

An experiment, utilizing purified diets which were fed to rats, was initiated in order to establish, more clearly, the effect of protein nutrition on hair growth.

REVIEW OF LITERATURE

PROTEIN REQUIREMENTS

The National Research Council (1953) has recommended protein levels for mink of 22 to 26 per cent, on a dry matter basis, from 7 to 16 weeks of age, and 16 to 22 per cent from 16 weeks to maturity. Sinclair (1960) and Allen (1962) suggested that the protein levels recommended by N.R.C. are too low. Conventional ranch mink rations contain about 40 to 50 per cent protein on a dry matter basis (Oldfield 1968). Sinclair (1960) reported that a 27 per cent protein ration, as compared to 44, 37, or 31 per cent protein rations, was sufficient in quantity and quality for mink from 7 to 27 weeks of age. Allen (1962) suggested that a 16 per cent protein ration was not sufficient for optimum growth, a 22 per cent ration was too low for adequate disease resistance, and that a 28 per cent protein ration appeared to be nearer to the optimum for good growth. Oldfield (1968) stated that mink growth and fur production remains quite good at protein levels of 30 and even 25 per cent, but at lower protein levels both growth and fur production of the mink tend to be reduced.

DIGESTIBILITIES

Mink appear to be able to adequately digest the wide variety of products normally used in their rations. Loosli et al. (1940) have reported dry matter digestibilities of 70 to 78 per cent; protein digestibilities of fresh protein feeds are reported at 84 to 93 per cent; of processed protein feeds 72 to 73 per cent; of N.F.E. 65 to 85 per cent and even raw starches appear to be well digested. Leoschke (1959) using mink measured true digestibility of fats which ranged from 91.9 to 97.2 per cent.

Apparent digestible protein studies of common mink feed ingredients indicated that chicken feet had a protein digestion coeffieient of 52.4 per cent, while chicken heads had a coefficient of 78.2 per cent, and other substances registered varying percentages with horse meat having the highest coefficient 92.1 per cent. Roberts and Kirk (1964) reported that the protein digestibility of three species of fish fed to mink ranged from 87.1 to 90.6 per cent. Protein digestibility of dry cereal meal was estimated to be approximately 70 per cent (Roberts & Kirk 1964).

Loosli and Smith (1940) estimated that 1.64 grams of nitrogen were required to maintain nitrogen balance in mink fed a ration which was adequate in energy. A sparing effect of digestible energy on protein was noted by Sinclair (1960). He also reported a significant difference between age groups in nitrogen retention. Age appeared to have a variable effect upon protein digestibility of male mink. When a low protein (22 per cent) diet was fed digestibility increased as the animals became older (11 to 21 weeks). At a dietary protein level of 28 per cent the effect of age ondigestibility still could be detected although to a lesser extent. Mink fed diets containing 30 to 37 per cent protein did not demonstrate any effect of age on protein digestibility. Age and sex of mink appeared to have no effect on the digestibility of energy when protein levels were below 30 per cent. However, male and female mink digested gross energy (from 5.0 to 5.7 kcal/g) to a greater degree at 25 weeks of age than at 15 weeks of age when protein levels were between 30 and 37 per cent (Allen 1962).

ENERGY REQUIREMENTS

The National Research Council indicate the energy requirements for mink to be 124 calories/kilogram body weight, or 2,370 calories per square

meter of body surface area. The National Research Council also suggests that mink can efficiently utilize raw wheat or oat cereals as a source of energy.

Allen (1962) introduced the concept of the calorie:protein ratio, the ratio of apparent digestible energy to apparent digestible protein. The ratio of gross energy to crude protein represents an estimate of the ratio calculated on an apparent digestible basis. At gross energy intakes greater than 5.0 kcal/g of dry matter, the body weight of male mink increased as the ratio of apparent digestible energy to apparent digestible protein decreased from 34 to 12. Therefore, with an energy level of 5.0 kcal/g in the ration, the optimum energy protein ratio appears to be between 12 and 13. A similar increase in growth occured for males which were fed energy levels lower than 5.0 kcal/g , but the growth increase was lower than for the mink fed the higher energy diets. It was observed, however, that liparous mink tend to produce a longer pelt, and in order to encourage fattening the energy protein ratio should be increased to 17 for males after sixteen weeks of age and this ratio maintained until pelting.

DRY RATIONS

Kifer and Schaible (1955) formulated and pelleted a dry ration consisting of soybean oil meal, fish meal, herring meal, dried meat scraps, livermeal, fish glandular hydrolysates, dried soluble blood, fish solubles, cooked cereal and yeast. Although the dry diet used in this experiment did not allow as rapid gains during growth as the control horse meat ration, the dry diet appeared to be adequate for maintainance. The weight differences between the control and experimental groups were more the result of fattening than of any other factor. Water consumption appeared to be a

problem in that, in the winter with the dry diet, all the water had to be obtained from the frozen water in the watering cups. This probably restricted water intake and may have effected the performance of the mink.

Oregon State University Experimental Station has conducted growth trials for several years using dry diets mixed into a paste. The dry ration consisted of 20.2 per cent herring meal; 14.8 per cent blood meal; 16.2 per cent lard; 29.6 per cent oat groats and 19.3 per cent of supplemental ingredients such as soybean meal, molasses, brewers yeast, beet pulp, and wheat bran. The growth curves of mink on the paste diets were generally lower than the control diets, but fur color was superior for the mink on the paste diets. Fur quality of the paste diet fed mink was equivalent or lower then the controls. The incidence of wet belly, an unprime condition on the belly, was reduced about a third for the mink on the paste diet compared to the control diet, but feed wastage due to the lack of binding in the paste diet resulted in increased feed costs.

HAIR CLASSIFICATION, GROWTH, and REPLACEMENT

Three general classifications of hair cycles have been suggested by Ryder (1964) which consist of: first, seasonal moults e.g. mink; second, waves of growth which regularly pass across the body, e.g. rats; third, hairs are replaced irregularly with each follicle having its own cycle apparently independent of that of its neighbour, e.g. man.

Mink have two moults annually; a spring and autumn moult, which consist of the old hairs being replaced by new hairs while in contrast, the fox only moults once a year.

In the rat, the formation and elongation of the hair ends at about 17 days of age, and constitutes the growing stage of the hair.

The transformation into a quiescent condition occurs within an interval of three or four days and usually by 21 days of age the root of the hair is securely lodged in a resting follicle, which remains inactive until 31 or 32 days of life. This resting period and growth period constitutes a hair cycle, which occurs approximately every 30 to 34 days. This cyclic hair growth in rats occurs as a wave over the body. Activity in follicles of the venter may be observed 2 to 3 days before it occurs in the dorsum. Thus, the wave begins in the venter, spreads dorsally, then anteriorly and posteriorly (Butcher 1951).

Ebling (1964) has broken the hair cycle down into three phases, instead of the two of Butcher: first, anagen, or the period of activity of growth; second, catogen, a short transition phase during which the hair forms a club; third, telogen, the resting stage.

Noback (1951) has written a review on the morphology and phylogeny of mammalian hair from which the following classification of hair types was taken.

TYPES OF MAMMALIAN HAIR

1. Hair with specialized follicles containing erectile tissue. Large, stiff hairs that are preeminently sensory have been variously designated as feelers, whiskers, sensory hairs, tactile hairs, vibrissal, etc. These occur in all mammals except man, and are grouped essentially as follows:

I. Active tactile hairs - under voluntary control.

II. Passive tactile hairs - not under voluntary control.

a) Follicles characterized by a circular sinus.

b) Follicles without a circular sinus.

2. Hairs with follicles not containing erectile tissue. Most of the remaining types of hair are more or less defensive or protective in function.