89

1959 Research in . . .

MINK NUTRITION

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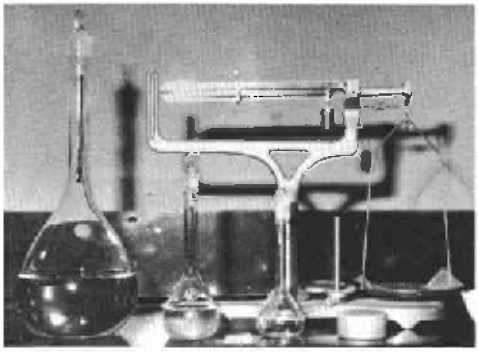

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Miscellaneous Paper 89

March 1960

Agricultural Experiment Station
Oregon State College
Corvallis

Foreword

Mink farming in the United States has grown from a production of 1.8 million kits in 1950 to over 5 million kits in 1958, a 177 percent increase. This would suggest a growing and thriving industry.

Like all segments of American agriculture, fur farming is beset with problems created by change. Rising feed and labor costs, price fluctuations, diseases and management problems plus foreign competition combine to make fur farming as hazardous as any other type of farming.

Oregon, the eighth ranking state with a production of over 200,000 kits in 1958 has some advantages over certain other states in the availability of marine fish species, but this too has its peculiar problems.

Oregon State College is pleased to participate in cooperative research designed primarily to evaluate the nutritional uses of less costly mink food constituents. Another phase of the program has been directed toward study of the nature, cause, and prevention of the "cotton fur" abnormality. Since 1954 this work has been supported by an annual grant from the Mink Farmers' Research Foundation, Milwaukee, Wisconsin, for which we are most grateful.

The Fur Farm of the Department of Dairy and Animal Husbandry presents herein a report of the work for 1959. It is hoped these results will be useful to Oregon fur breeders in helping them formulate better and cheaper rations for production of top quality mink.

We appreciate the interest and support of the Oregon State Fur Breeders Association. Special thanks are due members of the Advisory Committee whose counsel and advice has been valuable. We look forward to continued cooperation in the years ahead.

J. C. Miller, Head
Department of Dairy and Animal Husbandry

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Summary

Major points of interest in performance by diet groups 1 to 8 are listed below:

1. Growth and fur production of mink fed the control ration were highly satisfactory and serve as a standard for comparison.

2. Substitution of high quality protein with less expensive dry ingredients (cereal) during the period of fur growth resulted in equal body growth but superior fur color.

3. When 47 percent of the ration was supplied as dry ingredients, mink lacking considerably in size but generally equal in fur color and quality were produced at significantly lower ration costs.

4. A ration composed of generally available feed ingredients with a sustained high level of beef liver produced mink that showed sub-optimal growth but superior fur in comparison to control mink.

5. A ration containing 18 percent whalemeat produced mink that showed similar growth and fur production to mink fed the control ration containing horsemeat and tripe.

6. Mink fed a ration containing 20 percent hake in a processed form showed generally equal and in some respects superior performance to control animals, indicating the adequacy of this little-used resource for mink feeding.

7. Mink produced on a ration containing 70 percent turkey waste in lieu of fish compared favorably with control animals in growth and fur production, however fur color showed presence of an abnormal white banding.

8. Results from a ration containing synthetic liver indicated that good growth and fur production could be obtained without inclusion of fresh liver.

Developments in Mink Nutrition

1959 Progress Report

Introduction

Much has been learned, over the years, about the dietary requirements of ranch mink. From initial efforts directed towards imitation of the diet the animals consumed in their wild state, practical experience and research developed the complex and highly-supplemented mink rations of today. Problems still remain however--particularly problems concerning substitution of diet ingredients.

Former staples of the mink diet, including horsemeat and certain fish species, are short in supply and command prices which make their continued widespread use uneconomical. In this situation, the mink industry, like other agricultural enterprises, has utilized by-products. These by-products have characteristics which differ from their parent substances: Characteristics that must be known before the by-products can be effectively incorporated into mink feed mixes. One phase of the work reported here deals with the evaluation, both by chemical assay in the laboratory and by feeding trials with mink, of several by-product materials--whale meat, processed hake, and turkey waste.

Other work reported deals with modifications of the basal standard ration (fed group I in the experiments) including an increase in cereal content during the furring period, provision of the major portion of the diet in the form of dry ingredients and substitution of a "synthetic liver product" for fresh liver. An additional diet involved high sustained liver content (10%) and other supplementation designed to improve nutritional quality.

Animal tests with these materials have been compared with performance on a control ration composed of "standard" ingredients which have proved themselves in fur farm practice. Evaluation of all rations, and of their individual ingredients, has been made by the chemical proximate analysis scheme which identifies quantity of crude protein, fat, fiber, mineral matter and nitrogen-free extract present. These data are included in the report of each experimental group of animals, along with the percentage composition of the ration. Animal performance has been evaluated in terms of growth as determined by length and weight gains and of fur production as measured by color and quality. The latter determinations were made by an experienced commercial fur grader.

This year's report also includes an attempt at a quantitative evaluation of the pelts through measurement of pelt weight and length of underfur and guard hair, taken only from those animals pelted. Economics of each test ration have been assessed by evaluation of the basic feed cost (f.o.b. source) of raising animals from weaning to pelting as compared to the estimated valuation of pelts produced. These economic comparisons are expressed on a percentage basis in relation to the control (group 1) data, which have been given the value of 100. For example, test group 3 dark animals show a ration cost figure of 92 and a cost per dollar return of 68. This means that the ration ingredients cost only 92% as much as those fed the controls, while the feed ingredient costs per dollar return were only 68% as high as the controls.

In addition to tests concerning gross diet composition, basic studies have been continued on nature, cause, and prevention of the "cotton pelt" fur abnormality. This work has included supplementation of mink fed a cotton-inducing ration with purified

compounds in order to determine what nutritional entity will prevent the "cotton pelt" condition. Again, both laboratory and animal tests have been carried out involving "cotton" and "normal" mink.

Through the 1959 breeding year, 172 female mink were maintained at the Experimental Fur Farm, including 138 standard darks, and 34 sapphires. Ranch litter average was 4.27 young, and total kits counted was 734. Of these, 696 young animals were included in various test groups, and number and type is indicated in the report on each experimental treatment. Experiments started July 8, 1959, for dark mink, one week later for sapphires, and continued until pelting, with weights recorded for all test animals at monthly intervals. Where breeder animals were retained from test groups, live grades were taken and recorded at conclusion of the experiments.

TEST GROUP 1

Objective

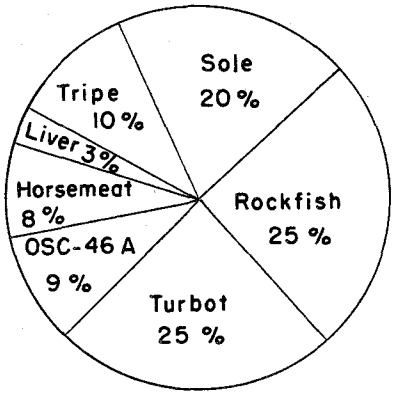
To provide a standard CONTROL RATION of ingredients which have given satisfactory growth and fur production as a basis for comparison with other test groups.

Method

Type and Number of Mink

Standard dark	31 males and 30 females
Sapphire	8 " " 8 "
Total	77 mink

Ration



July 8 - pelting

Proximate Analysis

Dry matter	30.91%
Crude protein*	57.54
Crude fat*	23.91
Crude fiber*	2.37
Ash*	10.52
Nitrogen-free extract*	5.66

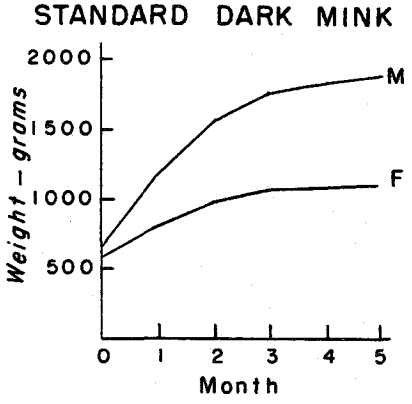
*Expressed as a percentage of the dry matter.

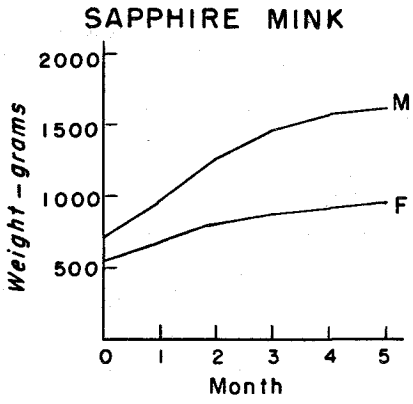
O.S.C. 46A Cereal Mix**

Wheat germ	25.00%
Alfalfa meal	12.50
Skim milk powder	8.30
Meat meal	16.67
Soybean oil meal	16.67
Ground oat groats	16.66
Brewer's yeast	4.20
	100.00%

**Fortafeed 2-49C at 0.40%; Terramycin (TM -10) at 0.25%; and Methionine at 0.05% were added.

Results





Males	Females		Males	Females
1132	506	Weight gain (gm.)	937	434
45.3	37.9	Animal length (cm.)	43.6	37.0
197	197	Fur color*	-	-
23.6	22.2	Length of guard fur (mm.)	23.3	22.2
13.8	12.7	Length of underfur (mm.)	12.9	12.4
126	137	Quality of fur*	-	-
109	58	Weight of dried skin (gm.)	93	51
26.1	21.4	Length of dried skin (inches)	24.8	20.8
$ 31.19	16.13	Estimated pelt value	$ 26.50	12.62
100		Cost per pound of ration (% of control)	100	
100		Ration cost per dollar return (% of control)	100	

*Fur color and quality, taken from dried skins, is rated from 100 (best) to 500 (poorest).

Discussion

Performance of mink in this group is the standard with which animals in other test groups can be compared. Growth and fur production were considered highly satisfactory (growth was better than in previous years); therefore, other groups comparing favorably can be considered satisfactory. Eight wet bellies (26.7% of the dark males pelted) occurred in this ration. Prevalence of the condition throughout the years in the college standard dark herd, as contrasted to a very low incidence of it in the sapphire mink on similar rations, suggests a genetic relationship in this disorder. Fourteen breeder animals were kept from this group.

TEST GROUP 2

Objective

To evaluate the substitution of additional cereal mix for horsemeat as an economy move during the furring period, and as a possible standard for future comparisons.

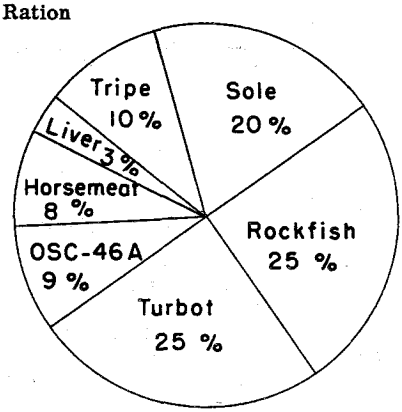
Method

Type and Number of Mink

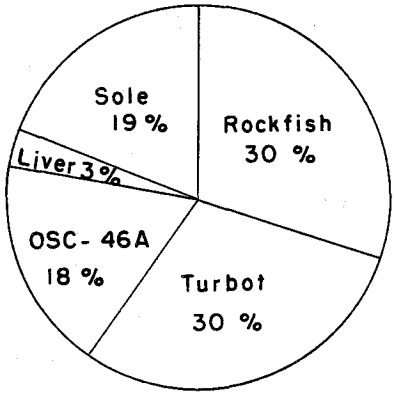
Standard dark ..... 31 males and 30 females
Sapphire ..... 8 " " 8 "

Total .....77 mink

Ration



July 8 - October 14



October 14 - pelting

O.S.C.-46A Cereal Mix**

Wheat germ	25.00%
Alfalfa meal	12.50
Skim milk powder	8.30
Meat meal	16.67
Soybean oil meal	16.67
Ground oat groats	16.66
Brewer's yeast	4.20
	100.00%

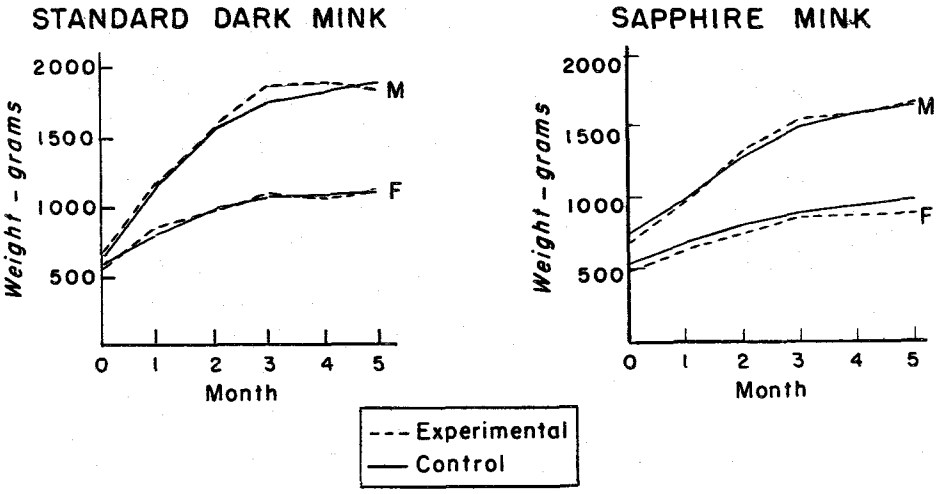
Proximate Analysis

	July	Oct.
Dry matter	30.91	36.69
Crude protein*	57.54	54.78
Crude fat*	23.91	22.08
Crude fiber*	2.37	3.46
Ash*	10.52	11.35
Nitrogen-free extract*	5.66	8.33

*Expressed as percentage of the dry matter.

**Fortafeed 2-49C at 0.40%; Terramycin (TM-10) at 0.25%; and Methionine at 0.05% were added.

Results



Males	Females		Males	Females
1125	518	Weight gain (gm.)	985	376
45.4	38.1	Animal length (cm.)	44.7	36.6
181	173	Fur color*	-	-
24.5	21.7	Length of guard fur (mm.)	25.0	22.8
14.2	12.9	Length of underfur (mm.)	14.2	12.5
129	130	Quality of fur*	-	-
106	60	Weight of dried skin (gm.)	96	47
26.2	21.7	Length of dried skin (inches)	25.3	19.8
$ 30.94	16.87	Estimated pelt value	26.00	11.63
88		Cost per pound of ration (% of control)	88	
88		Ration cost per dollar return (% of control)	93	

*Fur color and quality, taken from dried skins, is rated from 100 (best) to 500 (poorest).

Discussion

This group received the control ration until early October when a gradual change involving a complete removal of horsemeat and tripe and an increase in cereal was made. Since growth was already attained, costly high protein ingredients were no longer so necessary. In dark mink final size was equivalent to the controls, however fur color was considerably better. Results indicate that ration economy can be effected during the furring-out period without loss of fur quality. Fifteen (51.7%) of the dark males pelted showed wet belly symptoms. Seventeen animals were retained as breeders.

TEST GROUP 3

Objective

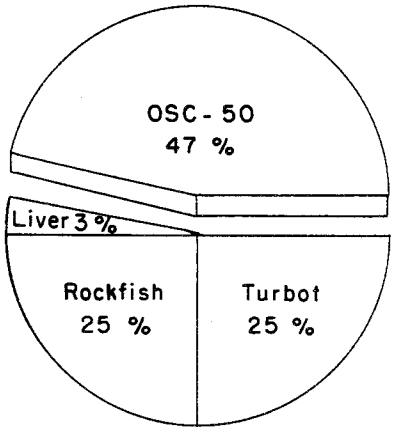
To develop a DRY (cereal) MIXTURE of high feed value (fed as 47% of the ration) to replace nutrients conventionally supplied by wet dietary constituents.

Method

Type and Number of Mink

Standard dark	31 males and 30 females
Sapphire	8 " " 8 "
Total	77 mink

Ration



July 8 - pelting

Proximate Analysis

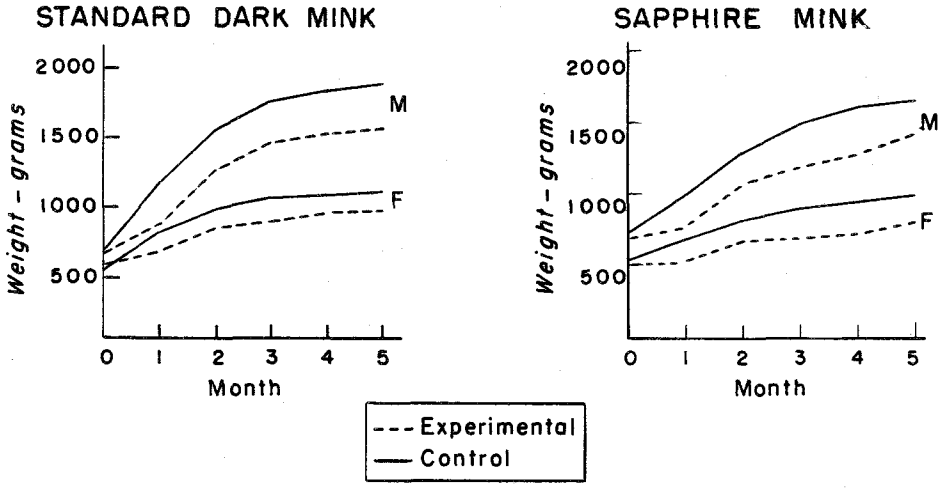
Dry matter	57.07
Crude protein*	51.00
Crude fat*	17.96
Crude fiber*	5.99
Ash*	8.90
Nitrogen-free extract*	16.15

*Expressed as percentage of the dry matter.

O.S.C.—50 Cereal Mix

Wheat germ	15.00%
Alfalfa meal	5.00
Skim milk powder	5.00
Soybean oil meal	15.00
Ground oat groats	20.00
Fish meal (herring)	35.00
Malt sprouts	5.00
	100.00%

Results



Males	Females		Males	Females
881	389	Weight gain (gm.)	754	300
43.5	37.5	Animal length (cm.)	42.4	35.9
182	197	Fur color*	-	-
24.0	21.9	Length of guard fur (mm.)	24.1	22.3
13.8	12.7	Length of underfur (mm.)	13.3	11.9
132	123	Quality of fur*	-	-
89	55	Weight of dried skin (gm.)	81	46
25.0	20.9	Length of dried skin (inches)	24.1	19.4
$ 31.79	16.07	Estimated pelt value	$ 24.88	11.75
92		Cost per pound of ration (% of control)	92	
68		Ration cost per dollar return (% of control)	73	

*Fur color and quality, taken from dried skins, is rated from 100 (best) to 500 (poorest).

Discussion

At first it was difficult to make this ration hold together on the wire, and this may partially explain the markedly sub-optimal growth as evidenced by the graph. The problem of keeping the feed on the wire was surmounted by addition of guar gum (a binder) and beet pulp to the ration. Fur color in dark males was better but quality poorer than the control males, however fur quality of dark females was 10 percent above the control females. Greater return over feed cost was realized in this group due to lower ration cost and fewer wet bellies. Ration costs were lower for two reasons: first, price per pound was 8% below the control ration and second, and probably most important, the dry matter content was nearly double that of the control, so considerably less feed was required. Seven (25%) of the dark males pelted showed wet belly symptoms.

TEST GROUP 4

Objective

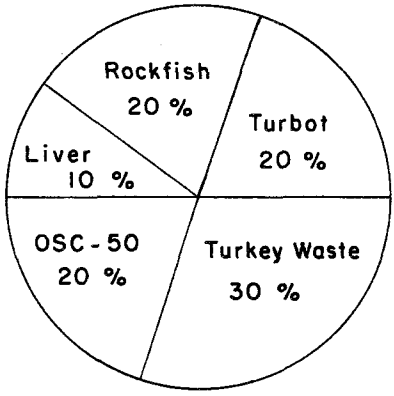
To compound a ration of generally available feed ingredients featuring a sustained high level of beef liver.

Method

Type and Number of Mink

Standard dark	30 males and 31 females
Sapphire	8 " " 8 "
Total	77 mink

Ration



July 8 - pelting

Proximate Analysis

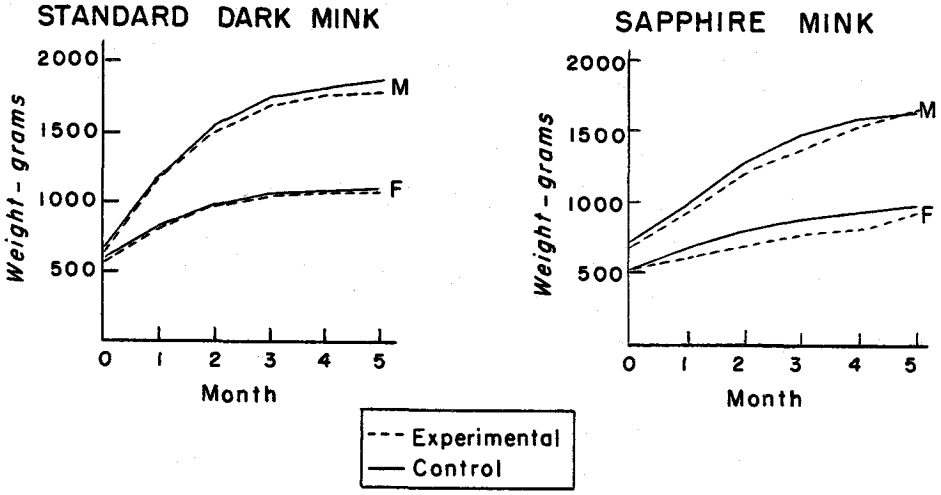
Dry matter	38.39
Crude protein*	59.34
Crude fat*	17.51
Crude fiber*	2.98
Ash*	11.66
Nitrogen-free extract*	8.51

*Expressed as a percentage of the dry matter.

O.S.C.—50 Cereal Mix

Wheat germ	15.00%
Alfalfa meal	5.00
Skim milk powder	5.00
Soybean oil meal	15.00
Ground oat groats	20.00
Fish meal (herring)	35.00
Malt sprouts	5.00
	100.00%

Results



Males	Females		Males	Females
1044	520	Weight gain (gm.)	965	389
44.9	37.9	Animal length (cm.)	42.7	36.3
186	190	Fur color*	-	-
24.8	21.6	Length of guard fur (mm.)	25.0	21.0
14.8	13.0	Length of underfur (mm.)	13.5	14.5
121	134	Quality of fur*	-	-
104	59	Weight of dried skin (gm.)	82	53
25.8	21.6	Length of dried skin (inches)	24.9	20.5
$ 32.45	16.52	Estimated pelt value	$ 27.25	13.75
95		Cost per pound of ration (% of control)	95	
76		Ration cost per dollar return (% of control)	73	

*Fur color and quality, taken from dried skins, is rated from 100 (best) to 500 (poorest).

Discussion

Although size of dark males in this group was somewhat lower than for the controls, color and length of fur were superior. Calculations reveal a 5% lower ration cost than that of the controls, also an advantage was gained in lower feed consumption because of the 8% higher dry matter content. Sapphire females showed uniformly good color and character. Nine (34.6%) of the dark males pelted showed wet belly symptoms. Eighteen mink were retained as breeders.

TEST GROUP 5

Objective

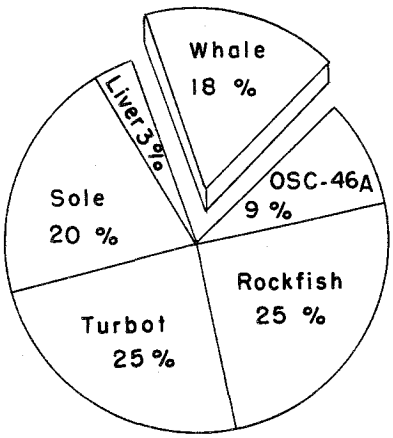
To evaluate WHALEMEAT (18%) as a replacement for horsemeat (8%) and tripe (10%), in the support of growth and fur production.

Method

Type and Number of Mink

Standard dark	31 males and 30 females
Sapphire	8 " " 8 "
Total	77 mink

Ration



July 8 - pelting

Proximate Analysis

Dry matter	30.09
Crude protein*	63.08
Crude fat*	18.88
Crude fiber*	2.34
Ash*	10.46
Nitrogen-free extract*	5.24

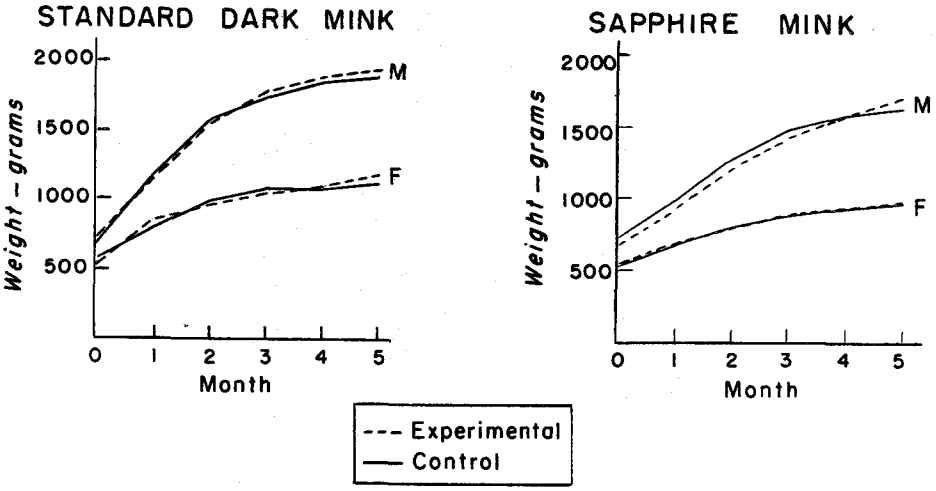
*Expressed as a percentage of the dry matter.

O.S.C.—46A Cereal Mix**

Wheat germ	25.00%
Alfalfa meal	12.50
Skim milk powder	8.30
Meat meal	16.67
Soybean oil meal	16.67
Ground oat groats	16.66
Brewer's yeast	4.20
	100.00%

**Fortafeed 2-49C at 0.40%; Terramycin (TM-10) at 0.25%; and Methionine at 0.05% were added.

Results



Males	Females		Males	Females
1193	560	Weight gain (gm.)	1014	434
45.9	38.2	Animal length (cm.)	43.0	37.4
193	214	Fur color*	-	-
25.3	22.6	Length of guard fur (mm.)	24.0	22.1
14.7	13.0	Length of underfur (mm.)	13.5	12.6
127	134	Quality of fur*	-	-
111	59	Weight of dried skin (gm.)	88	49
26.5	21.7	Length of dried skin (inches)	26.3	20.8
$ 31.27	16.30	Estimated pelt value	$ 25.88	12.13
97		Cost per pound of ration (% of control)	97	
96		Ration cost per dollar return (% of control)	100	

*Fur color and quality, taken from dried skins, is rated from 100 (best) to 500 (poorest).

Discussion

Although growth and fur production data reveal averages better than for the control group, fur color was lower in the case of the dark females. Production costs being slightly lower offset the lack of fur color and provide a net return comparable to that of the controls. Eleven (37.9%) of the dark males pelted showed wet belly symptoms. Nine animals were retained as breeders.

TEST GROUP 6

Objective

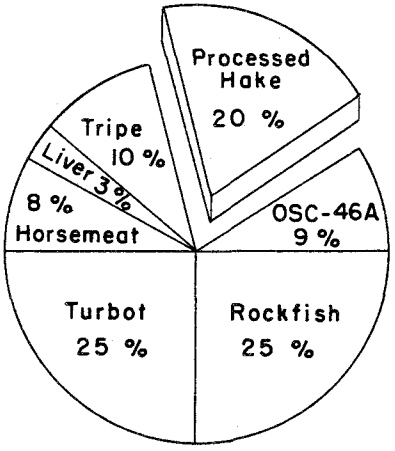
To evaluate PROCESSED HAKE (20%) as a replacement for sole (20%). (Previous studies have indicated that hake, which compared favorably in nutrient content with sole, offers promise when heat-treated in replacing fish species in high demand by other markets.

Method

Type and Number of Mink

Standard dark	31	males and 30 females
Sapphire	8	" " 8 "
Total	77	mink

Ration



July 8 - pelting

Proximate Analysis

Dry matter	32.28
Crude protein*	56.40
Crude fat*	22.43
Crude fiber*	1.98
Ash*	12.02
Nitrogen-free extract*	7.17

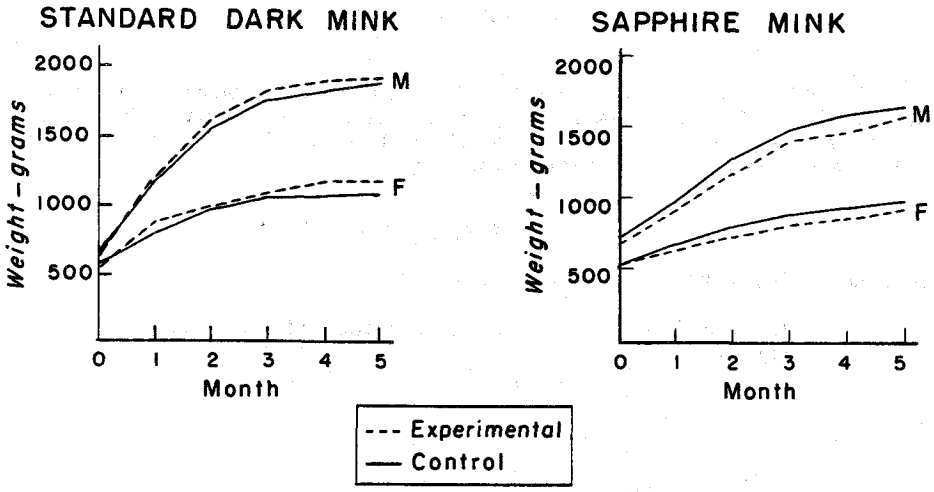
*Expressed as a percentage of the dry matter.

O.S.C.—46A Cereal Mix**

Wheat germ	25.00%
Alfalfa meal	12.50
Skim milk powder	8.30
Meat meal	16.67
Soybean oil meal	16.67
Ground oat groats	16.66
Brewer's yeast	4.20
	100.00%

**Fortafeed 2-49C at 0.40% Terramycin (TM-10) at 0.25%; and Methionine at 0.05% were added.

Results



Males	Females		Males	Females
1202	561	Weight gain (gm.)	909	413
45.5	38.3	Animal length (cm.)	43.0	36.4
168	210	Fur color*	-	-
24.9	22.2	Length of guard fur (mm.)	24.7	20.0
14.7	13.2	Length of underfur (mm.)	13.5	12.5
139	130	Quality of fur*	-	-
108	61	Weight of dried skin (gm.)	80	47
26.5	21.8	Length of dried skin (inches)	24.4	19.8
$ 31.32	16.00	Estimated pelt value	$ 26.25	13.50
100		Cost per pound of ration (% of control)	100	
104		Ration cost per dollar return (% of control)	103	

*Fur color and quality, taken from dried skins, are rated from 100 (best) to 500 (poorest).

Discussion

Numerous experiments involving hake (a fish relatively free from competitive markets) have been conducted at this station. Until recently, little value was realized from this fish as its use in the raw state caused poor growth and cotton pelts. Since a heat-sensitive factor appeared involved, a cooked product was developed and included as 20% of this ration. Growth and fur production in dark mink were improved over the controls; however growth of sapphire mink was below control sapphires. Fur color was better in dark males, poorer in dark females. Live gradings of female sapphires revealed uniformly good fur color and character. As compared to controls, feed consumption was higher. Thirteen (50%) of the dark males pelted showed wet belly symptoms. Twenty animals were retained as breeders.

TEST GROUP 7

Objective

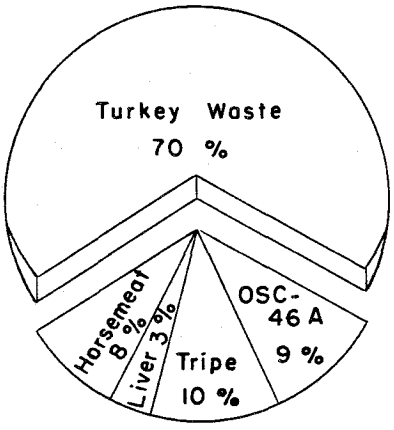
To evaluate a high level of TURKEY WASTE (70%) as a replacement for sole (20%), rockfish (25%) and turbot (25%). Increasing demands for available fish supplies provide an impetus to develop a ration around packing plant offal which will produce a quality mink of good size and fur standards.

Method

Type and Number of Mink

Standard dark	31 males and 30 females
Sapphire	8 " " 8 "
Total	77 mink

Ration



July 8 - pelting

Proximate Analysis

Dry matter	33.30
Crude protein*	54.49
Crude fat*	26.05
Crude fiber*	2.87
Ash*	11.70
Nitrogen-free extract*	4.89

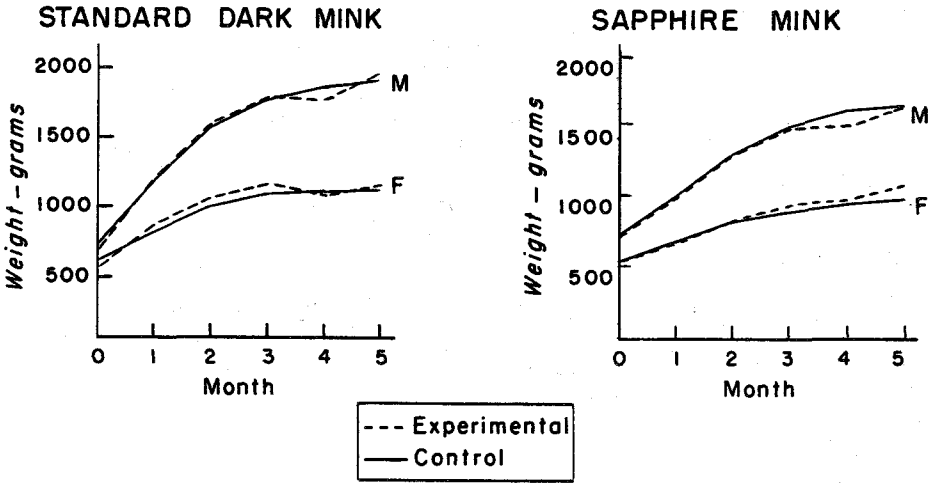
*Expressed as a percentage of the dry matter.

O.S.C.--46A Cereal Mix**

Wheat germ	25.00%
Alfalfa meal	12.50
Skim milk powder	8.30
Meat meal	16.67
Soybean oil meal	16.67
Ground oat groats	16.66
Brewer's yeast	4.20
	100.00%

**Fortafeed 2-49C at 0.40%; Terramycin (TM-10) at 0.25%; and Methionine at 0.05% were added.

Results



Males	Females		Males	Females
1211	582	Weight gain (gm.)	934	551
45.5	38.4	Animal length (cm.)	43.5	38.4
370	353	Fur color*	-	-
25.9	23.7	Length of guard fur (mm.)	25.3	23.0
14.8	13.7	Length of underfur (mm.)	14.0	13.3
127	137	Quality of fur*	-	-
110	61	Weight of dried skin (gm.)	92	53
26.8	22.1	Length of dried skin (inches)	25.4	21.6
$ 22.87	14.23	Estimated pelt value	$ 26.63	13.25
103		Cost per pound of ration (% of control)	103	
120		Ration cost per dollar return (% of control)	93	

*Fur color and quality, taken from dried skins, are rated from 100 (best) to 500 (poorest).

Discussion

Compared to control animals early growth was similar for males, superior for females; however a noticeable growth depression during the initial furring period occurred in all mink fed this ration as evidenced in the graph. Effects of this depression were reflected in the underfur of dark mink as a peculiar light banding. Due to this abnormal condition, pelt value estimates were severely reduced. Sapphire mink being normally light in color were not adversely affected. Both guard and underfur lengths were greater in this group than in the controls. Further research with this ration is necessary as the abnormal underfur color could stem from a factor other than the high level of turkey waste. Last year a ration containing 55 percent turkey waste produced good growth and fur production with no noticeable banding of the underfur. Fifteen (50%) of the dark males pelted showed wet belly symptoms. Six animals were retained as breeders.

TEST GROUP 8

Objective

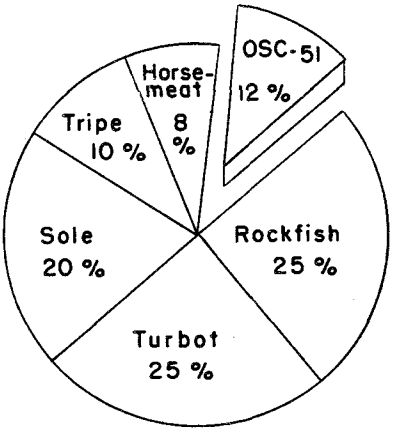
To evaluate a LIVER SUBSTITUTE (included at a level equivalent on a dry matter basis to 3% fresh liver) in mink diets for support of growth and fur production.

Method

Type and Number of Mink

Standard dark	24 males and 17 females
Sapphire	8 " " 8 "
Total	57 mink

Ration



July 8 - pelting

Proximate Analysis

Dry matter	32.67
Crude protein*	56.33
Crude fat*	23.80
Crude fiber*	3.55
Ash*	10.74
Nitrogen-free extract*	5.58

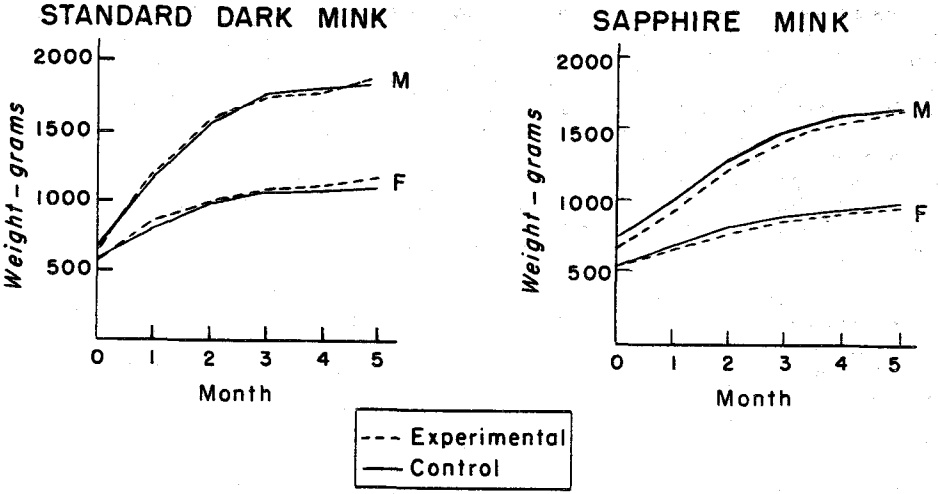
*Expressed as a percentage of the dry matter.

O.S.C.—51 Cereal Mix**

Wheat germ	24.27%
Alfalfa meal	12.41
Skim milk powder	8.06
Meat meal	16.18
Soybean oil meal	16.18
Ground oat groats	16.17
Brewer's yeast	4.08
	100.00%

**A synthetic liver was included at a level equivalent on a dry matter basis to 3% fresh liver. Fortafeed 2-49C at 0.40%; Terramycin (TM-10) at 0.25%; and Methionine at 0.05% were added.

Results



Males	Females		Males	Females
1175	571	Weight gain (gm.)	998	416
45.1	37.9	Animal length (cm.)	42.8	36.8
196	200	Fur color*	-	-
24.9	23.0	Length of guard fur (mm.)	25.3	23.0
14.9	13.4	Length of underfur (mm.)	14.3	12.5
125	118	Quality of fur*	-	-
107	63	Weight of dried skin (gm.)	91	48
26.4	22.3	Length of dried skin (inches)	25.3	19.8
$ 31.42	17.24	Estimated pelt value	$ 27.38	13.38
95		Cost per pound of ration (% of control)	95	
96		Ration cost per dollar return (% of control)	93	

*Fur color and quality, taken from dried skins, is rated from 100 (best) to 500 (poorest).

Discussion

General performance of animals in this group was slightly better than for the controls and indicates that satisfactory rations may be formulated without fresh liver. Length of guard and underfur, and also fur quality, indicate improvement over control mink. Seven (33%) of the dark males pelted showed wet belly symptoms. Sixteen animals were retained as breeders.

Fur Abnormality Studies

Progress of the cotton fur abnormality project in previous years includes demonstrating that cotton mink are afflicted by a nutritional disorder precipitated, at the O.S.C. Fur Farm, by a diet including Pacific hake (Merluccius productus) or Atlantic whiting (M. bilinearis). Evidence indicates that other conditions may also cause this abnormality. These fish species (also certain others) contain a factor capable of restricting normal growth, blood formation and underfur coloration in mink. Heating the fish makes this factor inactive and permits safe use of this food. Supplementing animals fed the causative ration with pure forms of folic acid, vitamin B_{12} and thiamine (various B vitamins concerned with hair coloration and/or blood formation) has had no effect on numbers of cotton mink produced or upon their physiological state. Injection of an organic iron preparation restores the normal blood condition in affected mink.

In an attempt to identify the nutritional entity involved, experimental work during the current year has been concerned primarily with addition of pertinent purified compounds to the causative ration in order to prevent symptoms of cotton fur. Further efforts were made to establish genetically resistant and susceptible strains of mink and to obtain information on mode of inheritance of the abnormality.

Method

One hundred standard dark mink kits selected either at random or from cotton females were fed the following ration which is known to produce a high percentage of cotton mink: hake - 50%, horsemeat - 7%, mixed rockfish - 10%, turbot - 15%, and OSC-49A cereal mix - 18% (composed of wheat germ meal - 25%, alfalfa meal - 13%, skim milk powder - 8%, soybean oil meal - 18%, meat meal - 18%, and ground oat groats - 18%). On this basal ration a number of treatments were superimposed, including injection with all known B vitamins, copper and iron and oral supplementation of the amino acids, lysine, and tyrosine.

Results are evaluated in terms of cotton incidence, growth as measured by monthly weigh periods, and blood formation indicated by hemoglobin levels.

Results and Discussion

Earlier work by Norwegian investigators indicated feed supplements high in B vitamins were capable of preventing occurrence of cotton mink. However, in these O.S.C. experiments, a group of twenty mink were injected intraperitoneally with a mixture of eleven well-known B vitamins at weekly intervals from July 21 until October 15, and no preventative effect was noted. Cotton incidence was 83 percent, growth was much below normal and hemoglobin levels showed a marked anemia. This information indicates that in all probability a lack of B vitamins is not so significant in the cotton syndrome as once was believed.

Much data have been accumulated to indicate that the amino acids lysine and tyrosine are important intermediaries in melanin formation, and although analysis of a cotton-inducing ration would indicate an adequacy of these amino acids, the possibility remains that some factor (antimetabolite) might be present which inhibited or prevented the animal's use of these dietary supplies. Of twelve mink supplemented orally with their calculated requirements of lysine and tyrosine added daily in purified form to the ration, underfur of ten failed to pigment normally. In addition, the mink showed small weight gains and had low hemoglobin values.

Copper was utilized as a supplement which seemed to offer considerable possibilities because of its role both in pigment and hemoglobin formation. Subcutaneous injection of copper glycinate at two levels into ten mink offered no protection against

cotton fur formation as nine of the treated mink were classified as cottons at conclusion of the experiment.

Results from 1958-59 experiments showed that an organic iron solution injected intramuscularly possessed ability to restore a normal blood picture to cotton mink. In light of this and similar work by others, iron supplementation was repeated during the growth and furring period to determine its effect on cotton incidence and growth as well as on blood formation. Results from this supplementation were most striking. Not one animal out of a group of twenty receiving injected iron developed the cotton condition as characterized by fur or blood picture. Growth also was improved significantly over animals not supplemented, as shown in Figure 1.

Data collected in 1958-59 suggested cotton mink were the result of a genetic-nutrition interplay in which certain mink families appeared more susceptible to the cotton-inducing factor than did other families. Experiments this year lend support to this and indicate that selection for cotton mink is effective. Selection of experimental animals last year from litters chosen at random resulted in a 63 percent cotton incidence. Selection of kits mainly from cotton females raised cotton incidence to 83 percent this year, a 20 percent increase. Means of inheritance of this susceptibility is not clear, but in general when cottons were mated to cottons the offspring when placed on the "causative" ration were largely cottons, as opposed to the case of normal mated to normal where both types of offspring fed the "causative" ration were produced in approximately equal proportions.

Present status of the project may be summarized as follows: the heat-sensitive factor in hake acts in susceptible mink to interfere in an unknown manner with utilization of dietary iron, thereby causing an iron deficiency in mink which shows up as the cotton syndrome. Practical means of avoiding the problem have been provided. Continued research will be profitable in demonstrating the exact nature of the inhibitory substance, metabolic steps by which it functions and the manner in which iron overcomes its effects.

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