RAINBOW TROUT (*SALMO IRIDEUS*) PRODUCED IN FINLAND

II. The effect of different food on the growth of rainbow trout

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For practical purposes, the ocean is even today a limitless source of animal protein highly suitable for the human diet (CHAPMAN 1966). However, production is increasing most rapidly in the tropical and subtropical seas, where large unutilized resources are known to exist. Finland is not self-supporting in fish production, and in 1962 the country imported 39.8 million kilograms of fish, of which 17.0 million kg were for human and 22.8 million kg for animal consumption (ANON. 1965). In order to reduce such imports, all the possibilities concerning economic fish cultivation in Finland should be studied. This country posseses good natural possibilities for fish cultivation, and rainbow trout has already been commercially cultivated.

Rainbow trout is the sole salmonid species used for cultivation (MANN 1961). It requires water with a depth of at least 1.3 to 2 metres and a temperature under 20°C and sufficient oxygen. Feeding can consist either of the natural food production of the pond or of artificial feeds, as is the case in commercial enterprises (MANN 1961). Through a selection of rapidly growing specimens with high food conversion it has been possible to obtain, by means of intensive feeding, fish having a weight of 200 g within 15 to 18 months. The size of trout for food purposes depends upon the market demand. In Germany, for instance, the following sizes of food trout are distinguished: dinner trout 130—170 g, portion trout 200—500 g, salmon trout 500—2000 g (MANN 1961).

The purpose of this study was to investigate three artificial dry foods in a feeding trial performed in trout rearing nets with trouts weighing 50 g at the beginning of the test.

Material and methods

The trial was carried out between June 22 and September 15, 1966, at Pornainen in the lake of Vermijärvi at a depth of 2.5 metres (Fig. 1). The temperature of the

Fig. 1. Trout rearing nets in the feeding trial

water at a depth of one metre was measured daily in the afternoon. The water was also tested for pH, color, $KMnO_4$-consumption and total hardness (HAASE 1954), and for coliforms using the MPN- method (ANON. 1958).

The test foods consisted of three different artificial dry foods with a 5 mm pellet size *Group I* was given an imported floating food which was made of white fish meal, dried whey solids, soya bean meal, dried brewers yeast, grass leaf meal, dextrinised wheat flakes, preserved animal fat, cod liver oil, riboflavin, calcium pantothenate, thiamine, choline chloride, A-, D_3-, E-, C and B_{12}-vitamin concentrate, salt, di-calcium phosphate, mangane sulphate, magnesium oxide, cobalt sulphate, copper sulphate, potassium iodide and sodium ferrite. The mixture contained 36 % crude protein, 4 % crude fat and 4.25 % crude fibre. *Croups II and III* received domestic, nonfloating foods, consisting of white fish meal, whale meat meal, soyabean oil meal, oat meal, wheat bran, dried brewers yeast, milk powder, A, D_3, E, C, and B_{12} vitamins, thiamine, riboflavin, calcium pantothenate, biotine, choline chloride, salt, ferric sulphate, copper sulphate, cobalt sulphate and potassium iodide. The food for Group II contained 39 % crude protein, 2.5 % crude fat and 2.5 % crude fibre; the figures for the food of Group III were 37.0 %, 4.0 % and 5 % respectively.

At the beginning of the experiment the fish weighed 50 g. and were kept at 8.5°C. There were 52 rainbow trout in Groups I and III and 60 trout in Group II. An approximate analysis of the composition of the fish was made at the beginning and at the end of the experiment. Each group was also tested for feed conversion, mortality, and individual and total weights. The trial was performed in trout rearing nets measuring 2.25 × 2.25 × 1.5 metres (Verkkoteollisuus, Hämeenlinna).

Results

Results of the water analyses on July 18, 1966 are as follows:

pH	6.65
Color (Pt mg/l)	69
Iron (mg/l)	0.1
$KMnO_4$-consumption (mg/l)	61.9
Total hardness (°dH)	2.36
Total coliforms per gram	2.0

The results indicate that the total numbers of coliforms by the MPN-method did not exceed 2 per gram and the $KMnO_4$consumption was 61.9 mg/1. The tempe-

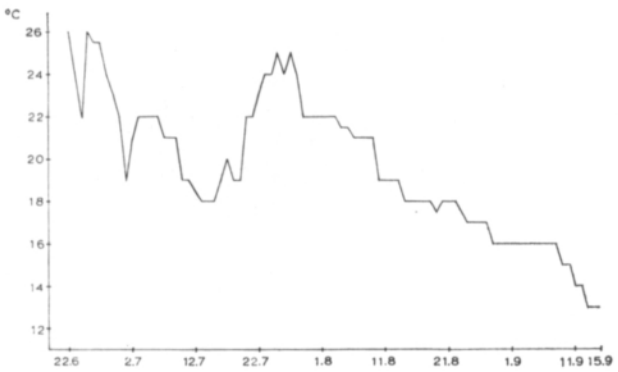

Fig. 2. The temperature of the water at a depth of one metre.

rature of the water (Fig. 2) was exceptionally high throughout the experiment. The maximum temperature at a depth of 1 m was 26°C and remained over 20°C continuously for 21 days.

Approximate analyses of the whole fish were made at the beginning of the experiment. At the end of the experiment both whole and gutted fish were analyzed in each group. The results of the approximate analyses of the test fish were as follows:

	Water %	Protein %	Fat %	Ash %	pH
Whole fish (June 22)	77.7	15.6	2.9	2.4	
Group I (Sept. 15)					
whole fish	73.1	16.3	7.4	1.9	6.25
gutted fish	73.9	16.9	4.1	3.1	6.30
Group II (Sept. 15)					
whole fish	70.4	16.7	7.2	3.7	6.40
gutted fish	75.1	16.8	3.4	3.3	6.28
Group III (Sept. 15)					
whole fish	73.2	16.8	6.3	2.6	6.22
gutted fish	76.1	15.8	4.5	2.5	6.20

The greatest differences between the test groups were in feed conversion and weight (Table 1). Feed conversion per live weight was greatest in Group I and

Table 1. Feed conversion, mortality and weight in different test groups.

Group	Feed conversion/kg of live weight	Number of fish: At the start	Sample July 15	Dead	At the end	Total weight, grams	Mean weight, grams	Min-max. weight, grams
I	2.04 kg	52	2	3	47	6240.6	132.78	12.9—220.7
II	1.58 kg	60	2	2	56	9561.4	170.74	68.9—252.8
III	1.76 kg	52	2	3	47	7243.6	154.12	33.6—308.7

smallest in Group II. In Group II all the fishes gained weight during the experiment In Groups I and III, on the other hand, there were some losses of weight.

Discussion

The trial was relatively limited owing to the short test period and the small number of fish.

The water used proved to be suitable since the mortality in the different groups was small although the temperature of the water, because of the exceptionally warm summer rose to 26°C and stayed over 20°C for a long time (Fig. 2).

When the distribution of fat was studied at the end of the experiment, it was found that most of the fat was situated in the intestines of the fish. In all groups the proportion of fat was higher in the whole fish than in the gutted fish: Group I 7.4 and 4.1 % respectively, Group II 7.2 and 3.4 % and Group III 6.3 and 4.5%.

The ash content of the whole fish depended mostly upon the condition of the intestinal tract. It also depended upon such factors as the size of the fish and the weight of the bones and fins. Since a more extensive study has been made on differences in the ash content, this aspect will not be further discussed here.

When comparing the feed conversion, large differences between the groups are seen (Table 1). In Group II the feed conversion was smallest, 1.58 kg food per kg of live weight; the corresponding figures in Groups III and I were 1.76 kg and 2.04 kg respectively.

Large differences also existed in the weights of the fish (Table 1). In Group II the mean weight was 170.74 g (range 68.9—252.8 g). This was the only group where all the fishes gained weight during the experiment. In Group III the mean weight was 154.12 g (range 33.6—308.7 g). In this group two of the fishes had lost weight during the experiment. In Group I the mean weight was 132.78 g (range 12.9—220.7 g), four of the fishes in this group had lost weight.

Pigment formation was typical for the trout in group I (Fig. 3). In Groups II and III the color was too light and in Group III some spottiness existed.

S u m m a r y

Three test groups of rainbow trout were cultivated in trout rearing nets to study the feed conversion, mortality and weight development of the different

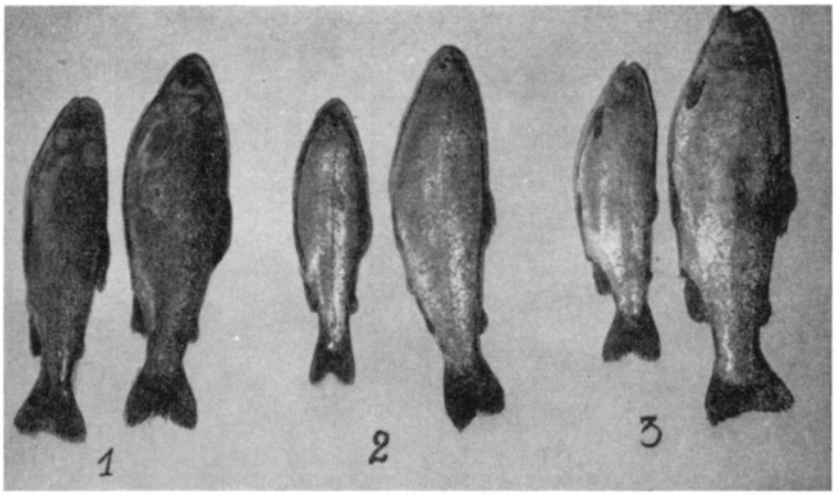

Fig. 3. Pigment formation for the trouts in different groups (1 = Group I, 2 = Group II, 3 = Group III).

groups. One of the groups was fed with a floating imported food and two groups with domestic non-floating dry food.

It was observed that the type of food had a distinct influence upon feed conversion and weight development. It also influenced the pigment formation of the fish but had no great effect on the chemical composition of the fish. There were some differences in the distribution of fat in the different test groups.

It was also noted that when water is chemically and microbiologically of good quality, no excessive mortality occurs even when the temperature of the water for a long period exceeds the optimum temperature of rainbow trout.

Recognition and appreciation is extended to the Institute of Limnology, University of Helsinki, for making the chemical water analysis in this study.

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SELOSTUS:

TUTKIMUKSIA SUOMESSA KASVATETUSTA KIRJOLOHESTA (*Salmo irideus*)

II. Rehujen hyväksikäytöstä ja vakutuksesta kirjolohen kasvuun

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Verkkoaltaissa suoritetussa kasvatuskokeessa seurattiin kirjolohen rehunkulutusta, kuolleisuutta ja painonkehitystä kolmessa eri koeryhmässä, jotka saivat ulkolaista kelluvaa ja kahta kotimaista ei - kelluvaa kuivarehua. Havaittiin, että kotimaisilla koerehuilla näytti olevan selvästi edullisempi vaikutus rehunkulutuksen ja painonkehitykseen. Pintapigmentin muodostus oli kuitenkin huonompi. Kalojen kemiallisessa koostumuksessa, kuten rasvan jakautumisessa havaittiin myös pieniä eroja eri koeryhmissä. Koesarja osoitti myös, että mikäli kasvatusvesi kemiallisesti ja mikrobiologisesti on hyvälaatuista, ei lämpötilan kohoaminen pitkäksikään ajaksi yli kirjolohen optimilämpötilan aiheuttanut kuolleisuudessa epätavallista nousua.

Johtopäätösten tekemiseksi koeaika oli lyhyt ja koemateriaali pieni.