EXPERIMENTAL STUDIES ON FEEDING THE COMMON CARP CYPRINUS CARPIO L. IN EGYPT

By

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INTRODUCTION

The productivity of water bodies, i.e. lakes, ponds and streams is measured in rates of reproduction, growth and survival of living organisms. These rates depend to a large extent on the amount and quality of food present. Fish as well as other animals require balanced diets of certain amounts of proteins, carbohydrates, fats, minerals and vitamins (DAVIS, 1956).

For pisciculture, some species require supplementary feeding to obtain higher yield, while others can be maintained exclusively on artificial food (HICKLING, 1962). Fish diets are usually prepared from a variety of ingredients of vegetable and animal matter or a combination of both. Laboratory and field studies have been carried out on the growth of the common carp *Cyprinus carpio* L. in many parts of the world and under a variety of environmental conditions (SCHAPERCLAUS, 1933 & 1954; WUNDER,1949 ;KURONUMA,1954 ;VAAS &SACHLAN, 1956 ; BONDI *et al*, 1957 ; HICKLING, 1962 and CHERVINSKI *et al*, 1968).

SCHÄPERCLAUS (1933) showed that supplementary feeding for the carp *Cyprinus carpio* L. not only allows a greater stock density, but also stimulates a better assimilation of the available natural food. Similar results were reported by other investigators (YASHOUV, 1956 : BROWN, 1957 and ALIKUNHI, 1957).

Several food material have been used as feed for carp in Europe. These include bran, brewers, grains, barely, oats, wheat, rice and maize that are given to the fish without further preparation. Waste-products of oil extraction from some seeds are also used, but these products induce a strong taste to the fish flesh. Lupine seeds are considered the best food for carp in Germany (SCHÄPERCLAUS, 1933). In Japan, fresh and dried silk worm pupae, in addition to rice bran are important fishfood for carp and eel (HIGURASHI & NAKAI, 1924 and FUJITA, 1933). In the Indo-Pacific area, HORA & PILLAY (1962) indicated that the common carp can be fed in a variety of artificial foods such as rice bran and different kinds of oil cakes. They added that shrimp wastes mixed with flour and corn meal make a good feed for carp. In Israel, sorghum and pelleted protein-rich diets have been used as food for carp (HEPHER & CHERVINSKI, 1965 and CHERVINSKI *et al*, 1968).

In Egypt, rice bran and mixtures of rice bran and cotton seed-cake are used as supplementary food for carp (El-BOLOCK & LABIB, 1968). However, there are no recorded data on the efficiency of these materials as diets for the fish either in quality or quantity. The main objectives of this study are :

(i) to evaluate the efficiency of rice bran, cotton seed-cake and different mixtures of both as food for carp, and (ii) to find out the level of feeding giving the best growth at a low cost.

MATERIAL AND METHODS

Experimental ponds

The nine experimental ponds used for this study are located at the Serow Fish Farm, Dakahlia Governorate, Egypt. Each pond has an area of 50 m^2 and banks and bottom ore made of cement. The bottom is covered with a layer of 10 cm of mud. All these ponds have a common supply from the main navigation canal. The water supply is controlled by means fo two iron gates erected on each pond. A very-mesh wire was fixed in the inlet to prevent the entrance of undesirable fish.

During the experimental period, the water was maintained at a depth of 50 cm. At monthly intervals, the water in each pond was drained and supplied by fresh water from the main canal.

Experimental fish

The experimental fish, *Cyprinus carpio* L. were taken from a single clutch. The parents were of about four years old and were also a progeny of a stock maintained at the Serow Fish Farm.

Spawning took place in special incubation ponds. About 5000 fry were transferred to a rearing pond of an area of one feddan (approx. 4000 m^2). The young fish were given the common food used rice bran. The fish where kept. in the rearing pond until they were transferred to the experimental ponds.

Fish diets

The main ingredients of the experimental diets were rice bran and cotton seed-cake locally available at relatively low price. They are also used as feed for livestock.

Experimental design

Two experiments were designed as follows:

Experiment I

For this experiment, a hundred fish chosen at random were used. They were about three months old of an average weight of 22.39 g and 10.78 cm total length. The fish were distributed randomly into four experimental ponds, 25 fish for each. The fish in the first and second ponds were fed rice bran at levels of 10% and 20% daily of the body weight respectively. The fish of the third and fourth ponds were fed cotton seed-cake at the two levels of 10% and 20% daily of the body weight respectively.

Experiment II

Five groups of fish 25 each, were taken at random and were placed in five experimental ponds. The fish were about three months old, of an average weight

of 22.47 g and 10.48 cm in total length. The fish were fed the experimental diet-mixtures of rice bran and cotton seed-cake in different proportions. The experimental groups were :

Group A : received a diet-mixture of 85% rice bran and 15% cotton seed-cake.
Group B : received a diet-mixture of 80% rice bran and 20% cotton seed-cake.
Group C : received a diet-mixture of 75% rice bran and 25% cotton seed-cake.
Group D : received a diet-mixture of 70% rice bran and 30% cotton seed-cake.
Grodp E : received no supplementary food and the fish were maintained on the natural diet in the ponds.

Preparation of diets

The experimental diets were offered to the fish in a wet form. For cotton seed-cake and the different diet-mixtures, the cotton seed-cake was weighed, soaked in water for a period of 24 hours and throughly mixed to the proper amount of rice bran.

Feeding

During the experimental period, the fish were fed once daily at 9.00 A.M., six days a week.

Growth measurements

The fish in each pond were weighed and measured individually at monthly intervals for a period of eight months. The total length of the fish was measured to the nearest millimeter and the weight to the nearest 0.5 gram.

RESULTS

Experiment I

The feeding tests started on October 26th, 1966 and were conducted for a period of eight months. The average monthly air and water temperature during the experiment were recorded (Table I). The chemical characteristics of the water are given in Table II.

The monthly average weights and lengths of the 25 fish in each of the four experimental ponds are presented in Tables III and IV. Growth curves (average weight and average length) based on monthly measurements are shown in Figs. 1 and 2.

It is apparent that the rate of growth of the fish fed rice bran was inferior to those that were fed with cotton seed-cake. For both feeds, increasing the level of feeding from 10% to 20% daily of the body weight did not show significant ncrease in the growth rate of the fish.

TABLE 1.— WATER CHARACTERISTICS OF THE MAIN MAIN CANAL AT SEROW FISH FARM. EGYPT

	Concentration
pH	8.3
Dissolved 0_2	6.3 ppm
Total alkalinity	292 ppm
Phosphate	0.1 ppm
Nitrite	0.2 ppm
Chlorosity	0.7 ppm

TABLE 2.— AVERAGE AIR AND WATER TEMPERATURE OF SEROW FISH FARM PONDS DURING 1966—1967 AT 11 A.M.

Month	Air temp. oC	Water temp. oC
Oct. 1966	24.7	23.9
Nov. 1966	23.5	23.0
Dec. 1966	19.6	16.9
Jan. 1967	16.3	15.1
Feb. 1967	16.4	14.7
Mar. 1967	18.1	17.4
Apr. 1967	24.3	24.2
May 1967	25.5	25.2
Jun. 1967	28.8	28.5
Jul. 1967	30.5	30.8
Aug. 1967	31.0	31.0
Sept. 1967	27.1	26.8
Oct. 1967	25.1	24.2
Nov. 1967	22.2	22.0

TABLE 3.– GROWTH IN WEIGHT OF THE *Cyprinus carpio* L. FINGERLINGS IN RESPONSE TO DIFFERENT DIETS FED AT TWO LEVELS OF 10 AND 20% DAILY OF BODY WEIGHT.

(Wight in grams)

Temperature range (14.7–31.3°C .)

Months after feeding	Rice bran				Cotton seed cake			
	10% of body wt.		20% of body wt.		10% of body wt.		20% of body wt.	
	Range	Mean ± S.D.*	Range	Mean ± S.D.	Range	Mean ± S.D.	Range	Mean ± S.D.
Oct.**	17– 38	22.39± 9.35	17– 38	22.39± 9.35	17– 38	22.39± 9.35	17– 38	22.39± 9.35
Nov.	25– 92	44.68±18.34	25– 85	45.80±14.50	22– 91	48.32±14.15	30– 95	48.32±15.95
Dec.	30–120	56.32±24.42	42– 94	61.88±12.88	40–110	60.88±16.44	42–125	65.80±22.16
Jan.	30–135	61.68±26.14	42– 95	62.48±14.43	45–117	66.53±16.93	42–135	66.92±26.58
Feb.	38–158	72.68±34.40	42–118	66.20±19.32	45–136	78.00±23.10	50–184	84.68±33.91
Mar	50–195	90.00±38.79	52–133	87.80±24.10	70–195	112.44±27.88	62–210	117.12±40.76
Apr.	70–260	129.32±45.16	80–195	120.40±25.59	115–245	160.60±32.73	115–310	172.68±49.67
May	105–260	155.00±42.37	130–240	156.60±26.73	150–290	213.00±35.67	160–390	236.80±57.72
June	130– 260	182.00±36.06	160–285	198.20±28.02	185–310	248.60±38.61	220–450	292.00±60.28

* Average of 25 fish ± standard deviation.

** Experiment started Oct. 26, 1966.

TABLE 4.- GROWTH IN LENGTH OF THE *Cyprinus carpio* L. FINGERLINGS IN RESPONSE TO DIFFERENT DIETS FED AT TWO LEVELS OF 10 AND 20% DAILY OF BODY WT.

(Lengths in centimeters)

(Temperature range: 14.7 – 31.3°C).

Months after feeding	Rice bran				Cotton seed cake			
	10% of body wt.		20% of body wt.		10% of body wt.		20% of body wt.	
	Range	Mean ± S.D.*	Range	Mean ± S.D.	Range	Mean ± S.D.	Range	Mean ± S.D.
Oct. **	9.0–13.5	10.78±1.50	9.0–13.5	10.78±1.50	9.0–13.5	10.78±1.50	9.0–13.5	10.78±1.50
Nov.	12.5–18.5	14.26±1.86	12.5–18.0	14.68±1.71	11.5–17.0	14.70±1.48	13.0–19.0	14.70±1.70
Dec.	12.5–20.0	15.34±2.01	12.5–18.0	14.78±1.55	13.5–18.5	15.84±1.52	13.0–20.0	15.22±1.95
Jan.	13.0–20.0	15.44±2.05	12.5–18.0	15.00±1.45	14.0–19.5	15.84±1.47	13.0–21.0	15.46±2.05
Feb.	13.0–21.5	16.44±2.28	12.5–18.5	15.28±1.48	14.0–21.0	17.06±1.61	15.0–23.0	17.22±2.10
Mar.	14.0–22.5	17.43±2.20	15.0–21.5	17.76±1.57	16.0–23.0	18.86±1.64	15.0–25.0	18.94±2.22
Apr. . .	17.5–23.5	20.70±2.20	18.0–24.5	20.38±1.55	20.0–26.0	22.46±1.46	19.0–28.0	22.72±2.02
May	19.0–27.0	22.88±2.08	20.0–26.5	22.82±1.50	22.0–28.0	25.10±1.60	23.0–30.0	25.82±1.95
June	19.0–27.5	23.34±1.94	22.0–27.0	23.90±1.21	23.0–28.0	25.50±1.32	24.0–31.0	26.08±1.80

* Average of 25 fish ± standard deviation.

** Experiment started Oct. 26, 1966.

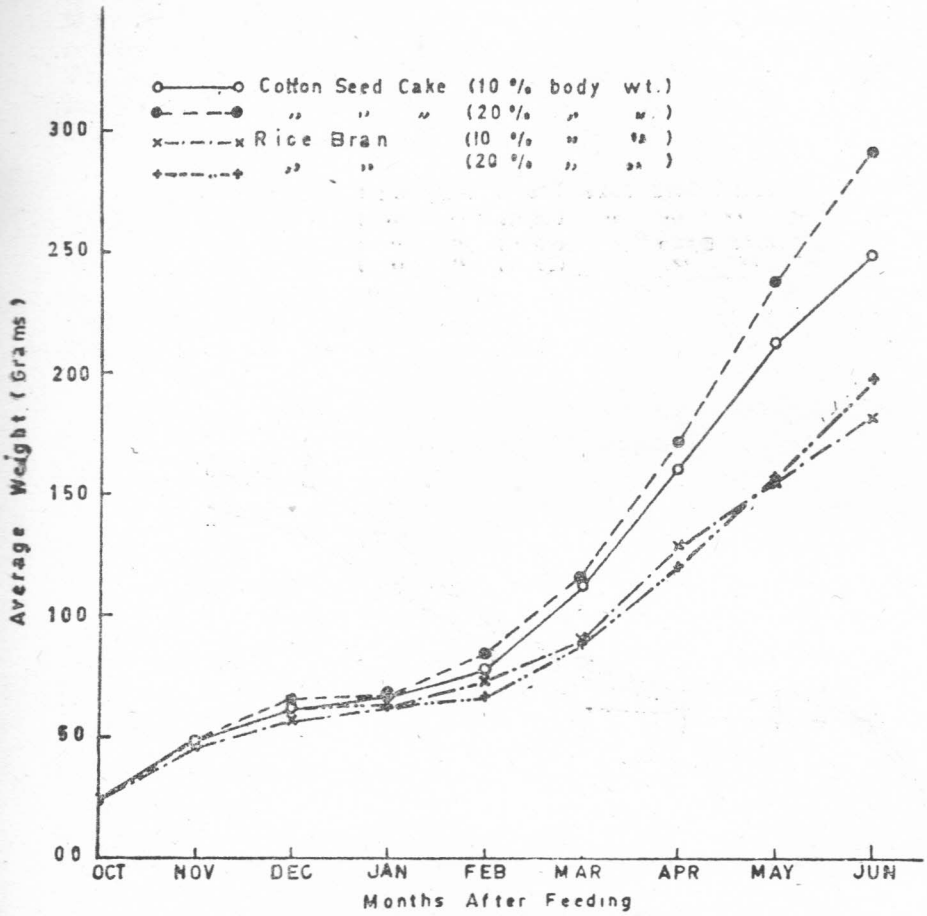

FIG (1) THE GROWTH IN WEIGHT OF THE CYPRINUS CARPIO L. FINGERLING FED RICE BRAN AND COTTON SEED CAKE AT TWO LEVELS OF10 AND 20 % OF BODY WT.

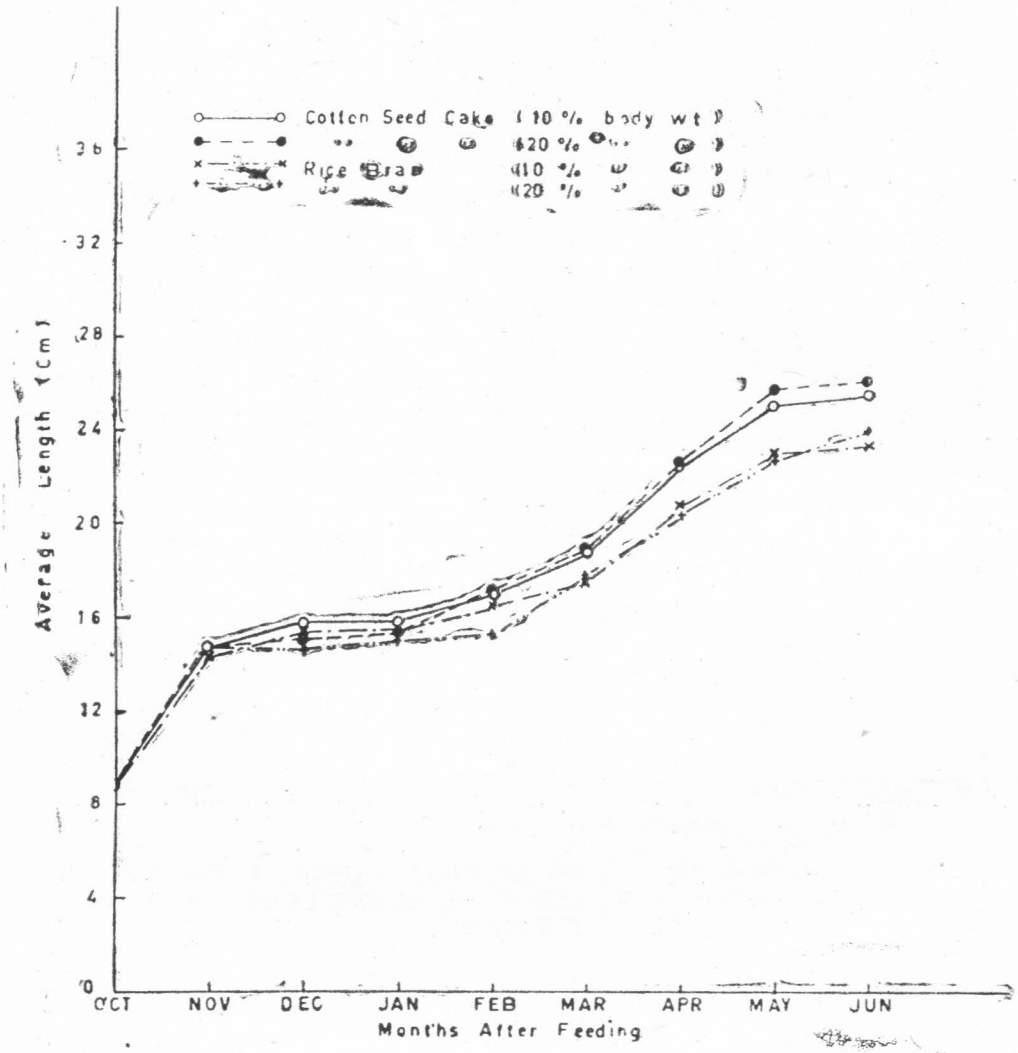

FIG (2) THE GROWTH IN LENGTH OF THE CYPRINUS CARPIO L. FINGERLINGS FED RICE BRAN AND COTTON SEED CAKE AT TWO LEVELS OF 10 AND 20% OF BODY WT.

The fish that were fed rice bran at a level of 10% of the body weight, increased from an initial weight of 22.39 g to an average of 182 g in eight months. This was an increase of about 713 per cent gain in weight. The average increase in length was from 10.78 cm to 22.34 cm (about 117% gain). On the other hand, the fish that received double the amount of rice bran feed, increased from an average weight of 22.39 g to an average of 198.2 g (about 785 fper cent gain). The average length increased from 10.78 cm to 23.9 cm (about 122% gain in length). The total amount of feed given to the fish and the food conversion coefficients were calculated (Table 5).

For cotton seed-cake feed, the fish that received the diet at a level of 10% of the body increased from an average weight of 22.39 g to 248.6 g (1010 per cent gain) at the end of the eight-months experimental period, while those receiving the diet at the level of 20% of the body weight, increased from an average weight of 22.39 g to 292 g (abiut 1204 per cent gain). The per cent gain in length was about 137 and 142 respectively. The food conversion coefficients are given in Table 5.

TABLE 5.— SUMMARY DATA ON THE GROWTH OF *Cyprinus carpio* L. FED RICE BRAN AND COTTON SEED-CAKE.

Feed	Rice bran		Cotton seed	
Level of feeding	10%	20%	10%	20%
Initial avg. wt. . . . . .(g)	22.39	22.39	22 39	22.39
Final avg. wt.. . . . . .(g)	182.00	198.20	248.60	292.00
Gain in weight . . . . . .(%)	712.86	785.21	1010.31	1204.15
Initial avg. length . . . . .(cm.)	10.78	10.78	10.78	10.78
Final avg. length . . . . .(cm.)	23.34	23.90	25.52	26.08
Gain in length . . . . . .(%)	116.52	121.70	136.73	141.93
Initial No. of fish/group	25	25	25	25
No. of deaths	—	—	—	—
Total supply of feed . . . .(kg.)	40.246	82.339	49.738	106.028
Feed conversion coefficient	10.08	18.73	8.79	15.74
Price/kg. feed . . . . . (millims)*	5.25	5.25	12.00	12.00
Cost/kg. fish . . . . . (millims)*	53.00	98.00	105.00	189.00

* 1000 millims = one Egyptian pound = 2.3 $ U.S. dollars.

It is obivous from Table V that producing a kilogram of carp on cotton seed-cake is extremely expensive and costs about twice that produced on rice bran.

In the light of the above results, it was decided to carry out further experiments in which diet-mixtures of rice bran and cotton seed cake were used. It is aimed to find out the cheapest mixture which gives a higher rate of growth in a short period.

Experiment II

The feeding tests started in October 28th, 1967 and were conducted for a period of eight months. The average monthly weights and lengths of the experimental fish of the different groups are presented in Tables 6 and 7. Growth curves are also shown in Figs. 3 and 4.

Group A

The fish of this group were maintained on the diet - mixture of 85% rice bran and 15% cotton seed cake. The fish increased from an initial average weight of 21.47 g to 196.5 g average weight at the end of the experimental period. This was an increase of 815 per cent gain. The average length increased from 10.48 cm to 24.1 cm (about 130% gain). The food conversion coefficient of this diet-mixture was 11.3. The fish were produced at a cost of about 71 millims* per kilogram.

Group B

This group of fish were fed a diet-mixture of 80% rice bran and 20% cotton seed cake. It is evident that the rate of growth of these fish is somewhat higher than that for the first group. The average weight increased from 21.47 g to 222.4 g showing about 936 per cent gain. The average length increased from 10.48 cm to 25.26 cm (141 per cent gain). The food conversion coefficient for this diet was 10.99, and the fish were produced at a cost of about 73 millims per kilogram.

Group C

The fish of this group were fed a diet mixture composed of 75% rice bran and 25% cotton seed-cake. These fish showed the highest rate of growth among the different experimental fish-groups. The average weight increased from an initial average of 21.47 g to 250.2 g (about 1065 per cent gain). The food conversion coefficient was 10.15. The cost of production of a kilogram of fish in this diet was 70.5 millims.

Group D

This group of fish was maintained on the diet-mixture of 70% rice bran and 30% cotton seed-cake. The growth rate of the fish was inferior to that of group C. The fish increased from an average weight of 21.47 g to 218.6 g (about 918 per cent gain). The average length increased from 10.48 cm to 25.16 cm (about 140% gain). The food conversion coefficient was 10.2 and the cost of production of a kilogram of fish was 74.3 millims.

Group E

The fish of this group were not given any supplementary food and were maintained on the natural diet present in the experimental ponds. It is obvious that the growth rate of these fish was markedly lower than that for the other experimental fish-groups supplemented with the diet-mixtures.

* 1000 millims = one Egyptian pound = 2.30 $

TABLE 6.—GROWTH IN WEIGHT F THE *Cyprinus carpio* L. FINGERLINGS IN RESPONSE TO DIFFERENT DIET-MIXTURES FED AT LEVEL OF 10% DAILY OF BODY WEIGTH.

(Weight in Grams)

(Temperature range 14.7 — 31.3°C)

Months after Feeding	85% Rice bran + 15% Cotton seed		80% Rice bran % 20% Cotton seed		75% Rice bran + 25% Cotton seed		70% Rice bran + 30% Cotton seed		Natural Diet	
	Range	Mean ± SD*	Range	Mean ± SD*	Range	Mean ± SD*	Range	Mean ± SD*	Range	Mean ± SD*
Oct.**	18— 42	21.47± 6.93	18— 42	21.47± 6.93	18— 42	21.47± 6.93	18— 42	21.47± 6.93	18— 42	21.47± 6.93
Nov.	48— 84	65.44±10.25	50—108	76.89±15.30	60—102	79.04±12.14	36— 79	53.76±14.13	35—105	50.92±14.24
Dec.	50—100	77.92±12.65	53—134	90.20±21.15	63—131	96.92±19.23	50—125	71.44±20.06	45—110	73.28±16.00
Jan.	60—110	85.00±14.40	60—140	94.68±20.58	68—137	102.08±19.85	50—130	75.40±21.89	55—111	74.40±16.50
Feb.	70—120	95.40±16.12	70—150	101.60±21.05	80—150	111.20±19.27	48—160	89.12±28.36	45—112	74.16±14.60
Mar.	75—130	104.90±16.26	79—185	117.68±24.66	90—174	128.00±23.98	62—205	115.60±31.86	58—109	75.00±14.18
Apr.	100—170	137.00±21.07	105—233	160.96±30.00	120—228	159.40±31.76	100—230	153.40±34.40	60—173	84.24±22.77
May	120—205	159.20±27.43	120—250	178.60±32.00	120—260	186.80±40.38	150—260	193.40±34.49	72—200	104.00±25.42
Jun.	155—270	196.50±32.20	146—316	222.40±39.87	155—345	250.20±48.35	160—270	218.60±33.83	— —	— —

* Average of 25 fish ± standard deviation.

** Exper iment started October 28, 1967.

TABLE 7.—GROWTH IN LENGTH OF THE *Cyprinus carpio* L. FINGERLINGS IN RESPONSE TO DIFFERENT DIET-MIXTURES FED AT LEVEL OF 10% DAILY OF BODY WEIGHT

(Length in Centimeters)

(Temperature range 14.7 — 31.3°C)

Months after Feeding	85% Rice bran + 15% Cotton seed		80% Rice bran + 20% Cotton seed		75% Rice bran + 25% Cottun seed		70% Rice bran + 30% Cotton seed		Natural diet	
	Range	Mean ± SD*	Range	Mean ± SD*	Range	Mean ± SD*	Range	Mean ± SD*	Range	Mean ± SD*
Oct.**	9.0—13.5	10.48±1.17	9.0—13.5	10.48±1.17	9.0—13.5	10.48±1.17	9.0—13.5	10.48±1.17	9.0—13.5	10.48±1.17
Nov.	14.5—18.5	16.78±1.00	14.5—20.0	17.14±1.40	16.0—20.0	17.82±1.04	13.0—17.5	15.00±1.38	13.5—20.0	15.24±1.37
Dec.	15.0—19.0	17.22±1.03	15.5—20.0	17.90±1.34	16.4—20.5	18.30±1.13	14.0—19.0	15.82±1.71	14.0—19.0	16.90±1.33
Jan.	16.0—20.0	18.00±1.14	16.0—20.0	18.00±1.28	16.5—21.0	18.54±1.22	14.5—20.0	16.10±1.75	15.0—19.0	17.02±1.23
Feb.	17.0—20.5	19.00±1.06	17.0—21.0	19.00±1.30	18.5—23.0	20.00±1.36	15.0—22.0	17.64±1.83	15.0—19.5	17.22±1.18
Mar.	17.0—20.5	19.10±0.97	17.5—21.5	19.30±1.38	18.5—23.0	20.20±1.30	16.0—23.5	18.86±1.88	15.5—19.5	17.12±1.23
Apr.	19.0—23.0	21.10±1.18	19.0—24.5	21.92±1.44	19.0—25.0	22.02±1.56	19.0—25.5	22.00±1.77	17.0—24.0	18.68±1.46
May	21.5—25.0	23.50±1.14	21.0—26.5	23.80±1.50	19.0—28.0	24.34±2.00	22.0—27.0	24.40±1.54	20.0—26.5	22.10±1.33
Jan.	23.0—27.5	24.10±1.31	23.0—28.5	25.26±1.64	22.0—30.0	25.48±1.89	23.0—28.0	25.16±1.47	— —	— —

* Average of 25 fish ± standard deviation.

** Experiment started October 28 1967.

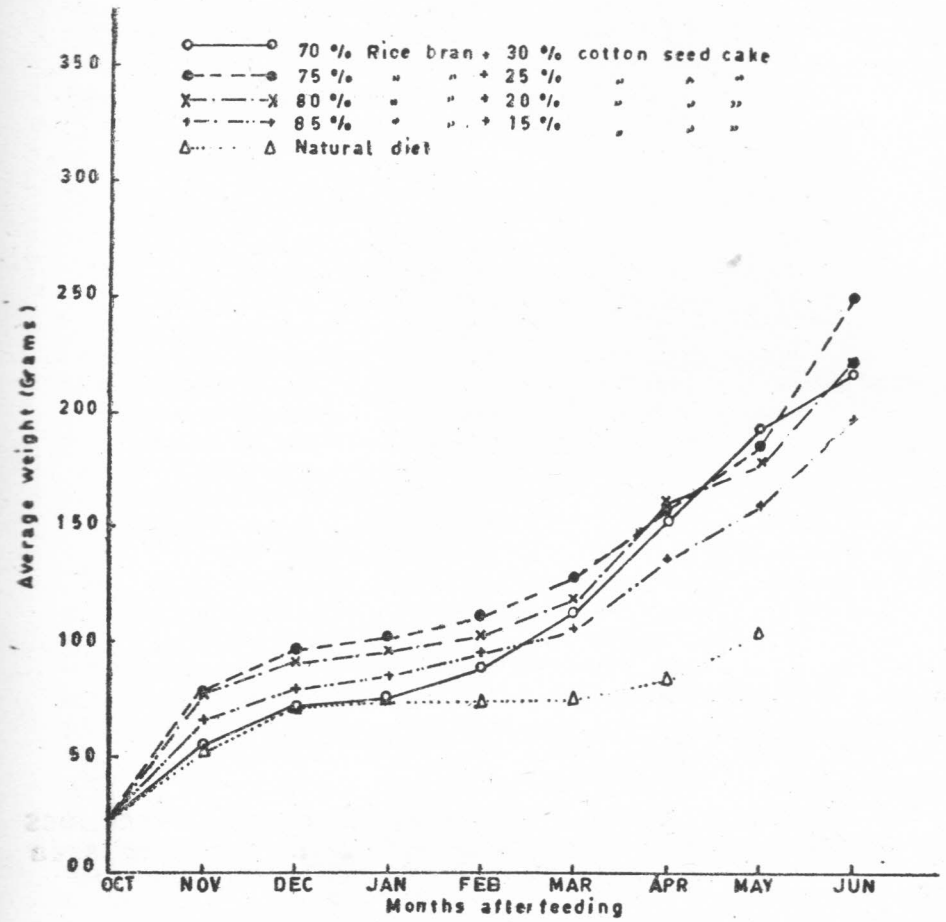

FIG (3) THE GROWTH IN WEIGHT OF THE CYPRINUS CARPIO L. FINGERLINGS FED DIFFERENT DIET_MIXTURES OF RICE BRAN AND COTTON SEED CAKE

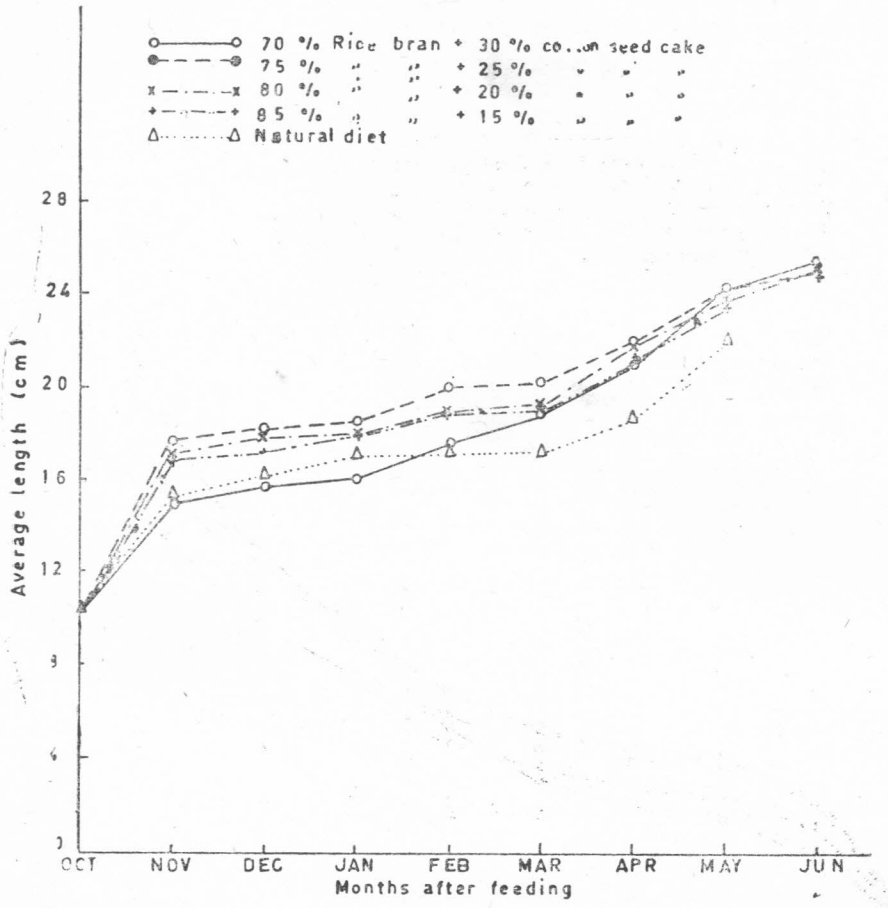

FIG. (4) THE GROWTH IN LENGTH OF THE CYPRINUS CARPIO L. FINGERLINGS FED DIFFERENT DIET - MIXTURES OF RICE BRAN AND COTTON SEED CAKE

It was also noticed that there was no obvious growth during the winter months (December to February), as compared with the other groups showing a slight increase in growth. (Fig 3). High mortality of 36% occurred during May and the experiment was discontinued. The stomachs of the dead and some live fish were analyzed and were found empty of any food material. There were no obvious symptoms of infectious diseases. The fish showed distress and it seems that the high mortality percentage is mainly due to the insufficient amounts of natural food available during the season of high growth rate.

DISCUSSION

Although the availability of suitable food is one of the main factors that control the growth rate of fish some other environmental and biological factors including the chemical and physical properties of the water (temperature, light cycles, genetic factors, sex, age, space limitations, diseases, and parasites) are of prime importance. For pond-fishes three types of food are available to the fish : 1) food elements produced as a result of the biological processes 2) the natural food and 3) the artificial food supplemented to the fish.

Earlier workers established that carp in the fry stage eat zooplankton and thus depend mainly on animal diet (SCHÄPERCLAUS 1933 ; NAKAMURA 1947 ; ALIKUNHI, 1952 ; ALIKUNHI *et al*, 1954, 1955 and MITRA & MOHAPATRA 1956). But , as the fish grow they become able to digest and absorb vegetable as well as animal matter. The choice of the ingredients of the diet depends on their availability, nutritional values palatability to the fish and cost. From the economic point of view special considerstion is given to the cost of the diet in relation to fish production, thus favouring less expensive diets. The results of the present study clearly indicate that feeding the carp fingerlings on diet-mixtures of rice bran and cotton seed-cake gave better growth than using rice bran only. Although cotton seed-cake feed was superior to rice bran it is not recommended as the solely food because of its relatively high cost and due to some changes in the flavor of the fish-flesh. In addition, the demand on cotton seed-cak as food for livestock is very high. Moreover it is well known that raising carp or trout on one single kind of feed tends to create nutritional inbalance (TAMURA, 1961).

The addiditon of cotton seed-cake to rice bran improved its efficiency as a diet for the fish. A comparison between the four experimental diet-mixtures shows that maximum increases in the per cent gain of fish was obtained at a relatively low cost on the diet mixture composed of 75% rice bran and 25% cotton seed-cake. The fish maintained on this diet gained almost 1065 per cent as compared to 815, 936 and 918 per cent for the other tested diets (Table 8).

It is evident that the calculated values of the food conversion coefficients of the experimental diets are relatively high as compared to those recorded in the literature as feed for carp (TAMURA, 1961 and HICKLING, 1962). Several factors related to the specific conditions of the present experiments, contribute

to this result. These factors include : (1) the insufficient amounts of the natural diet, essential for the growth of carp, in the experimental cement ponds may have an adverse effect on the assimilation of food (SCHÄPERCLAUS, 1933). (2) The limited space and the frequent renewing of the water supply. This was done to prevent the entrance of prolific fishes such as *Tilapia* sp. and *Clarias* sp fry usually present in the water. COBLE (1967) reported that space limitation is among the factors that affect the growth of fish. (3) The experiment did not cover the whole growing season (March to November), and was ended in June. (4) Feeding at the full experimental level during the winter months of December through February, where there was little or no pronounced growth for the fish in return to the amount of food given. This may partly account for the high values of the conversion coefficients of the various diets used.

TABLE 8.—SUMMARY DATA ON THE GROWTH OF *Cyprinus caspio* L. FED DIFFERENT DIET MIXTURES OF RICE BRAN AND COTTON SEED-CAKE.

Feed	85% rice bran + 15% cotton seed	80% rice bran + 20% cotton seed	75% rice bran + 25% cotton seed	70% rice bran + 30% cotton seed
Initial avg. wt. . . .(g)	21.47	21.47	21.47	21.47
Final avg. wt.. . . .(g)	196.50	222.40	250.20	218.60
Gain in weight . . .(%)	815.23	35.86	1065.34	918.16
Initial avg. length .(cm.)	10.48	10.48	10.48	10.48
Fianl avg. length . .(cm.)	24.10	25.26	25.48	25.16
Gain in length . . .(%)	129.96	141.03	143.12	140.07
Initial No. of fish/group . . .	25	25	25	25
No. of deaths	—	—	—	—
Total supply of feed (kg)	49.054	55.240	58.032	50.271
Feed conversion coefficient . .	11.31	10.99	10.15	10.20
Price/kg. feed . . . (Millims)*	6.26	6.60	6.93	7.28
Cost/kg fish . . . (Millims)*	70.79	72.53	70.34	74.25

* 1000 millims = one Egyptian pound = about 2.3 $ U.S. dollars.

The low growth rate during the winter months may be due to the prevailing low temperatures during these months which lower the feeding and metabolic rates of the fish even when the food was given in sufficient quantity. This conclusion is supported by the findings of some investigators (HATHWAY, 1927 ; BROWN, 1945 ; SWIFT, 1961 and BRETT *et al*, 1969) who indicated that the ability of fish to feed at low temperatures ismarkedly less than at higher temperatures. The efficiency of utilization of the food was low when the temperature was low and also when the activity of the fish is high. Moreover, when food is present in abundance an optimum temperature for growth has been recorded which varied among the different species.

Several workers demonstrated that cessation in growth in the late fall and winter occurs independently of the food supply, while others concluded from experimental evidence that in temperate regions, the growth of fish is at least partially controlled by food supplies and temperature (WEYMOUTH, 1923 ; CRENSER, 1926 and VAN OOSTEN, 1929). Temperature has been shown to control the response of fish to growth hormones (BROWN, 1957).

The present experimental results support the previous observation on the time of the formation of the dark annuli which takes place during January to March when the temperature is at its minimum (LABIB, 1970). This agrees with the conclusion of NIKOLSKY (1963) who indicated that it is not correct to consider the time at which rings are laid down as a result of retardation of the metabolism either by disturbances of feeding or due to unfavourable changes in temperature.

SUMMARY

1. Feeding tests for the common carp *Cyprinus carpio* L. fingerlings of about three months old were carried out for a period of eight months, from October to June. The test feeds were rice bran, cotton seed-cake and four diet-mixtures of different proportions of rice bran and cotton seed-cake. During the experimental period, the monthly water temperature ranged between 14.7 and 31.4°C.

2. Cotton seed-cake gave a better growth for the fish than rice bran feed. However, cotton seed-cake is not recommended as the sole diet for carp due to the relatively high cost of production and due to changes in the flavor of the fish flesh. For both feeds, increasing the level of feeding from 10 to 20% daily of the fish weight did not significantally increase the growth rate of the fish.

3. The addition of cotton seed-cake to rice bran improved the efficiency of rice bran as a diet for carp. The diet mixture composed of 75% rice bran and 25% cotton seed-cake gave the highest gain in weight at a relatively low cost, comparable to cotton seed-cake.

4. In spite of the abundant supplementary food given to the fish, they did not show appreciable gain in weight during the winter months of December through February.

5. The natural diet alone present in the cement experimental ponds failed to satisfy the requirements of maintenance and growth for the experimental fish.

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REFERENCES

ALIKUNHI, K.H. 1952.— On the food of young carp Jour. Zoo. Soc. Idia. 4 : 77–84.

ALIKUHNI, K.H., CHAUDHURI, H. & RAMACHANDRAN, V. 1954.—On the mortality of carp fry in nursery pond and the role of plankton in their survival and growth Indian J. Fish 2 : 257–313.

ALIKUNHI, K.H. 1957.—Fish pond culture in India. Farm. Bull. No. 20, Ind. Coun. Agr. Res., New Delhi.

BONDI, A., SPANDORF, A. & CALMI, R. 1957.—The nutritive value of various feeds of carp Bamidgeh 9(4).

BRETT, J.R., SHELBOURN, J.E. & SHOOP, C.T. 1969.—Growth rate and body composition of fingerling, sockeye salmon *Oncorhynchus nerka*, in relation to temperature and ration size. J. Fish. Res. Bd. Canada 26 : 2363–2394.

BROWN, M.E. 1945.—Growth of brown trout (*Salmo trutta* Linn) III. The effect of temperature on the growth of two years old trout J. Exptl. Biol. 13 : 145–155.

BROWN, M.E. 1957.—Experimental studies on growth *In* Physiology of fishes (Edt. M. E. Brown) Vol. I, Chapter IX : 361–400. Academic Press Inc., New York.

CHERVINSKI, J., HEPHER, B. & TAGARI, H. 1968.—Studies on carp nutrition. II. Effect of protein - rich diet on fish yield in farm ponds. Bamidgeh 20(1) : 6–15.

COBLE, D. W. 1967.—Relationship of temperature to total annual growth in adult smallmouth bass J. Fish. Res. Bd. Canada 24 : 87–99.

CRENSER, C.W. 1926.—The structure and growth of the scales of fishes in relation to the interpretation of their life history with special reference to the sunfish, *Eupotomis gibbosus* Misc. Publ. Univ. Mich. Mus. Zool. No. 17, 82 pp.

DAVIS, H.S. 1956.—Culture and diseases of game fishes University of Califorina Press, 332 pp.

EL-BOLOCK, A. R. & LABIB, W.D., 1968.—Carp cutlure in the U.A.R. FAO World Symposium on warm-water pond fish culture, Rome (18 to 25 May, 1966).

FUJITA, K. 1933.—Aquiculture, Tokyo (In Japanese) 259 pp.

HATHWAY, E.S. 1927.—The relation of temperature to the quantity of food consumed by fishes J. Anim. Ecol. 8 : 428-434.

HEPHER, B. & CHERVINSKI, J. 1965.— Studies on carp nutrition. The influence of protein rich diets on growth Bamidgeh 17(2) : 31–46.

HICKLING, C.F. 1962.—Fish culture Faber and Faber, London 295 pp.

HIGURASHI, T. & NAKAI, N. 1924.—Hatching experiments of carp eggs (In Japanese) Suisan Koshujo Hokoku 21(2) : 35–41.

HORA, S.L. & PILLAY, T.V. R. 1962.—Handbook of fish culture in the Indo-Pacific region, FAO Fisheries Biology, Technical paper No. 14, 204 pp, FAO, Rome.

KURONUMA, A.K. 1954.—Carp culture in rice fields as a side work of Japanese farmers, Ministry of Agriculture and Forestry, Japan.

LABIB, W.D. 1970.—Biological studies on common carp, *Cyprinus carpio* L. in Egypt M. Sc. Thesis, Faculty of Science, Cairo University.

MITRA, G.N. & MOHAPATRA, P. 1956.—On the role of zooplakton in the nutrition of carp fry Indian J. Fish 3 : 299–310.

NAKAMURA, C. 1947.—The feeding habits of carp fries (In Japanese) Bull. Japan Soc. Sci. Fisheries 13 : 111–112.

NIKOLSKY, G.V. 1963.—The ecology of fishes (Translated from Russian by L. BIRKETT) Academic Press, New York.

SCHAPERCLAUS, W. 1933.—Textbook of pond culture U.S. Fish Wildi. Serv., Fish. Leaflet 311, 260 pp.

SCHAPERCLAUS, W. 1954.—Fischkrankheiten. Verlag Akademie, Berlin.

SWIFT, D.R. 1961.—The annual growth rate in brown trout (*Salmo trutta* Linn) and its cause J. Exptl. Biol. 38 595–604.

TAMURA, T. 1961.—Carp culture in Japan In Fish as food (Edt. G. BORGOSTROM) Vol. I, Chapter 4 : 103–120. Academic Press, New York and London

VAAS, K.F. & SACHLAN, M. 1956.—Cultivation of common carp in running water in West Java. Proc. 6th. Session, I.P.F.C. Tokyo (1955) FAO, Bangkok.

VAN OOSTEN, J. 1929.—Life history of the lake herring (*Leucichthys artedi* Le Sueur) of Lake Huronas revealed by its scales with a critique of the scale method Bull. U.S. Bur. Fisheries 44 Doc. No. 1053 265–428.

WEYMOUTH, F.W. 1923.—The life history and growth of the pism clam Fish Bull. Sacramento, 120 pp.

WUNDER, W. 1949.—Fortschrittliche karpfenteichwirtschoft Erwin Nagele, tuttgart.

YASHOUV, A. 1956.—Problems in carp nutrition Bamidgeh 8(5).