ARTIFICIAL FEEDING OF CARP FRY

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INRTODUCTION

With the start of an intensive fish culture programme in UAR, it was felt necessary to develop a more suitable and balanced diet for better production of healthy carp fry. With this in view, preliminary work commenced in Barrage Fish Culture Research Station ; aiming to enhance fish production and minimizing the rearing period . While the present work is limited to observation on survival and growth of carp fry, and mainly envolving a practical nursery diet for them, it is proposed to continue investigations for suitable, cheap and productive artificial food for fingerlings as well as for adult fish.

Advantage was taken of the experience of earlier workers like Schaperclaus (1933), Ali Kounhi (1952) Ali Kounhi et. al (1954–1955), Lakshmann et al (1967) and many others who established zooplankton as the main natural food for carp fry. Accordingly, all tested items of feed were compared with this standard food. Growth and survival were taken as the criteria for deciding the comparative merit of the different items of food.

Consistency and availability of feed as possible factors affecting growth (Wolf (1951 *b*) were also taken into consideration.

A series of laboratory and field experiments on rearing of carp fry from hatchening to two or three weeks old were conducted using different types of feeds. After the preliminary testing of different feeds, poorer ones were eleminated and the more promising items were tested. The latter were analysed chemically to determine their protein, carbohydrate, fat and ash contents. Vitamin assay had however to be omitted for laboratory facilities.

During field expeiments, the rate of stocking of fry per square meter was taken into consideration as a factor affecting the rate of growth of the reared fry.

MATERIALS AND METHODS

During the spawning season of carp fish in the Barrage Fish Farm, three days old offsprings of one female were collected. At that stage, the yolk sac was completely absorbed and the fry were ready to move freely and to start feeding. Uniformity was maintained in initial feeding (Palmer et. al, 1951), and fry were fed from the third day after hatching. In the presented work, fry were collected gently from the spawning ponds by means of cloth nets specially prepared for that purpose. They were collected early in the morning and transferred with great care to the lab using plastic pails; so as not to hurt during transportation until they were distributed in the experimental jars.

Three experiments were conducted : the first was carried out in the lab using glass jars for detecting the suitable kind of food which gives the best results in growth and which may be used later on.

The second experiment was also carried out in the lab using larger glass tanks for confirming the most suitable food to be used.

The third experiment was carried out in the field. Cement nursery ponds were used, the bottom of which were lined with a thick layer of clay. These were used for the application of the results obtained from the second experiment, and to determine the suitable kind of food for field production of fingerlings.

Trials were made to use different components of diets containing different origins, which can be used as artificial food for the fry. The main components used in these different types of diets were : dried beef liver, fish meal, egg yolk, and dried vegetables. These main components were mixed with wheat flour or dried powdered bread in different proportions. In addition, yeast was added as a source of vitamin. B complex and sodium chloride as a mineral salt. The different mixtures used in all the experiments are shown in tables 1, 4 and 7.

The various items of food were first dried thoroughly and there after powdered in a mortar. The powder was seived through a fine mesh wire netting and kept in air tight containers. The mixtures of food used were chemically analysed. Protein level was estimated by Kjeldahl's digestion method, and fat was determined by ether extraction. Ash was estimated by total ignition and crobhydrate content was calculated by difference.

The chemical composition of the above mentioned diet mixtures were tabulated in tables 2, 5 and 8.

EXPERIMENTS

First Fxperiment :

In the first laboratory experiment, eleven triplicate groups of fry were tested and the mean result of each group was calculated. Glass jars, ten litres in capacity, were used. In this experiment, ten different diets (Table 1) were used ; each for one group. Besides, the eleventh group was fed exclusively upon natural food and used as control. Tap water was used in this experiment. Natural food was introduced to each of the eleven experimental groups early in the morning. This natural food was collected from the rearing ponds of the Barrage Fish Farm using plankton nets. In the afternoon only, ten groups were fed on artificial diets, while the control was fed again with natural food.

Water in all the experimental jars was removed together with the remnants of food once daily, about 2 hours after the introduction of the second diet, and fresh tap water was added again (Imam, 1969).

This experiment was continued for one month. Weights of the fry were estimated at the beginning of the experiment and then weekly, to determine the increase in growth. Due to the difficulty of determining the fresh weight of the fry, it was found better to determine its dry weight. Ten fry were placed in 70% alcohol, dried on a filter paper then in an oven at 32°C. for six hours, and at 60°C the next eighteen hours. These dried fry were placed in a desiccator for one hour after which they were immediately weighed on an analytical balance (Das, 1967).

EXPERIMENT I

TABLE 1.—PERCENTAGE COMPOSITION OF DIETS IN FIRST EXPERIMENT.

Diet No.	Liver	Fish Meal	Wheat flour	Egg yolk	Veget.	Sodium chloride	Yeast
1	100	—	—	—	—	—	—
2	99	—	—	—	—	0.5	0.5
3	97.5	—	—	—	—	0.5	2.0
4	50	—	47.5	—	—	0.5	2.0
5	30	—	67.5	—	—	0.5	2.0
6	15	—	68.5	—	15	0.5	2.0
7	10	—	87.5	—	—	0.5	2.0
8	—	30	68.5	—	—	0.5	2.0
9	—	—	67.5	30	—	0.5	2.0
10	—	—	68.5	—	30	0.5	2.0

TABLE 2.—PERCENTAGE CHEMICAL ANALYSIS OF DIETS IN FIRST EXPERIMENT.

Diet No.	Water	Protein	Fat	Carbo-hydrate	Ash	Sodium chloride	Vitamin
1	2.50	64.30	9.80	19.10	4.30	—	—
2	2.48	63.66	9.72	18.92	4.22	0.5	2.0
3	2.46	62.65	9.57	18.62	4.20	0.5	2.0
4	6.90	57.90	5.52	44.75	2.43	0.5	2.0
5	8.78	27.46	3.82	55.75	1.69	0.5	2.0
6	9.98	21.28	2.48	59.34	3.06	0.5	2.0
7	10.68	17.06	2.13	66.68	0.95	0.5	2.0
8	10.02	35.03	1.33	50.02	1.10	0.5	2.0
9	8.17	17.68	19.45	50.81	1.39	0.5	2.0
10	11.18	15.10	1.12	62.92	4.45	0.5	2.0

RESULTS

The results obtained were tabulated in table 3. From these results, it is observed that the group of fry which was completely fed by natural food as control, gave the highest rate of growth reaching a dry weight of 0.02 gm/fish, till the end of the experiment. following this was that group fed upon diet No. 8 reaching a dry weight of 0.019 gm/fish. Then followed that group fed upon diet No. 4 reaching a dry weight of 0.015 gm/fish at the end of the experiment.

TABLE 3.—MEAN DRY WEIGHT OF FISHES DURING THE FIRST EXPERIMENT

Exp. No.	Diet. No.	13/5	23/5	1/6	9/6
		wt/gm	wt/gm	wt/gm	wt/gm
1	Plankton	0.0012	0.0052	0.0203	0.0212
2	1	0.0012	0.0013	0.0070	0.0097
3	2	0.0012	0.0017	0.0054	0.0088
4	3	0.0012	0.0019	0.0069	0 0086
5	4	0.0012	0.0022	0.0098	0.0150
6	5	0.0012	0.0028	0.0089	0.0106
7	6	0.0012	0.0022	0 0057	0.0100
8	7	0 0012	0 0016	0.0064	0.0100
9	8	0.0012	0.0034	0.0106	0.0190
10	9	0.0012	0.0024	0.0073	0.0090
11	10	0.0012	0 0012	0.0075	0.0100

All the rest of the groups which were fed upon diets rather than those above mentioned, gave at the end of the experiment lower rates of growth of nearly the same range without remarkable variations.

During the first week, it was noticed in all jars that the fry were prefering the natural food than the artificial one. After the first week the fry started to get accustomed to artificial diet feeding to a certain limit, and their ability of feeding increased with time.

It has been also noticed that there was no mortality of fry throughout the whole experiment, but it is worthy to mention that the fry in all the jars rather than those fed on natural food and those supplied with diet No. 8 and 4 were not in a good condition.

Second Experiment :

In this laboratory experiment, six glass tanks of $73 \times 44 \times 50$ cm. in dimensions were used. In each tank, 200 carp fry from a single female as in the first experiment were placed.

Five different types of artificial food mixtures (Table 4) were used, besides one was fed upon natural food only and used as control.

As in the first experiment, tanks were fed twice daily. Natural food was introduced early in the morning to all the six tanks. In the afternoon, five different diets were introduced to five tanks, and the control was fed again with plankton. Tap water was used and removed once daily two hours after the second meal.

This experiment continued for three week, and the rate of growth of the fry was determined by the same way as described in the first experiment.

EXPERIMENT II

TABLE 4.—PERCENTAGE COMPOSITION OF DIETS IN SECOND EXPERIMENT.

Dite No	Liver	Fish Meal	Wheat flour	Dried bread	Sodium chloride	yeast
1	97.5	—	—	—	0.5	2.0
2	50.0	—	47.5	—	0.5	2.0
3	50.0	—	—	47.5	0.5	2.0
4	—	50.0	—	47.5	0.5	2.0
5	—	27.5	—	70.0	0.5	2.0

TABLE 5.—PERCENTAGE CHEMICAL ANALYSIS OF DIETS IN SECOND EXPERIMENT

Dite No.	Water	Protein	Fat	Carbo-hydrate	Ash	Sodium chloride	Vitamin
1	2.46	62.65	9.57	18.62	4.20	0.5	2.0
2	6.90	37.90	5.52	44.75	2.43	0.5	2.0
3	6.65	38.87	6.68	42.25	3.05	0.5	2.0
4	8.19	52.40	0.87	33.94	2.10	0.5	2.0
5	8.95	35.12	2.21	49.32	1.90	0.5	2.0

RESULTS

Results obtained during this experiment are tabulated in table 6. After the first week, the fry depending completely upon natural food, gave the best rate of growth followed those fed upon diet No. 5 and lastly the fry fed upon diet No. 4. At the end of the experiment it has been found that the fry fed upon diet No. 5 attained the highest rate of growth reaching a dry weight of 0.078 gm. per fish followed by those fed upon diet No. 4 reaching a dry weight of 0.064 gm. per fish. These two diet gave higher rates of growth than the control fed upon natural food only whose fishes reached a dry weight of 0.035 gm.

per fish only. Fry fed upon diet No. 1 attained the lowest rate of growth reaching a dry weight of 0.015 gm. per fish only. No mortality was observed throughout the duration of the experiment but it was observed that the fry fed upon diet No. 1, were lean and not in a good condition.

TABLE 6.—MEAN DRY WEIGHT OF FISHES DURING THE SECOND EXPERIMENT

Exp. No.	Dite No.	26/5	7/6	17/6
		Wt/gm	Wt/gm	Wt/gm
1	Plankton	0.0012	0.0082	0.053
2	1	0.0012	0.0042	0.015
3	2	0.0012	0.0054	0.036
4	3	0.0012	0.0054	0.035
5	4	0.0012	0.0074	0.064
6	5	0.0012	0.0078	0.078

Third Experiment :

In the third experiment, confirmation of the prospecting mixtures of diets were tried again in the field using ten cement nursery ponds. Four of these were 80 m^2 in capacity each, while the remaining were 40 m^2. Fry were collected as in the previous experiments three days after hatching. The rate of stocking of fry per square meter was taken into consideration.

In ponds Nos. 1, 2, 3 and 4, the rate of stocking was 10 fry/m^2. Ponds 5, 6 and 7, the rate of stocking was 15 fry/m^2, and ponds 8, 9 and 10, were stocked at 20 fry/m^2.

The ponds were supplied with Nile water, which was partially renewed every day. The fry throughout the experiment were depending completely on natural food during the first week. These nursery ponds were well prepared so as to furnish a good supply of natural food during the whole experiment.

The first pond was left depending completely on natural food as control, without any additional supply of diet throughout the experiment.

The first group of nurseries includes ponds No. 2, 5, and 8, were fed after the first week upon diet No. 2 (Table 7). The second group includes ponds No. 3, 6, and 9, were fed upon diet No. 1 ; while the third group includes ponds No. 4, 7 and 10, were fed upon diet No. 3.

EXPERIMENT III

TABLE 7.—PERCENTAGE COMPOSITION OF DIETS IN THE THIRD EXPERIMENT.

Dite No.	Fish meal	Dried bread	Sodium Cl.	Yeast
1	97.5	—	0.5	2.0
2	47.5	50.0	0.5	2.0
3	27.5	70.0	0.5	2.0

TABLE 8.—PERCENTAGE CHEMICAL ANALYSIS OF DIETS IN THE THIRD EXPERIMENT

Diet No.	Water	Protein	Fat	Carbo-hydrate	Ash	Sodium chloride	Vitamin
1	6.32	87.53	1.50	—	2.15	0.5	2.0
2	8.62	51.28	1.08	34.60	1.92	0.5	2.0
3	8.95	35.12	2.21	49.32	1.90	0.5	2.0

Artificial food was introduced once daily in the afternoon and was placed on wooden tables. An amount of artificial food equivalent to twice the weight of the fry at the beginning of the expriment was introduced during the second week, and thrice the weight of the fry during the third week (Lakshmann, 1967).

The experiment continued for three weeks and the rate of growth was estimated weekly by determining the total body length to the nearest millimeter, and its fresh weight to the nearest milligram.

RESULTS

Results obtained are tabulated in table 9. It has been noticed that there was no difference in the rate of growth after the first week in which all the fry were left to feed naturally. After the second week, the rate of growth of fry showed great variations in all the nurseries according to the type of food and the rate of stocking of fry per square meter.

TABLE 9.—Mean Length And Mean Fresh Weight Of Fishes During The Third Experiment

Pond No.	Diet No.	27/6		4/7		11/7		18/7	
		L.	Wt.	L.	Wt.	L.	Wt.	L.	Wt.
1	Plankton	0.9	0 0012	2.2	0.028	4.5	1.36	5.8	3.3
2	1	0.9	0.0012	2.3	0.031	4.7	1.45	5.8	3.4
3	2	0.9	0.0012	2.2	0.029	5.0	1.94	6.4	4.1
4	3	0.9	0.0012	2.3	0.029	5.1	2.12	7.14	5.8
5	1	0.9	0.0012	2.2	0.028	3.7	0.80	4.80	1.8
6	2	0.9	0.0012	2.2	0.027	4.1	0.98	4.9	2.0
7	3	0.9	0.0012	2.2	0.028	3.9	0.89	4.9	2.0
8	1	0.9	0.0012	2 2	0.028	3 6	0.56	3.8	0.9
9	2	0.9	0.0012	2.2	0.026	4.0	0.65	4.6	1.4
10	3	0.9	0.0012	2.2	0.029	3.7	0.67	4.6	1.5

Diet No. 3 used in nurseries No. 4, 7 and 10 gave the highest rate of growth. The fry in pond 4 (10 fry/m²) reached a mean length of 5.1 cm., and a mean fresh weight of 2.12 gm./fish after the second week ; and 7.14 cm. and 5.8 gm./fish after the third week. While in pond No. 7 (15 fry/m²) the fry reached a mean length of 3.9 cm. and a weight of 0.89 gm. after the second week, and 4.9 cm. and 2 gm. after the third week.

In pond No. 10 (20 fry/m²), fry reached a mean length of 3.7 cm. and a mean fresh weight of 0.67 gm./fish after the second week, while it reached a mean length of 4.6 cm. and 1.5 gm./fish after the third week.

Following this came the group of nurseries No. 2, 5 and 8, fed on diet No. 2. In pond No. 2 (10 fry/m²), the fry reached after the second week a mean length of 5 cm. and a mean weight of 1.94 gm./fish and after the third week ; 6.4 cm. and 4.1 gm./fish.

In pond No. 5 (15 fry/m²), there was no difference in the rate of growth of fry compared with those in pond No. 7 fed on diet No. 3. The same observation was found in pond No. 8 (20 fry/m²) in which the fry gave nearly the same rate of growth as those in pond No. 10 fed on diet No. 3.

Then came the fryfed on diet No. 1 which gave comparatively lower rate of growth than the other groups in the corresponding rate of stocking.

On the other hand, it has been observed that the control nursery pond without supplementary artificial feeding throughout the whole experiment attained the lowest rate of growth which was remarkable after the second and third weeks.

DISCUSSION

In discussing the comparative merits of the above suggested mixtures of a fish fry diet, it may be relevant to consider the various feed items that are widley used in other countries as fish feeds.

In our experiments, some limited types of feeds were used according to their availability. Mixtures of diets were tried according to their nutritive value especially with regards to their protein and carbohydrate levels.

It is clear that natural food is an important factor in the growth of carp fry in ponds especially in the first week. The rich plankton produced provide necessary natural food. As recorded, early fry prefer zooplankton (Ling, 1967). It would be a mistake economically to neglect this food which has a qualitative as well as quantitative values. The protein and other nutrients in the natural food should be taken into consideration and the supplementary diet added in such a way as to balance the natural food. The protein content in natural food is very high reaching about 60 % of its dry matter (Schaperclaus, 1961 ; Mann, 1961).

It has been found that it is important to provide the fry after the first week with additional artificial food. The supplementary food differs according its nature and chemical composition.

As stated by previous authors, proteins and carbohydrates play a major part in determining the success or failure of any fish diet (Philips *et. al*, 1956). It is known however that the percentage of food protein that can be utilized to satisfy the protein needs of the fish body, depends on the protein quality of the food. A protein food can be considered as highest protein quality if its analysis is approximating to that of the body protein, or if this protein food produces the best rate of growth (Wood, 1952).

In the second experiment, it has been found that the experimental diets in which dried liver was used as a main source of protein, gave lower rate of growth of fry than those mixtures in which fish meal was used as a source of protein. In this experiment, diet No. 5 having a protein level of about 35% of fish meal origin, gave nearly double the rate of growth in comparison with the diet No. 3 having a protein level of about 38% of dried liver origin; although the percentage of carohydrate in both diets have nearly the same level.

The same observation was also found in the first experiment, in diet mixtures in which fish meal was used, and gave relatively better results than other mixtures

in which different kinds of protein origin were used. This indicates that although protein is an important factor in the rate of growth of carp fry, it is preferred to be of a quality that approximates to that of the fish.

Owing to this fact, fish meal only—as a source of protein—was used during the third experiment. In spite of the vital importance of protein in fry diet, it has been found that it is useless to be found in high percentage.

In the nursery ponds (third experiment), a protein level of about 35% (diet No. 3) gave the best results ; followed by that level of about 51% (diet No. 2) ; then came that diet containing 87% (diet No. 1).

However it is known that carbohydrates play an important role as a component in the mixture diet, if the fry are fed on a high level protein diet, then part of this protein is converted into energy. This source of energy could be provided even better by the carbohydrate in added feeds. As has been found in the nurseries, diet No. 3 with a carbohydrate level of about 49% was better than diet No. 2 with carbohydrate level of about 34%; and the latter two diets were better than diet No. 1 which was composed mainly of fish meal without addition of any source of carbohydrate.

It has been also found that small percentage of salts as sodium chloride, and vitamins as vitamin B complex are important in the diet mixtures.

It is evident therefore that when natural food is abundant in the pond, a protein rich diet would not have any advantage over carbohydrate rich diet, and a suitable food mixture must be balanced according to the natural food and consists of a suitable percentage of the main two components namely protein and carbohydrate ; which can provide the fry with its metabolic requirements and growth.

It has been also found that natural food is much suitable for carp fry during the first week of its life ; perhaps because they prefer it for its highest quality or the fry did not get used to feed on artificial food during this early period of life. After the first week, the fry get used to feed on artificial food beside the natural one, perhaps because the natural food in this stage will not offer to them all their nutritive requirements specially the carbohydrate.

Although a suitable diet for carp fry is the most important factor during its early stage of life, however, the rate of stocking is also very important. It has been found in the field experiment that as the rate of stocking per square meter increased, the rate of growth of fry decreased even though being fed with the same diet and subjected to the same conditions.

The effect of a suitable diet was found also to be more pronounced in a less stocked ponds (10 fry/m^2) than in the other higher stocking (15 and 20 fry/m^2). At the lowest rate of stocking (10 fry/m^2), the suitable diet mixture No. 3 restults in a pronounced difference in the rate of growth of fry after the third week than those fed upon diets No. 2 and 1.

When the rate of stocking increased to 15 or 20 fry/m², there was almost no difference between the three different diets. So, the rate of stocking is an important factor which must be taken into consideration during carp fry production.

From the results obtained, one can manage nurseries with the proper rate of stocking and suitable diet according to the requirements to obtain the desired number of healthy fry in a certain period.

CONCLUSION

The selection of the most effective and economic artificial diet for the production of healthy carp fry in a short period was the aim of this work.

During the first week, it has been found that carp fry depend completely upon natural food. After the first week, artificial food can be introduced as supplementary diet to balance the natural one and to enhance the rate of growth of carp fry.

Artificial food which was found to give the highest rate of growth was thatdiet containing a protein level of about 35%, carbohydrate level of about 49% together with vitamins and mineral salts.

It has also been found that the rate of stocking of fry/m² is an important factor. The most suitable rate of stocking of carp fry was found to be 10 fry/m².

So, if the nursery ponds were well prepared so as to furnish a good supply of natural food, and the proper rate of stocking together with suitable artificial diet were taken into consideration, one can obtain the desired number of healthy carp fry in a certain peiod.

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