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EVALUATION OF SQUID MANTLE MEAL AS A PROTEIN SOURCE IN PENAEID NUTRITION[1]

by

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EVALUATION OF SQUID MANTLE MEAL AS A PROTEIN SOURCE IN PENAEID NUTRITION

Abstract

In studies aimed at finding cheaper, more efficient feeds for use in intensive culture of penaeids, squid mantle meal was used as a component. Laboratory-reared juvenile *Penaeus aztecus* were fed experimental diets based upon a standard ration, 5-5/70B containing 49 percent rice bran. Rice bran was replaced by varying percentages of either α-soy flour or squid mantle meal. Increase in mean weight, biomass and survival were more satisfactory with feeds containing 5 or 15 percent squid mantle meal than with feeds containing higher percentages of (30 or 49 percent) squid meal. Growth at the higher concentration (49 percent) of α-soy was also reduced. Regardless of protein source, both growth and survival were less when protein exceeded 60 percent.

Addition of squid meal in low percentages appears favourable to shrimp growth and may be economical in areas where squid can be obtained at low cost.

EVALUATION DE LA FARINE DE MANTEAU D'ENCORNET COMME SOURCE DE PROTEINES POUR LA NUTRITION DES PENEIDES

Résumé

Lors d'études destinées à trouver des aliments meilleur marché et plus efficaces pour l'élevage intensif des pénéides, on a utilisé comme composant des aliments la farine de manteau d'encornet. L'on a appliqué à des juvéniles de *Penaeus aztecus* élevés en laboratoire des régimes alimentaires basés sur une ration standard de 5-5/70B contenant 49 pour cent de son de riz. Le son de riz a été remplacé en pourcentages variables soit par de la farine de α-soja, soit par de la farina de manteau d'encornet. L'accroissement du poids moyen, de la biomasse et du taux de survie était supérieur avec les aliments contenant de 5 ou 15 pour cent de farine de manteau d'encornet qu'avec ceux contenant des pourcentages plus élevés (30 ou 49 pour cent) de ce composant. La croissance a également diminué pour un taux de concentration plus élevé (49 pour cent) de la farine de α-soja. Quelle que soit l'origine des protéines, la croissance et le taux de survie étaient moindres lorsque leur taux de concentration excédait 60 pour cent.

L'adjonction de farine d'encornet en faibles pourcentages semble favoriser la croissance des crevettes et peut présenter un intérêt économique dans les régions où il est possible de se procurer des encornets à peu de frais.

VALOR DE LA HARINA DE MANTO DE CALAMARES COMO FUENTE DE PROTEINAS PARA LA NUTRICION DE PENEIDOS

Extracto

En los estudios tendentes a encontrar piensos más baratos y eficaces para el cultivo intensivo de peneidos se ha utilizado, entre otras cosas, harina de manto de calamares. Se alimentó a formas juveniles de Penaeus aztecus criadas en laboratorio con raciones experimentales basadas en una ración uniforme 5-5/70B con un 49 por ciento de salvado de arroz. Se sustituyó el salvado de arroz, en diversos porcentajes, por harina de α-soja o harina de manto de calamar. El aumento del peso medio y de la biomasa y la supervivencia de los camarones resultaron más satisfactorios con piensos con un 5 o 15 por ciento de harina de manto de calamares que con piensos con porcentajes mayores de dicha harina (30 o 49 por ciento). También con la concentración más elevada (49 por ciento) de α-soja el crecimiento resultó menor. Independientemente del origen de la proteínas, tanto el crecimiento como la supervivencia disminuyeron con un contenido de proteínas superior al 60 por ciento.

La adición de harina de calamar en pequeños porcentajes resulta favorable para el crecimiento de los camarones y puede resultar una solución económica en las zonas donde es posible conseguir calamares a bajo costo.

1. INTRODUCTION

One of the main problems in intensive shrimp culture is to find an inexpensive artificial diet which ensures the rapid growth of shrimp from juvenile to commercial size with good survival. To solve this problem we have been testing diets for Penaeus aztecus based on the diet FDSC 5-5/70B (Meyers and Zein-Eldin, 1973). Variations of this diet have been made by changing the quality and percentage of protein and by replacing rice bran with α-soy and squid meal.

2. MATERIAL AND METHODS

Glass aquaria with a 60-l capacity were prepared with undergravel filters and filter beds consisting of oyster shell and sand (Zein-Eldin and Meyers, 1973). Natural sea water used in the experimentation was passed through a 5-μ filter and then through a quartz ultraviolet sterilizer. Aquaria were placed in controlled temperature rooms maintained at $27 \pm 1^{o}C$. Both temperature and salinity varied somewhat during the course of the experiments. In experiment PSQ-1, recorded temperatures ranged between 28.6 and 31.6°C, and salinities between 21.5 and 24.8 ppt. In experiment PSQ-2, temperature ranged between 26.8 and 30.0°C and salinity between 21.4 and 23.6 ppt.

In experiment PSQ-1, ten hatchery-reared Penaeus aztecus were placed in each aquarium; the initial biomass per aquarium ranged from 4.875 to 6.142 g. In PSQ-2, 15 animals were placed in each aquarium; the initial biomass per aquarium ranged from 5.069 to 7.442 g. Two aquaria were used for each diet. Experimental animals were measured (rostrum-telson length) to the nearest 0.5 mm and weighed to the nearest mg approximately every two weeks. Animals were identified by cutting uropods to establish individual growth rates.

The shrimp were fed twice daily. The initial feeding level was approximately 5 percent of the biomass per day. Uneaten feed was removed daily together with exuviae and any dead shrimp. The amount of feed was adjusted so that animals were provided as much as they would eat, and was not held at a fixed percentage of biomass. The amount fed was recorded and feed efficiencies and conversion ratios were calculated using corrected weight as described by Kitabayashi et al. (1971a).

Some of the feeds contained squid mantle meal as a component. This was prepared from fresh squid obtained from commercial fishermen. Viscera and pen were removed, the mantles were boiled for five minutes in water containing 5 percent sodium chloride, and the solids removed by filtration. Solids were dried in an oven at 80°C and ground to produce the meal. Mantles only were used in this series of experiments because of the variability in condition of the gonads of the live animals.

2.1 Feed Composition

Feeds were produced using a cold extrusion process with a high viscosity alginate as a binder (Meyers, Butler and Hastings, 1972). Diet composition is listed in Table I together with the protein percentages determined by analysis. Addition of components was made at the expense of rice bran, the component present in largest amount and found to be least digestible (Lee, 1971). In diets B and C soy protein was used in place of some of the rice bran. In diets D, E, F, and K varying percentages of squid mantle meal were substituted.

3. RESULTS

3.1 Experiment PSQ-1

Diets were based upon the control diet containing 3 percent soy meal. Rice bran was replaced at two levels of both soy meal and squid meal; additional soy flour at 15 percent (total 18 percent soy) in diet B, and 49 percent (52 percent total soy) in diet C; 15 percent squid meal (F), and 49 percent squid meal (D).

Table I

Feed components (percent) used in diets for experiments PSQ-1 and PSQ-2. Sources of ingredients other than squid meal as given in Zein-Eldin and Meyers (1973)

	Control (5-5/70B)	B	C	D	E	F	K
Menhaden	8.0	8.0	8.0	8.0	8.0	8.0	8.0
Shrimp meal	31.5	31.5	31.5	31.5	31.5	31.5	31.5
Rice bran	49.0	34.0	-	-	19.0	34.0	44.0
α - soy flour	3.0	18.0	52.0	3.0	3.0	3.0	3.0
Squid meal	-	-	-	49.0	30.0	15.0	5.0
Menhaden solubles	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lecithin	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Alginate	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Na hexametaphosphate	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Vitamin mix	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Protein percent by analyses	35.5	47.3	69.0	62.5 to 65.1	55.4	44.9	43.0

Animals fed diet F (15 percent squid) increased in mean weight from 0.5 to 3.5 g (Table I, Fig. 1) while animals fed either diet B or the control feed (5-5/70B) reached about 2.4 g, and those fed D (49 percent squid) were only 2.0 g after 49 days. During the first 13 days of experimentation, shrimp growth with feed D was similar to that with feed F, but after this time growth on feed D decreased and deaths occurred. Animals fed diet C weighed only 1.163 g at the end of the experiment.

Initial combined biomass (for each diet in two aquaria) varied between 9.95 and 11.63 g, or 4.88-6.14 g per aquarium (21.95-27.30 g/m^2). Combined biomass increased more than 30 g for the groups fed F and for those fed the control (60 g/m^2), but the increase was less than 5 g for those given feeds C and D (Fig. 2). Best survival was observed among animals fed the control, while animals fed diet D (49 percent squid mantle meal) had the highest mortality rate. Survival was not always equal between replicates. For example, one of the groups fed diet F showed 90 percent survival, while only 30 percent of the animals survived in the other.

Feed efficiency varied between 22.2 and 30.9 percent, or conversion rates varied between 3.2 and 4.5 (Table II). The significance of these differences is doubtful.

3.2 Experiment PSQ-2

The results of the first experiment suggested that squid mantle meal at 15 percent level was superior, but that amounts as large as 49 percent were unsatisfactory; consequently, in this new series of experiments we tested two additional levels of squid mantle meal, 5 percent (K) and 30 percent (E). As a further comparison, two replicate tanks of shrimp were fed a commercially available feed obtained from Japan (K-25)[1/], previously found to be the most successful in promoting growth of *P. aztecus* (Zein-Eldin and Corliss, in press).

The greatest increase in mean weight occurred among shrimp fed diet F which gained from 0.44 to 4.10 g in 42 days (Table III). Good growth was also obtained with K-25 (3.14 g increase). Animals fed other test diets reached a final weight of 2.5-3.0 g (Table III and Fig. 3).

1/ Obtained from Kyowa Hakko Kogyo Co. Ltd

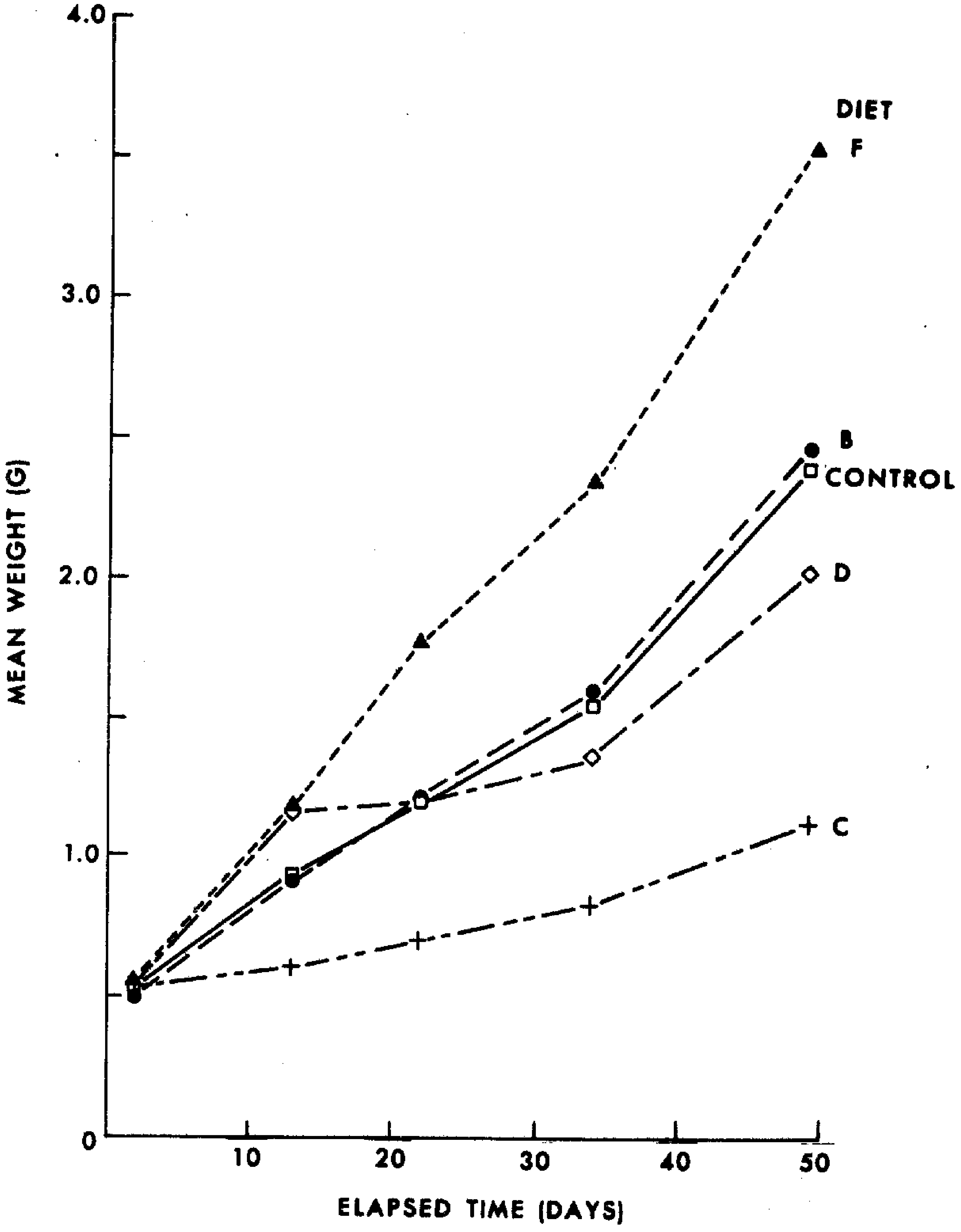

Fig. 1 Experiment PSQ-1. Increase in mean weight of P. aztecus juveniles fed diets containing soy and squid meal. Composition of experimental feeds as given in Table I

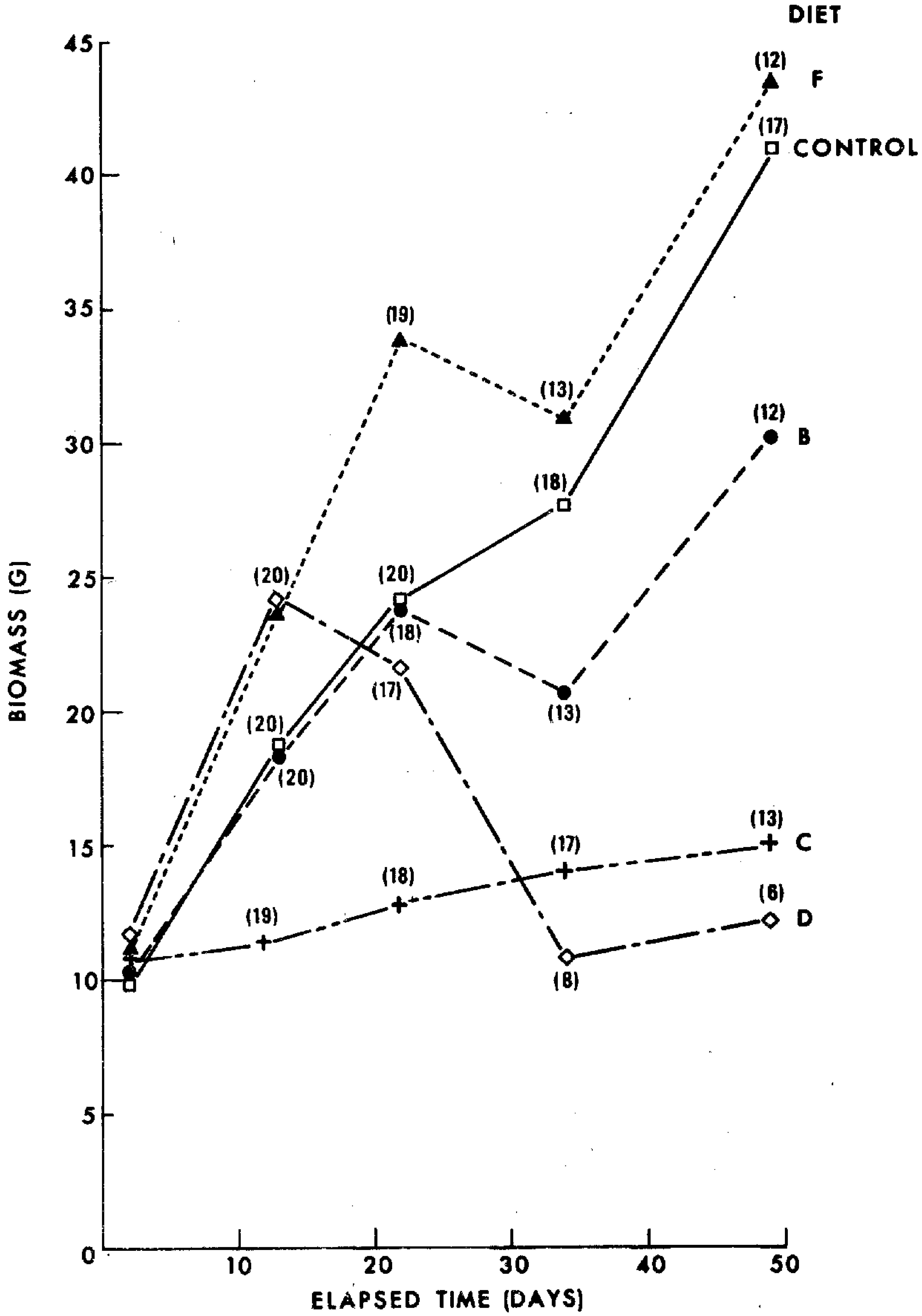

Fig. 2 Experiment PSQ-1. Change in combined biomass of replicate tanks of juvenile P. aztecus fed diets containing soy and squid meal. Numbers in parenthesis indicate survivors at each measurement period

Table II

Experiment PSQ-1. Effects of diets with two levels of soy and squid meal on the growth, survival and conversion rate of laboratory-reared *Penaeus aztecus* - Elapsed time: 49 days

Diet	Mean weight (g)		Biomass (g)		Survival (%)	Amount fed (g)	Feed efficiency (%)	Conversion rate	Protein ingested (g)
	Initial	Final	Initial	Final					
B	0.52 ± 0.215	2.52 ± 0.716	10.41	30.30	60.0	103.6	30.9	3.2	49.0
C	0.53 ± 0.234	1.16 ± 0.345	10.75	15.12	65.0	40.3	25.6	3.9	28.0
D	0.55 ± 0.261	2.02 ± 0.786	11.63	12.17	28.5	71.6	24.2	4.1	45.0
F	0.55 ± 0.233	3.62 ± 1.039	11.04	43.54	60.0	168.2	22.2	4.5	76.0
Control	0.49 ± 0.224	2.42 ± 0.705	9.95	41.19	85.0	126.4	28.2	3.5	45.0

Table III

Experiment PSQ-2. Effects of diets with different levels of squid meal on the growth, survival and conversion rates of laboratory-reared *Penaeus aztecus* - Elapsed time: 42 days

Diet	Mean weight (g)		Biomass (g)		Survival (%)	Amount fed (g)	Feed efficiency (%)	Conversion rate	Protein ingested (g)
	Initial	Final	Initial	Final					
D	0.42 ± 0.096	3.05 ± 1.075	12.78	21.40	30.0	181.7	28.1	3.5	118.3
E	0.41 ± 0.090	2.83 ± 1.412	12.32	28.32	33.3	188.3	25.7	3.9	104.3
F	0.44 ± 0.108	4.10 ± 0.668	13.26	49.16	40.0	190.3	40.3	2.4	85.4
K	0.44 ± 0.119	2.54 ± 1.015	13.39	48.36	63.3	174.3	29.5	3.4	74.9
K-25	0.44 ± 0.149	3.61 ± 0.540	13.27	64.91	60.0	187.5	40.5	2.5	108.6
Control	0.48 ± 0.135	2.53 ± 0.868	14.15	45.60	60.0	178.3	28.3	3.5	63.3

Total initial biomass (for each diet in two aquaria) ranged between 12.32 and 13.39 g (5.71 and 7.44 g per aquarium; 25.38-33.07 g/m^2). Final biomass was greatest among animals fed K-25; 64.91 g or an increase of 51.64 g in 42 days (Fig. 4). Final biomass was similar among the three feeds: F (15 percent squid), K (5 percent squid), and the control; with increase in biomass of 35.91 g for F, 34.97 g for K, and 31.45 g for the control. Diets higher in squid meal (D and E), produced much lower biomass increase, only 8.63 g among animals fed D (49 percent squid meal) and 16.0 g among animals fed E (30 percent squid meal).

The increase in biomass is related to survival of the shrimp, with survival least in the aquaria fed D and E, and highest with K and K-25. As in the first experiment, survival between replicate tanks of animals fed F was not consistent, with nine animals surviving in one tank, but only three in the other.

The best efficiency, about 40 percent, was obtained with diets K-25 and F (Table III). Others in the test were about 10-15 percent less, ranging from 25-29 percent.

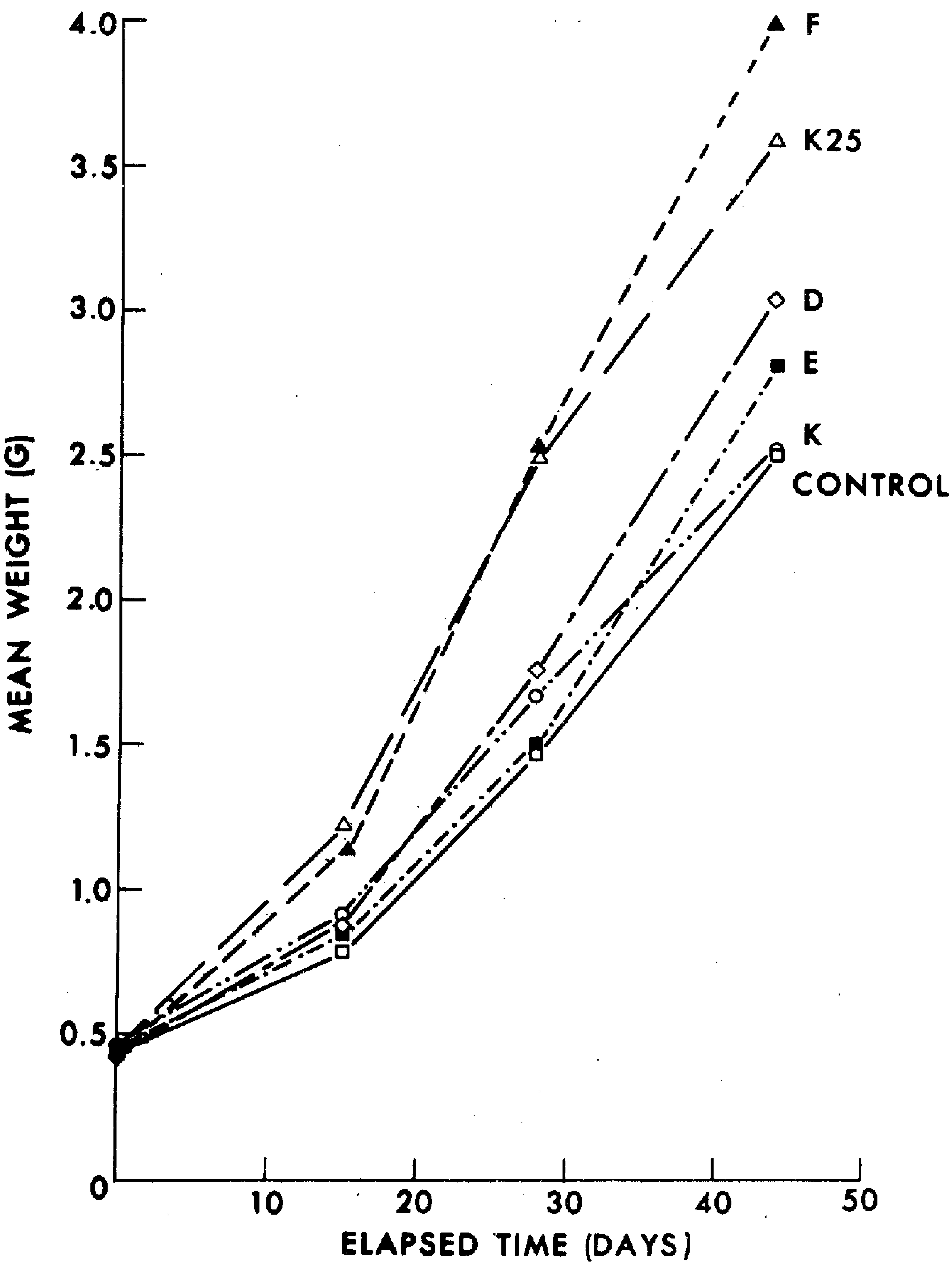

Fig. 3 Experiment PSQ-2. Increase in mean weight of P. aztecus fed diets containing various levels of squid mantle meal. Feed composition as given in Table I

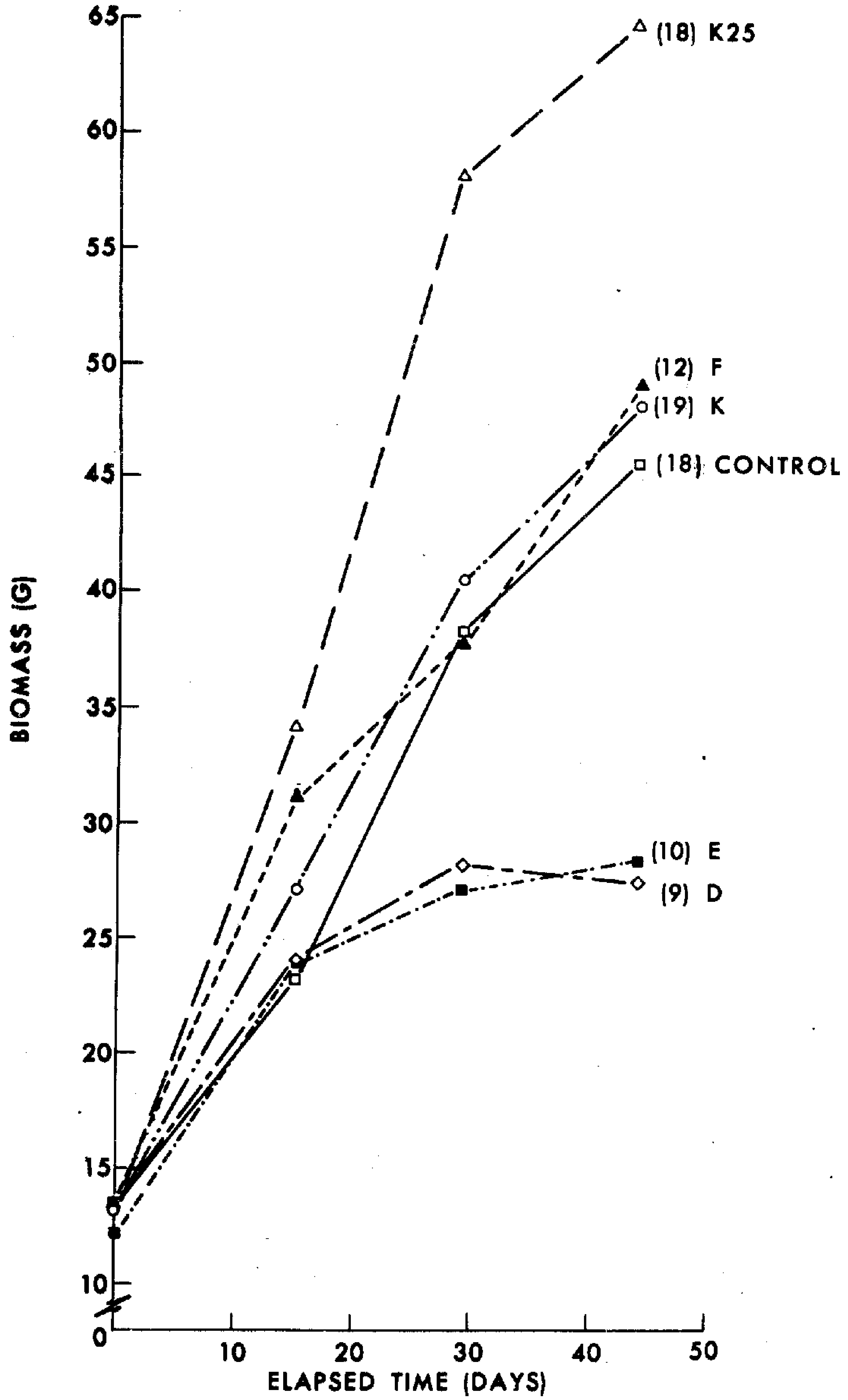

Fig. 4 Experiment PSQ-2. Increase in combined biomass of P. aztecus juveniles fed diets containing various percentages of squid meal. Numbers in parenthesis indicate survivors at termination of experiment

Animals in PSQ-2 generally grew somewhat better than those in the earlier experiment, although the first experiment was seven days longer than the second. Conversely, survival was somewhat less in PSQ-2 than in PSQ-1; and in both experiments replicate tanks did not have similar survival. In both experiments, however, animals fed diet D (49 percent squid meal) began to die after about two weeks and in both series survival of these groups of animals was least, and survival of animals fed the control diet was either highest, or very nearly so.

4. DISCUSSION

We used diets with different percentages of soy flour, diet C, with 52 percent (49 percent more than the control), and diet B, 18 percent (15 percent more than the control). Good growth occurred only with the diet with the lesser amount of soy flour. Zein-Eldin and Corliss (in press), however, reported growth comparable to that with the control when soy flour was present in percentages as great as 58 percent, and only slightly decreased growth with 78 percent soy flour. Sick and Andrews (1973) also used a feed with 58 percent soy meal which produced superior growth in Penaeus duorarum. Therefore, the inhibition of growth with diet C is unlikely to be a result of an excess of soy flour, or a consequent lack of methionine. It may be due to some synergistic relationship among the components. Texture of feeds containing large amounts of soy bean meal also varies from that of rice bran feeds, and may play an important role in feed acceptability. Significantly less feed was ingested by those animals given diet C (Table II).

These experiments utilized feeds with a limited range of protein contents (Table I). In both cases with high protein (diet C with 69 percent protein as fed, and diet D with 62.5-65.1 percent protein as fed), growth was less than on the diet using the same components but with lower protein content. This is in agreement with the studies of Zein-Eldin and Corliss (in press) who suggested that the optimum protein percentage was greater than 43 percent but less than 65 percent in feeds with components including large amounts of soy flour. Studies of Venkataramiah, Lakshmi and Gunter (1975) also suggested that protein percentages greater than 50 percent resulted in decreased growth in P. aztecus.

Balazs, Ross and Brooks (1973) suggested that the best growth in P. aztecus and P. japonicus was obtained with more than 40 percent protein, and Deshimaru and Shigeno (1972) tested no diets for P. japonicus that had less than 60 percent protein. Others have reported decreased growth at high protein levels. Lee (1971) working with P. monodon, also reported a lower growth rate at 62 percent protein as compared to 46 percent, although growth increased with protein percentage in the range of 2-46 percent. Finally, Andrews, Sick and Baptist (1972) found the best growth with P. setiferus when feeding diets with protein between 28 and 32 percent, and decreasing growth between 40 and 52 percent.

It would thus appear that growth does not have a simple relationship to the percentage of protein but is related both to the quality of these proteins and to the relations among the other components of the diet.

It may also be worth considering whether various species have differing protein requirements based upon ability to use different amounts of vegetable material.

Squid has been used as a protein source by several authors (Subrahmanyam and Oppenheimer, 1969; Kitabayashi et al., 1971b; Deshimaru and Shigeno, 1972; Kittaka, 1975), both whole and in the form of meals and extracts. Kitabayashi et al. (1971b) used diets of 56-74 percent squid meal in their experiments with P. japonicus, while Deshimaru and Shigeno (1972) used diets with lower percentages (20-47 percent) for the same species which resulted in better growth than with diets containing fish meal. Both the feed efficiency and the survival reported by the Japanese authors exceeds that which we determined under different conditions and with another species. Our best growth was obtained with diets containing 5 or 15 percent squid meal, while with larger amounts of squid (30 and 49 percent) mortality was high and growth decreased.

These studies suggest the favourable response of growing shrimp to the addition of small amounts of squid meal in the feed. This component may thus be of economic potential in those areas of the world in which squid can be obtained at low cost.

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