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飼料中添加酵母粉對黑鯛成長之影響

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Effect of Yeast Powder Added in Diet on the Growth of Black Porgy (*Acanthopagrus schlegeli*)

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In this trial, cane molasses yeast processed by the Taiwan Sugar Company were used to evaluate its effect on the growth rate, food conversion rate and protein efficiency ratio of black porgy *(Acanthopagrus schlegeli)*, compared with other kind of yeast.

The food conversion rate of black sea bream fed diet containing 6% cane molasses yeast were 3.16 to 3.56. It was better than that of fish fed diet containing 0% yeast (3.86 to 4.58). The protein efficiency ratios of the former were 0.74 -0.89, still better than that of the latter, which were 0.58-0.66. However, the efficiency of the diet containing this level of yeast are the best in all the levels.

The growth rate of black sea bream fed diet containing cane molasses yeast are better than fish fed diet containing brewer yeast or beet sugar molasses yeast after 8 weeks.

關鍵字：黑鯛、酵母粉、成長。

Key words: Black porgy, Yeast powder, Growth.

前　言

酵母屬於SCP（ single cell protein ）之一大類，由於可被部份魚類充分利用，同時富含維生素及未知成長因子（ UGF ）而被積極研究。以鯉魚之飼料試驗爲例，石油酵母可取代魚粉 30 ～ 45 %，且飼料效率略有昇高；鰻魚以 35 %之比例取代魚粉，馴養後之飼料效率亦有提高之現象；香魚養殖以取代 15 %者爲最佳；而虹鱒飼料試驗中取代 30 %量者，與全魚粉飼料組並無差異，但魚肉却有不佳之嗅味。石油酵母飼育鰻魚，較一般以魚粉飼料飼育者，脊骨較長，肥滿度也較低 (1)(2)(3)

(4)(5)(6)。

其他如水蚤或輪蟲等餌料生物可以利用酵母粉投餵，進行大量培養。但部份酵母如大量生產之麵包酵母，雖亦可使用於輪蟲等之增殖，但營業上則有偏差。以單獨攝取此種酵母之餌料生物飼育魚類幼苗，常導致仔稚魚營養不良而大量死亡(7)(8)(9)(10)。

酵母一向被當作部分的維生素供給源，或是以未知成長因子之來源應用於飼料中，最近因純度高的維生素價格比以往低廉，故以 UGF 爲目的的使用例子較多。本省水產飼料中亦有添加酵母者，惟酵母含量僅佔飼料之 2.0～3.5％，故其添加目的仍著重於維生素、UGF 之補充。其添加之種類，省產者除蔗糖酵母外，尚有啤酒酵母，進口者則除前二者外，尚有甜菜酵母。其形態以乾燥酵母粉爲主，部份業者爲降低生產成本，亦有以利用黃豆粉或米糠製成之發酵酵母粉。

台糖公司秉承良好的品牌信譽生產高品質之酵母粉，加之以此實際調製水產飼料，亦有良好的結果，故其售價雖高，仍爲部份業者所樂用，唯目前因有多種品牌之激烈競爭，市場之佔有率仍偏低。本試驗針對酵母粉之最適添加量及不同品牌及種類之酵母粉飼育黑鯛進行效用之比較評估，期以科學的結果供消費業者參考，同時也供該公司作爲爾後產銷決策及價位評定之依據。

材料與方法

一、試驗材料：

試驗用黑鯛苗，購自本所台南分所，經馴養一個月後，於 60 × 30 × 45 cm之水族箱中（水量約50公升）進行三重複之試驗。每一水族箱均裝設打氣石，將打氣機送來之空氣分散於水中，以增加水中之溶氧。水族箱上方加裝過濾器，以濾除水中之污物。

養魚試驗用海水自蓄水池汲取後，先經 30 μm 之濾水管及砂濾池濾除水中之雜質，貯於密閉且不透光之蓄水桶充分打氣備用，使用時再經紫外燈殺菌及 15 μm 之濾水管，以分段除去浮游物質，其鹽度爲 31～33 ppt；pH 8.0～8.2。飼育水溫 18～24℃；光照時間定爲 12：12（L：D），每一水族箱每日換水⅓，每週清洗上方過濾器一次。

各飼料單元均係飼料級，酵母粉係台糖公司之產品，及市售進口之產品。

二、試驗方法：

A、不同酵母粉添加量對黑鯛成長之影響：

飼料中添加不同量（3％、6％、9％）之酵母粉，與未添加酵母粉（0％）之飼料進行黑鯛飼育試驗，以比較添加酵母粉與否對黑鯛之成長影響，及何種添加量方爲黑鯛飼料中之最適添加量。各試驗飼料均調配成爲等蛋白、等能量，能量以無氮碳水化合物調整，飼料配方示如表 1。各組飼料混合後以濕粒型態造粒，並分小包凍藏備用。

飼育時採用飽食法投餌，飼料投放時，詳細觀察攝食情況，魚飽食不再攝餌時即停餵，每日早上及下午各餵食一次。

試驗進行八週。試驗魚每隔兩週秤重一次，秤重前浸泡於含有MS 222麻醉劑之海水中，待其昏迷後，以紗布吸乾體表附著的水分，再行秤重。秤量過之試驗魚移入清淨海水中打氣，待其清醒後放回水族箱中。秤重之同時，將水族箱中之舊水排掉，以清水洗淨，再放入新水備用，將魚放回水族箱後，以硫酸銅 2 ppm及富來頓 Furazolidone 3～4 ppm 藥浴，預防病原感染。

B、不同品牌之酵母粉對黑鯛成長之影響：

以市售不同品牌之酵母粉，如啤酒酵母、甜菜酵母等依最適添加量混合於飼料中，進行黑鯛飼育試驗，以瞭解種類不同之酵母粉對黑鯛之成長是否有影響，各組特點說明詳如表 2。

飼料配方之調製原則及飼育之試驗方法同A項所述，配方列如表 3。

表1　添加不同量蔗糖酵母粉之黑鯛用飼料配方

Table 1　Formulation of diet containing different levels of cane molasses yeast powder for black porgy.

Ingredients	Kinds / content (%)				Remarks
	Y－0	Y－3	Y－6	Y－9	
Fish meal	47.0	44.8	42.7	40.6	c.p.*1 = 63.5 %
Soya meal defatted	18.0	18.0	18.0	18.0	c.p. = 40.2 %
Yeast	0.0	3.0	6.0	9.0	c.p. = 45.1 %
Dextrin	15.0	15.0	15.0	15.0	
α — starch	6.0	6.0	6.0	6.0	
Feed oil	6.0	6.0	6.0	6.0	fish's / soya's = 1
Vitamin mix *2	2.0	2.0	2.0	2.0	
Mineral mix *3	3.0	3.0	3.0	3.0	
Cellulose	3.0	2.2	1.3	0.4	

*1　c.p. means crude protein content

*2, *3　according to Halver's formuwla

表2　試驗用各組酵母粉之特點說明

Table 2　Description on yeast powder used in diet for black porgy trials.

Class	Descriptions		
	Kind of yeast	Level (%)	Supplier, Co.
T－0	—	0	
T－6	Cane molasses	6	Taiwan sugar Co.
M－6	Brewers	6	Maowang enterprise Co.
P－6	Beet molasses	6	Bouchiang enterprise Co.
C－6	Yeast culture	6	Chiuchen Co.

三、計　　算：

各組試驗飼料對黑鯛成長影響之評估以飼料效率（Food conversion rate, FCR）、蛋白效率比（Protein efficiency ratio, PER）及成長率（Growth rate, GR）作爲判定標準，其計算公式分別如下：

$$\text{飼料效率} = \frac{\text{攝餌量（g）}}{\text{體重增加量（g）}}$$

$$\text{蛋白效率比} = \frac{\text{體重增加量（g）}}{\text{蛋白攝取量（g）}}$$

$$\text{成 長 率} = \frac{\text{體重增加量（g）}}{\text{初　重（g）}} \times 100\,\%$$

表3　不同品牌酵母粉之黑鯛飼料配方

Table 3　Formula of diet containing different kind of yeast powder for black porgy.

Ingredients	Kinds of diet / Content (%)					Remarks
	T－0	T－6	M－6	P－6	C－6	
Fish meal	47.0	42.7	42.7	42.7	42.7	c.p.*1 = 63.5 %
Soya meal defatted	18.0	18.0	18.0	18.0	18.0	c.p. = 40.2 %
Yeast	0.0	6.0	6.0	6.0	6.0	c.p. = 45.1 %
Dextrin	15.0	15.0	15.0	15.0	15.0	
α — starch	6.0	6.0	6.0	6.0	6.0	
Oil	6.0	6.0	6.0	6.0	6.0	fish's / soya's = 1
Vitamin mix*2	0.0	0.0	0.0	0.0	0.0	
Mineral mix*3	3.0	3.0	3.0	3.0	3.0	
Cellulose	5.0	3.3	3.3	3.3	3.3	

*1 c.p. means crude protein content

*2, *3 according to Halver's formula

結果與討論

一、不同酵母粉添加量對黑鯛成長之影響：

依前述方法配成之飼料，其一般成分經分析結果列如表4。

黑鯛經八週飼育，每兩週之體重變化情形列如表5。酵母粉含量較高之6、9%組，其體重分別爲48.76 ± 19.80 g及46.90 + 19.64 g，百分比偏差約爲40.6 %及41.90 %，均較含量低的0、3%各組爲佳。

各組之蛋白效率比，經計算結果如表6，以6%組之0.74爲最高，其次爲9%組之0.69，未添加之0%組及3%組均爲0.66，顯示6%組之蛋白利用率最佳。

飼料效率經計算結果如表7，各組不同期間之飼料效率略有不同，可能與飼育期間之水溫變化有

表4　添加不同量蔗糖酵母粉之黑鯛用飼料一般成分

Table 4　The chemical composition of diets containing cane molasses yeast powder for black porgy.

Kind of composition analyzed	Level (－%) / Content (%)			
	Y－0	Y－3	Y－6	Y－9
Crude protein	26.64	26.70	26.83	25.21
Crude fat	6.73	6.69	6.78	6.48
Crude ash	9.11	8.84	8.75	8.54
Moisture	34.00	34.61	35.08	34.51

表 5　黑鯛飼以含不同量酵母粉之配合飼料 8 週後體重之變化

Table 5　Changes in body weight of black porgy fed diets containing different levels of cane molasses yeast.

Feeding period	Level (—%) / body weight *			
(weeks)	Y—0	Y—3	Y—6	Y—9
Initial	31.01 ± 16.63	33.88 ± 15.71	32.46 ± 13.95	32.12 ± 12.97
2	35.45 ± 18.36	38.43 ± 19.81	37.78 ± 14.35	35.87 ± 16.11
4	38.40 ± 20.65	40.70 ± 21.65	40.40 ± 16.08	38.98 ± 17.03
6	43.18 ± 22.16	45.52 ± 23.48	45.43 ± 17.92	43.59 ± 18.27
8	45.36 ± 24.17	47.77 ± 24.05	48.76 ± 19.80	46.90 ± 19.64

* Mean (gm) ± S.D.

表 6　黑鯛飼以含不同量酵母粉配合飼料之蛋白效率比

Table 6　Comparison on protein efficiency ratio of black porgy fed diets containing different levels of cane molasses yeast.

Feeding period	Level (—%) / protein efficiency ratio			
(weeks)	Y—0	Y—3	Y—6	Y—9
2	0.67	0.72	0.82	0.72
4	0.63	0.54	0.60	0.62
6	0.74	0.80	0.86	0.72
8	0.60	0.56	0.68	0.68
Means	0.66	0.66	0.74	0.69

表 7　黑鯛飼以含不同量蔗糖酵母粉配合飼料之飼料效率

Table 7　Comparison on feed conversion rate of black porgy fed diets containing different levels of cane molasses yeast.

Feeding period	Level (—%) / feed conversion rate			
(Weeks)	Y—0	Y—3	Y—6	Y—9
2	3.86	3.47	3.16	3.98
4	3.96	4.62	4.29	4.35
6	3.42	3.12	3.18	3.64
8	4.18	4.45	3.62	3.86
Means	3.86	3.92	3.56	3.96

關，但各組間比較，其平均值仍以 6 %組之 3.56 爲最佳， 0 %、3 %及 9 %組則分別爲 3.86、3.92 與 3.96。

成長率如圖 1，6 %組與其他各組比較在各成長階段均爲最佳，其八週之成長率約爲 50 %；0、3、9 %各組之成長率則在各階段中互有增減。

死亡率如表 8，6 %組均無死亡，而 9 %組則有 28.12 %之死亡率，其次分別爲 0、3 %各組之 3.12、6.25 %。

各組試驗前後體重測定值之 T 檢測分析結果列如表 9，6 %組較 0、9 %組有明顯之差異，而與 3 %組之間雖無明顯差異，但由圖 2、圖 3 之體重分佈圖比較，可看出 3 %組之體重分佈有偏低之傾向。至於 Duncan's multiple range 檢測之結果列如表 10，6 %組亦較 0、3、9 %各組爲佳。

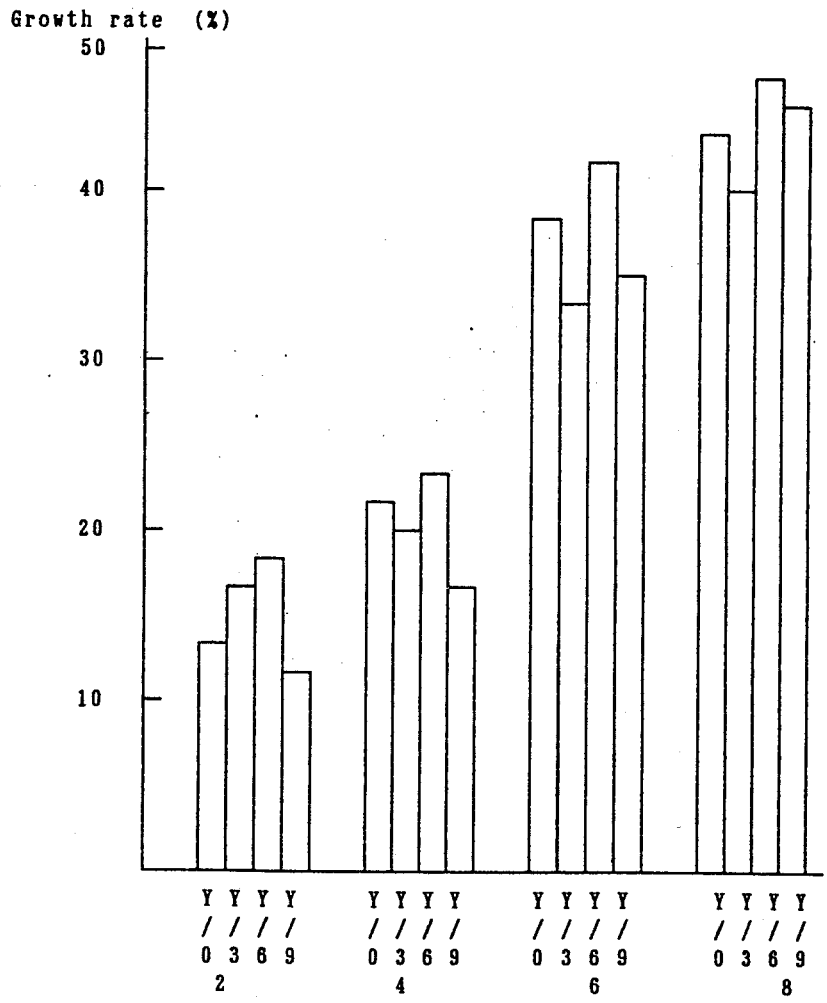


圖 1　黑鯛飼以不同添加量酵母粉之配合飼料 8 週間之成長率

Fig. 1　Growth rate of black porgy fed diet containing different contents of yeast powder during initial 8 weeks.

表 8　黑鯛飼以含有不同量蔗糖酵母配合飼料 8 週後之死亡率

Table 8　Mortality of black porgy fed diets containing different levels of cane molasses yeast.

Survival No and mortality	Level (%)			
	Y — 0	Y — 3	Y — 6	Y — 9
Initial No.	32	32	32	32
Final No.	31	30	32	23
Mortality (%)	3.12	3.25	0	28.12

表 9　黑鯛飼以含不同量酵母粉之配合飼料 8 週後體重之 T 檢測

Table 9　T test (LSD) for weight of black sea bream fed diet containing different contents of yeast powder.

DIET Comparison	Lower Confidence Limit	Difference Between Means	Upper Confidence Limit	
7 — 6	— 0.539	4.270	9.079	
7 — 8	0.759	5.568	10.377	***
7 — 5	3.739	8.548	13.357	***
7 — 3	12.617	17.426	22.235	***
7 — 2	13.641	18.450	23.259	***
7 — 4	15.232	20.041	24.850	***
7 — 1	17.921	22.730	27.539	***
6 — 7	— 9.079	— 4.270	0.539	
6 — 8	— 3.511	1.298	6.107	
6 — 5	— 0.531	4.278	9.087	
6 — 3	8.347	13.156	17.965	***
6 — 2	9.371	14.180	18.989	***
6 — 4	10.962	15.771	20.580	***
6 — 1	13.651	18.460	23.269	***
8 — 7	—10.377	— 5.568	— 0.759	***
8 — 6	— 6.107	— 1.298	3.511	
8 — 5	— 1.829	2.980	7.789	
8 — 3	7.048	11.858	16.667	***
8 — 2	8.073	12.882	17.691	***
8 — 4	9.663	14.473	19.282	***
8 — 1	12.352	17.161	21.970	***
5 — 7	—13.357	— 8.548	— 3.739	***
5 — 6	— 9.087	— 4.278	0.531	
5 — 8	— 7.789	— 2.980	1.829	
5 — 3	4.068	8.878	13.687	***
5 — 2	5.093	9.902	14.711	***
5 — 4	6.683	11.493	16.302	***
5 — 1	9.372	14.181	18.990	***
3 — 7	—22.235	—17.426	—12.617	***
3 — 6	—17.965	—13.156	— 8.347	***
3 — 8	—16.667	—11.858	— 7.048	***
3 — 5	—13.687	8.878	— 4.068	***
3 — 2	— 3.784	1.025	5.834	
3 — 4	— 2.194	2.615	7.424	
3 — 1	0.495	5.304	10.113	***

表9　黑鯛飼以含不同量酵母粉之配合飼料8週後體重之T檢測（續）

Table 9　T tests (LSD) for weight of black porgy fed diet containing different contents of yeast powder.

DIET Comparison	Lower Confidence Limit	Difference Between Means	Upper Confidence Limit	
2 — 7	— 23.259	— 18.450	— 13.641	***
2 — 6	— 18.989	— 14.180	— 9.371	***
2 — 8	— 17.691	— 12.882	— 8.073	***
2 — 5	— 14.711	— 9.902	— 5.093	***
2 — 3	— 5.834	— 1.025	3.784	
2 — 4	— 3.219	1.590	6.399	
2 — 1	— 0.530	4.279	9.088	
4 — 7	— 24.850	— 20.041	— 15.232	***
4 — 6	— 20.580	— 15.771	— 10.962	***
4 — 8	— 19.282	— 14.473	— 9.663	***
4 — 5	— 16.302	— 11.493	— 6.683	***
4 — 3	— 7.424	— 2.615	2.194	
4 — 2	— 6.399	— 1.590	3.219	
4 — 1	— 2.120	2.689	7.498	
1 — 7	— 27.539	— 22.730	— 17.921	***
1 — 6	— 23.269	— 18.460	— 13.651	***
1 — 8	— 21.970	— 17.161	— 12.352	***
1 — 5	— 18.990	— 14.181	— 9.372	***
1 — 3	— 10.113	— 5.304	— 0.495	***
1 — 2	— 9.088	— 4.279	0.530	
1 — 4	— 7.498	— 2.689	2.120	

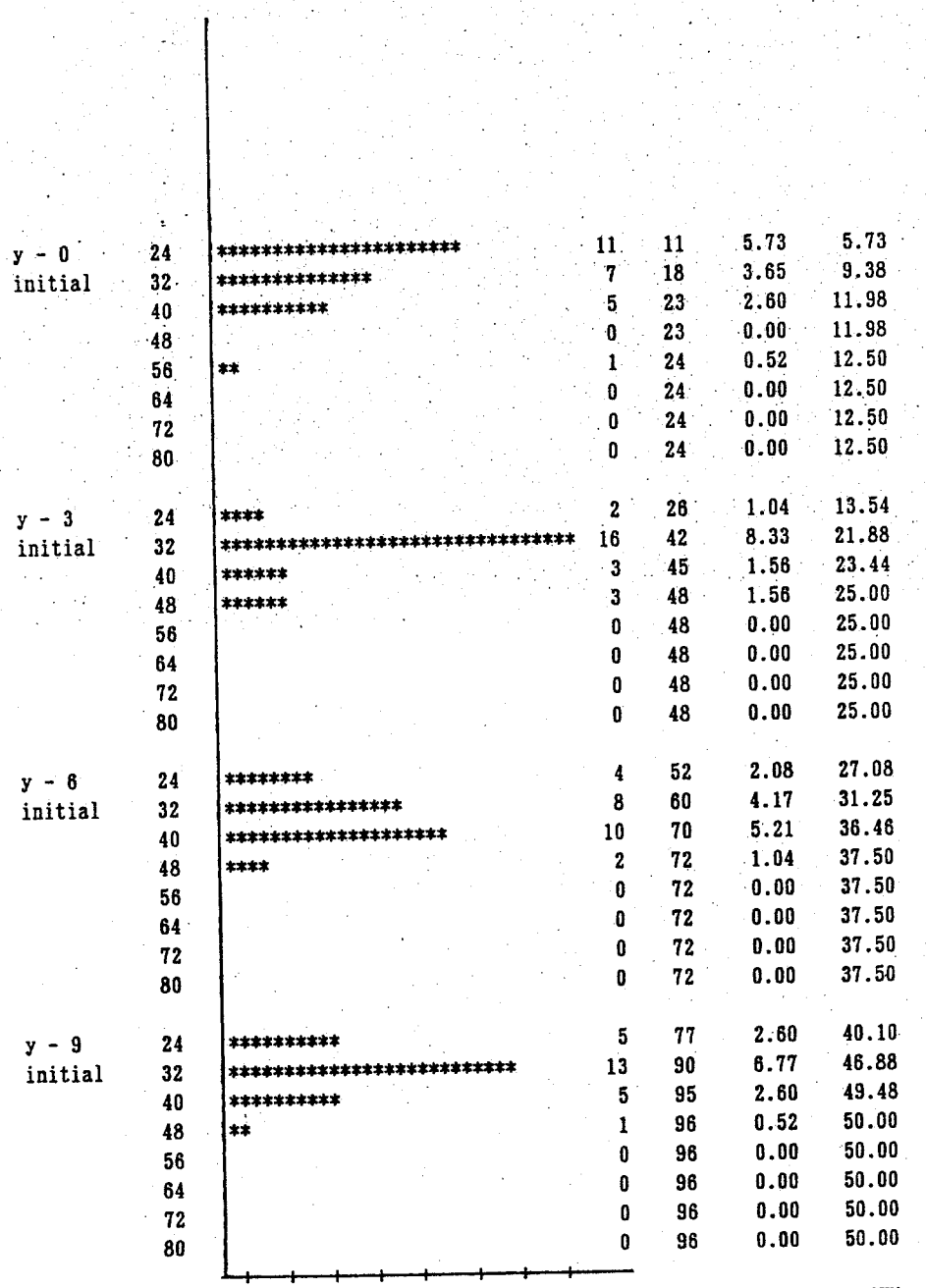
NOTE : a. This test controls the type I comparisonwise error rate not the experiment-wise error rate.

b. Alpha = 0.05　Confidence = 0.95　df = 184　MSE = 71.29773
Critical Value of T = 1.97294　Least Significant Difference = 4.8091

c. Comparisons significant at the 0.05 level are indicated by " *** ".

d. *1) No 1 — 8 defined as :

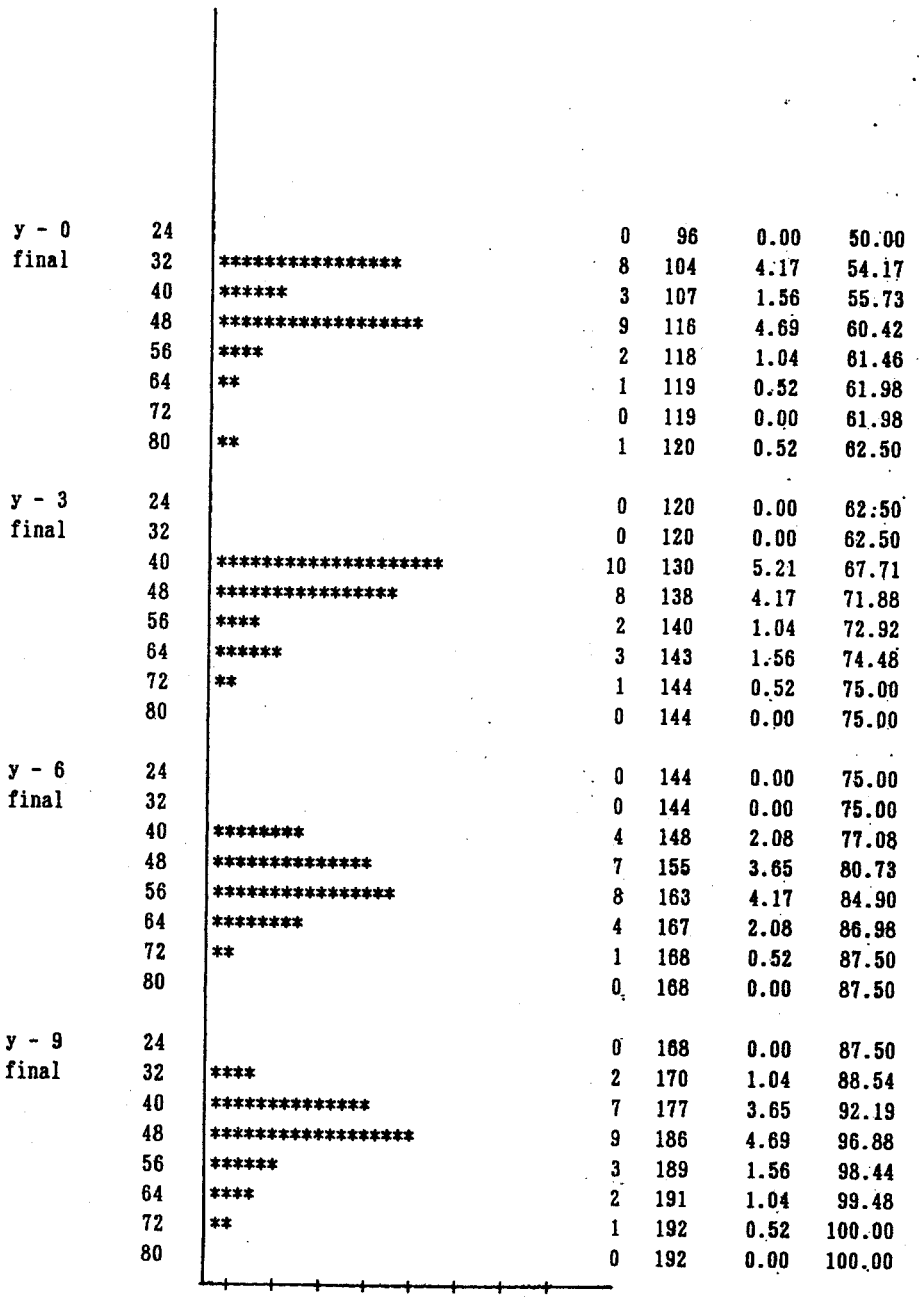
1 : initial weight of y—0 class　　5 : final weight of y—0 class
2 : initial weight of y—3 class　　6 : final weight of y—3 class
3 : initial weight of y—6 class　　7 : final weight of y—6 class
4 : initial weight of y—9 class　　8 : final weight of y—9 class



DIET	WEIGHT MIDPOINT		FREQ	CUM.	PERCENT FREQ	CUM. PERCENT
y - 0 initial	24	**********	11	11	5.73	5.73
	32	*******	7	18	3.65	9.38
	40	*****	5	23	2.60	11.98
	48		0	23	0.00	11.98
	56	**	1	24	0.52	12.50
	64		0	24	0.00	12.50
	72		0	24	0.00	12.50
	80		0	24	0.00	12.50
y - 3 initial	24	****	2	26	1.04	13.54
	32	**********	16	42	8.33	21.88
	40	******	3	45	1.56	23.44
	48	******	3	48	1.56	25.00
	56		0	48	0.00	25.00
	64		0	48	0.00	25.00
	72		0	48	0.00	25.00
	80		0	48	0.00	25.00
y - 6 initial	24	********	4	52	2.08	27.08
	32	**********	8	60	4.17	31.25
	40	**********	10	70	5.21	36.46
	48	****	2	72	1.04	37.50
	56		0	72	0.00	37.50
	64		0	72	0.00	37.50
	72		0	72	0.00	37.50
	80		0	72	0.00	37.50
y - 9 initial	24	**********	5	77	2.60	40.10
	32	**********	13	90	6.77	46.88
	40	**********	5	95	2.60	49.48
	48	**	1	96	0.52	50.00
	56		0	96	0.00	50.00
	64		0	96	0.00	50.00
	72		0	96	0.00	50.00
	80		0	96	0.00	50.00

圖 2　不同添加量酵母粉之配合飼料試驗之黑鯛最初體重分佈圖

Fig.2　Frequency bar chart of initial weight of black porgy fed diet containing different contents of yeast powder.



DIET	WEIGHT MIDPOINT		FREQ	CUM.	PERCENT FREQ	CUM. PERCENT
y - 0 final	24		0	96	0.00	50.00
	32	**********	8	104	4.17	54.17
	40	******	3	107	1.56	55.73
	48	**********	9	116	4.69	60.42
	56	****	2	118	1.04	61.46
	64	**	1	119	0.52	61.98
	72		0	119	0.00	61.98
	80	**	1	120	0.52	62.50
y - 3 final	24		0	120	0.00	62.50
	32		0	120	0.00	62.50
	40	**********	10	130	5.21	67.71
	48	**********	8	138	4.17	71.88
	56	****	2	140	1.04	72.92
	64	******	3	143	1.56	74.48
	72	**	1	144	0.52	75.00
	80		0	144	0.00	75.00
y - 6 final	24		0	144	0.00	75.00
	32		0	144	0.00	75.00
	40	********	4	148	2.08	77.08
	48	**********	7	155	3.65	80.73
	56	**********	8	163	4.17	84.90
	64	********	4	167	2.08	86.98
	72	**	1	168	0.52	87.50
	80		0	168	0.00	87.50
y - 9 final	24		0	168	0.00	87.50
	32	****	2	170	1.04	88.54
	40	**********	7	177	3.65	92.19
	48	**********	9	186	4.69	96.88
	56	******	3	189	1.56	98.44
	64	****	2	191	1.04	99.48
	72	**	1	192	0.52	100.00
	80		0	192	0.00	100.00

圖 3　不同添加量酵母粉之配合飼料飼育黑鯛 8 週後之體重分佈圖

Fig. 3　Frequency bar chart of weight of black porgy fed diet containing different contents of yeast powder after 8 weeks.

表 10　黑鯛飼以含不同量酵母粉之配合飼料 8 週後體重之 Duncan's multiple range 檢測

Table 10　Duncan's multiple range test for weight of black porgy fed diet containing different contents of yeast.

Duncan Grouping	Mean	N	DIET
A	52.637	24	7 *1
A B A	48.367	24	6
B B	47.069	24	8
B B	44.089	24	5
C	35.211	24	3
C D C	34.187	24	2
D C D	32.596	24	4
D D	29.908	24	1

NOTE: a. This test controls the type I comparisonwise error rate, not the experimentwise error rate.

b. Alpha = 0.05　df = 184　MSE = 71.29773

Number of Means　2　3　4　5

Critical Range　4.8422223　5.0918937　5.2525497　5.373242

Number of Means　6　7　8

Critical Range　5.4748116　5.5578275　5.6257551

c. Means with the same letter are not significantly different.

d.*1) No 1 — 8 defined as :

1 : initial weight of y—0 class　5 : final weight of y—0 class

2 : initial weight of y—3 class　6 : final weight of y—3 class

3 : initial weight of y—6 class　7 : final weight of y—6 class

4 : initial weight of y—9 class　8 : final weight of y—9 class

由上述試驗結果顯示，酵母粉 6 %之添加量，不論其成長率、蛋白效率比以及飼料效率等均有最佳之結果，故接續進行之試驗採用 6 %之添加量作爲比較組；又因與未添加酵母粉之 0 %組比較，兩者成長率之差異僅約爲 5 %，未有預期中之效果，擬增加未添加維生素之空白組，以了解是否因爲添加維生素，而未能突顯酵母粉之功效。

二、不同品牌酵母粉對黑鯛成長之影響：

一般成分分析結果列如表 11 。

以含不同品牌酵母粉之配合飼料飼育黑鯛經 8 週後魚體重之變化列如表12，蔗糖酵母粉 T — 6 組爲 59.40 ± 11.35 g ，與啤酒酵母粉 M — 6 組之 57.82 ± 14.15 g 及甜菜酵母粉 P — 6 組之 57.22 ± 18.19 g 相較，平均值相差不大，但其標準差却較小，如此魚體型相近比較不會因大小參差而導致互相殘食，此種現象對鬥爭性很強之黑鯛，在飼育管理上非常有利，有助於活存率之提高（表 13 ）。

未添加酵母粉與添加調製酵母粉之 T — 0 組及 C — 6 組，試驗結束之魚體重分別爲55.92±16.54

表11　不同品牌酵母粉飼料之一般成分

Table 11　Chemical composition of diets containing different kinds of yeast powder.

Composition	Kinds of diet / Content (%)				
	T－0	T－6	M－6	P－6	C－6
Crude protein	27.35	27.57	30.13	28.90	29.57
Crude fat	8.24	7.80	7.46	7.45	7.67
Crude ash	9.46	9.34	9.96	10.08	9.74
Moisture	28.64	27.50	26.70	27.49	27.95

表12　黑鯛飼以不同品牌酵母粉飼料之體重變化

Table 12　Changes in body weight of black porgy fed diets containing different kinds of yeast powder.

Feeding periods (weeks)	Kinds of diets / Body weight (g)				
	T－0	T 6	M－6	P－6	C－6
Initial	46.53 ± 12.48*	46.35 ± 11.16	46.50 ± 11.15	46.35 ± 12.87	46.39 ± 11.54
2	49.00 ± 13.42	47.92 ± 11.85	49.66 ± 11.97	49.82 ± 12.47	48.66 ± 12.21
4	51.42 ± 14.91	52.43 ± 11.36	53.38 ± 12.53	52.80 ± 16.57	52.50 ± 14.72
6	53.92 ± 15.83	56.44 ± 11.61	55.20 ± 13.59	55.25 ± 17.71	54.70 ± 15.86
8	55.92 ± 16.54	59.40 ± 11.35	57.82 ± 14.15	57.22 ± 18.19	55.81 ± 17.48

* Mean (gm) ± S.D.

表13　黑鯛飼以不同品牌酵母粉配合飼料8週後之死亡率

Table 13　Mortality of black porgy fed artificial diets containing different kinds of yeast powder after 8 weeks.

Survival No. and Mortality (%)	Kinds of diet				
	T－0	T－6	M－6	P－0	C－6
Initial No.	18	18	18	18	18
Final No.	16	18	12	17	17
Mortality	11	0	33	6	6

g及55.81 ± 17.48 g，均較T－6組、M－6組、P－6組者爲差，顯示酵母粉確有補充維生素不足之功能。

黑鯛飼以含不同品牌酵母粉之配合飼料，經8週後之蛋白效率比，如表14所示，T－6組飼育期間約爲0.69～1.06，平均值爲0.89，較M－6組、P－6組、C－6組平均值之0.70、0.64、0.56，有相當顯著之差異；T－0組之蛋白效率則不論飼育期間或全期之平均值，均較其他各組爲差，顯示酵母粉有促進黑鯛對飼料中蛋白質利用率之功效。

各試驗飼料飼育黑鯛8週後之飼料效率，列如表15，起初以M－6組之2.86爲佳，但第三週之後，則以T－6組之2.53爲最佳，飼育期間T－6組的飼料效率約在2.53～4.18之間，平均值爲3.16，較其他如M－6、P－6、C－6及T－0等各組之3.81、4.57、5.88及4.58爲優，可知蔗糖酵母粉初期之接受性可能較啤酒酵母粉差，但經過較長期之飼育比較，則仍以蔗糖酵母粉爲最佳。

各試驗飼料飼育黑鯛之成長率如圖4，T－6組經飼育8週後有最佳之成長率，至於此階段之試驗黑鯛最初體重分佈情形如圖5，飼育8週後之體重分佈如圖6，並用T檢測及Duncan's multiple range檢測，結果列如表17、表18，可看出飼育前各組均調整至相似之情況，但最後除T－6組及M－6組外，其他各組均呈現相當大之差異，是否因爲添加不同種類酵母粉而使黑鯛產生體型差異分佈，其原因則有待更進一步之研究與探討。

表14　黑鯛飼以不同品牌酵母粉配合飼料之蛋白效率比

Table 14　Comparison on protein efficiency ratio of black porgy fed diets containing different kinds of yeast powder.

Feeding periods	Kinds of diet / Protein Efficiency Ratio				
(weeks)	T－0	T－6	M－6	P－6	C－6
2	0.60	0.87	0.86	0.74	0.74
4	0.61	0.92	0.69	0.73	0.68
6	0.67	0.06	0.66	0.67	0.55
8	0.42	0.89	0.59	0.41	0.27
Means	0.58	0.89	0.70	0.64	0.56

表15　黑鯛飼以不同品牌酵母粉配合飼料之飼料效率

Table 15　Comparison on food conversion rate of black porgy fed diets containing different kinds of yeast powder.

Feeding periods	Kinds of diet / Food conversion rate				
(weeks)	T－0	T－6	M－6	P－0	C－6
2	4.42	3.03	2.86	3.91	3.31
4	4.38	2.88	3.58	3.88	3.71
6	3.73	2.53	4.58	3.99	5.26
8	5.77	4.18	4.22	6.49	11.25
Means	4.58	3.16	3.81	4.57	5.88

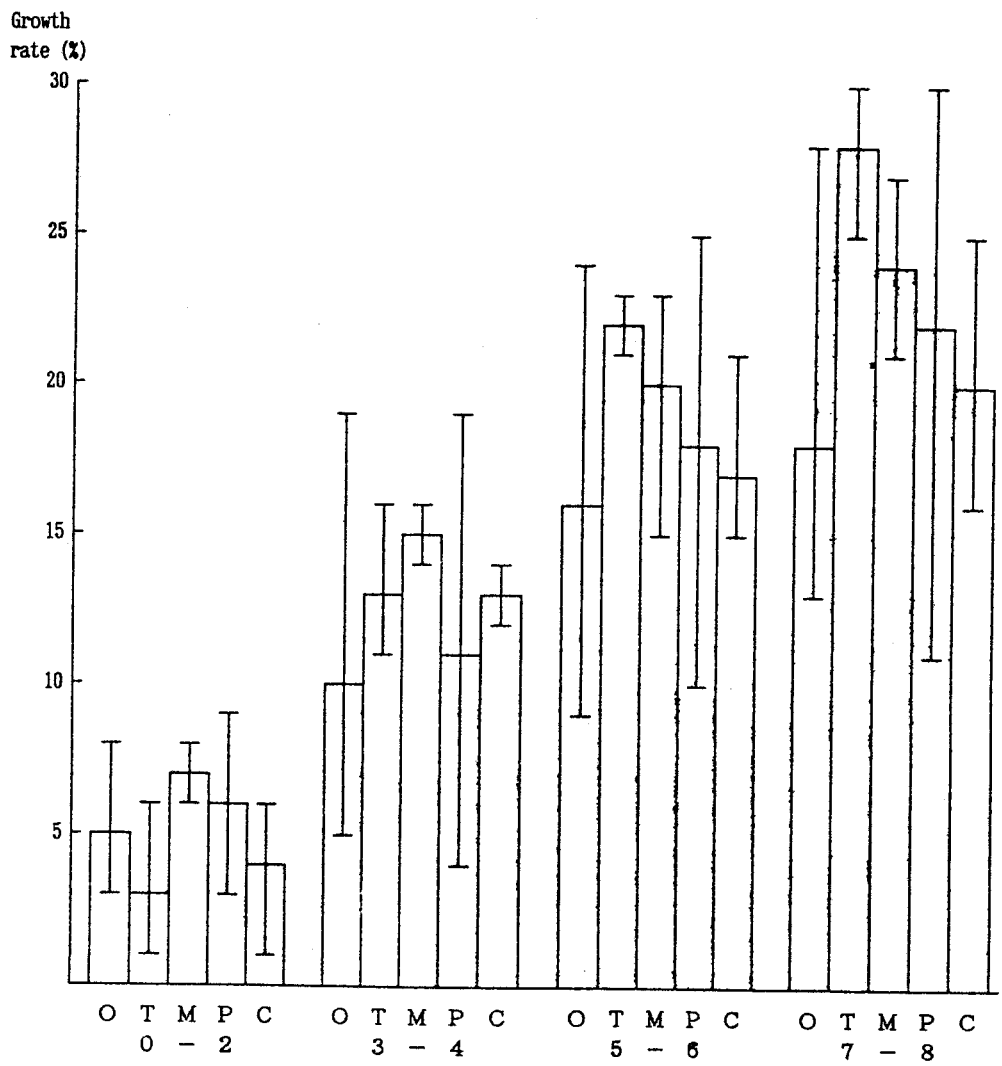
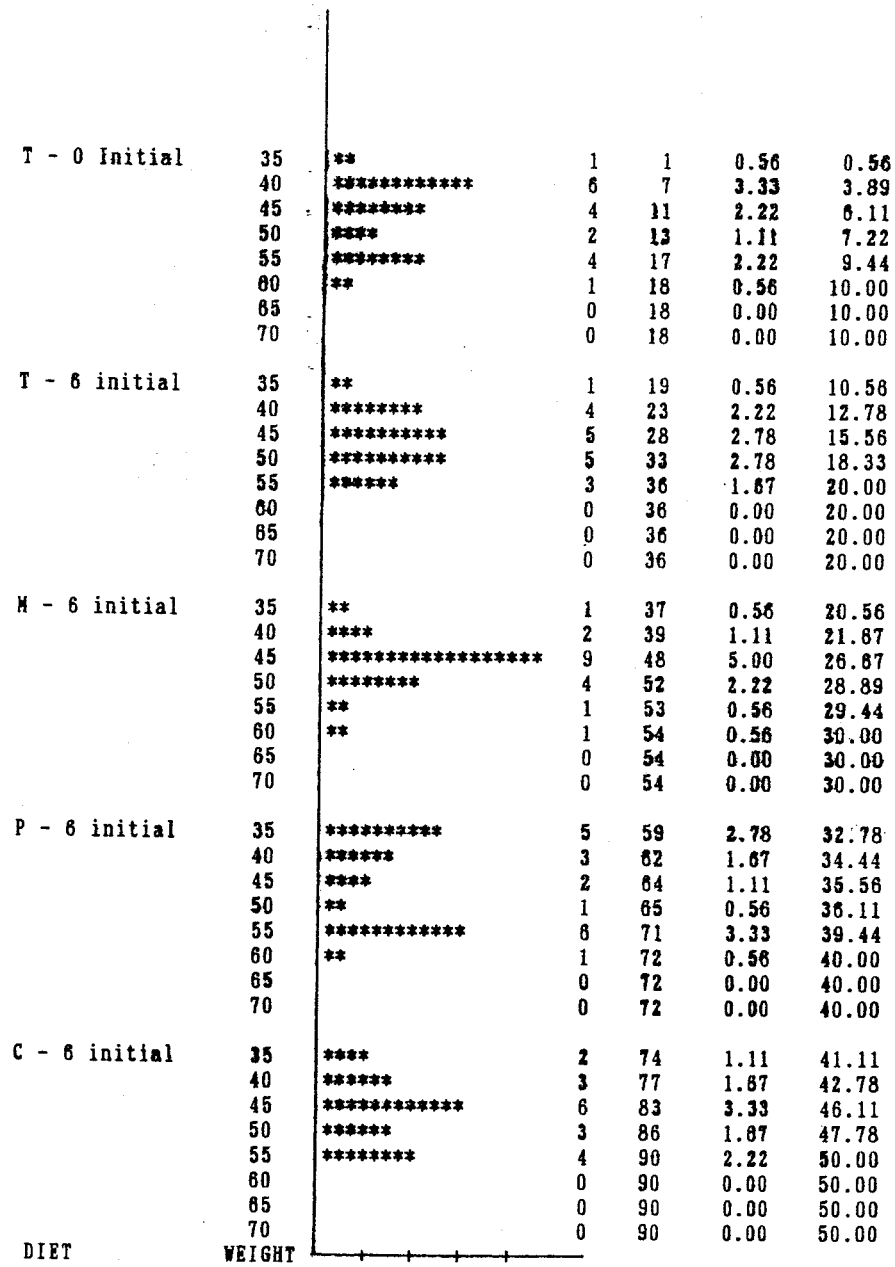


圖 4　黑鯛飼以含不同品牌酵母粉配合飼料 8 週間之成長率

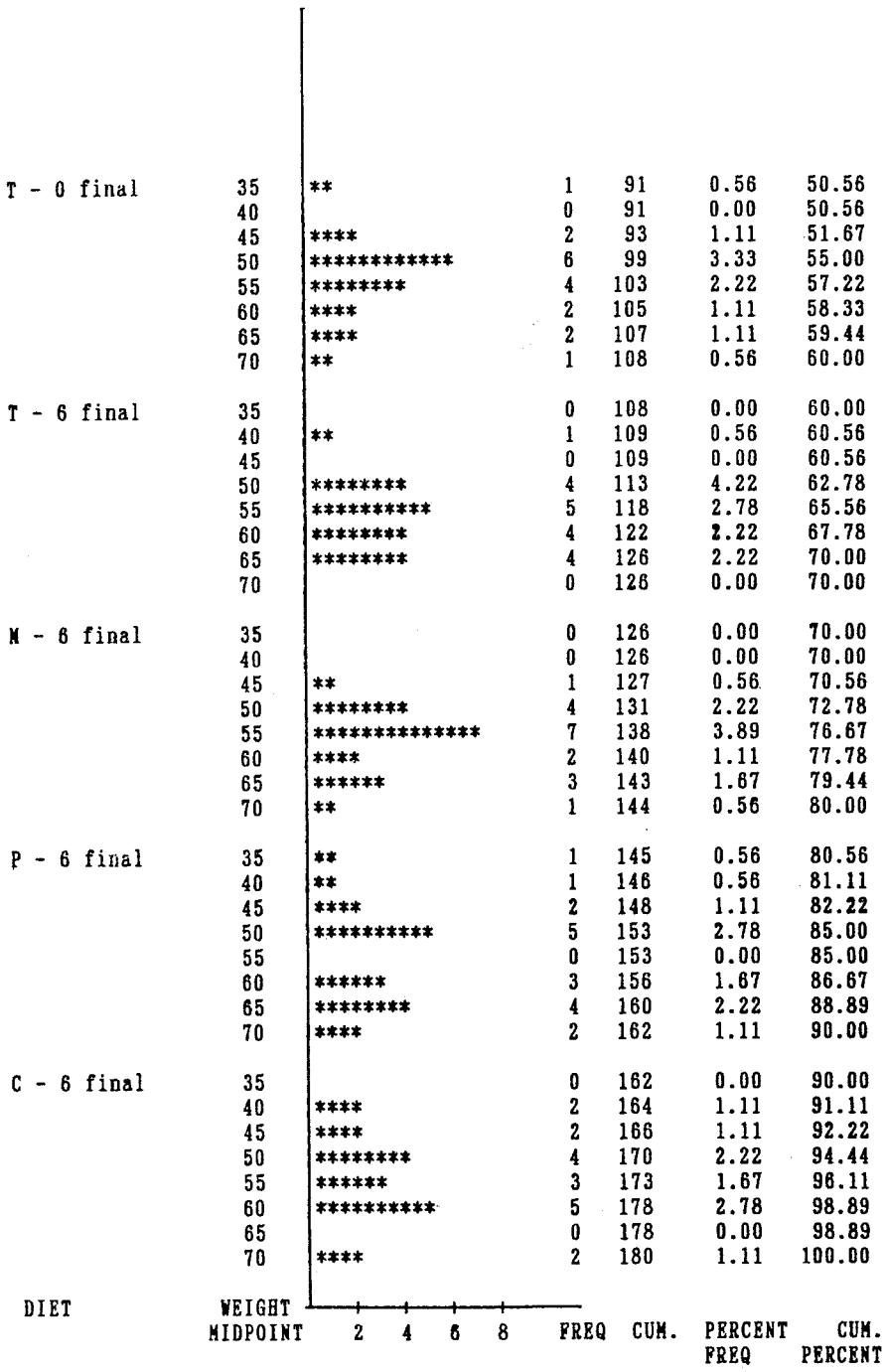
Fig. 4　Growth rate of black porgy fed diet containing different kinds of yeast powder during 8 weeks.



DIET	WEIGHT MIDPOINT	2 4 6 8	FREQ	CUM.	PERCENT FREQ	CUM. PERCENT
T - 0 Initial	35	**	1	1	0.56	0.56
	40	**********	6	7	3.33	3.89
	45	********	4	11	2.22	6.11
	50	****	2	13	1.11	7.22
	55	********	4	17	2.22	9.44
	60	**	1	18	0.56	10.00
	65		0	18	0.00	10.00
	70		0	18	0.00	10.00
T - 6 initial	35	**	1	19	0.56	10.56
	40	********	4	23	2.22	12.78
	45	**********	5	28	2.78	15.56
	50	**********	5	33	2.78	18.33
	55	******	3	36	1.67	20.00
	60		0	36	0.00	20.00
	65		0	36	0.00	20.00
	70		0	36	0.00	20.00
M - 6 initial	35	**	1	37	0.56	20.56
	40	****	2	39	1.11	21.67
	45	**********	9	48	5.00	26.67
	50	********	4	52	2.22	28.89
	55	**	1	53	0.56	29.44
	60	**	1	54	0.56	30.00
	65		0	54	0.00	30.00
	70		0	54	0.00	30.00
P - 6 initial	35	**********	5	59	2.78	32.78
	40	******	3	62	1.67	34.44
	45	****	2	64	1.11	35.56
	50	**	1	65	0.56	36.11
	55	**********	6	71	3.33	39.44
	60	**	1	72	0.56	40.00
	65		0	72	0.00	40.00
	70		0	72	0.00	40.00
C - 6 initial	35	****	2	74	1.11	41.11
	40	******	3	77	1.67	42.78
	45	**********	6	83	3.33	46.11
	50	******	3	86	1.67	47.78
	55	********	4	90	2.22	50.00
	60		0	90	0.00	50.00
	65		0	90	0.00	50.00
	70		0	90	0.00	50.00

圖 5　含不同品牌酵母粉配合飼料試驗之黑鯛最初體重分佈圖

Fig.5　Frequency bar chart of initial weight of black porgy fed diet containing different kinds of yeast powder.



DIET	WEIGHT MIDPOINT	2 4 6 8	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
T - 0 final	35	**	1	91	0.56	50.56
	40		0	91	0.00	50.56
	45	****	2	93	1.11	51.67
	50	**********	6	99	3.33	55.00
	55	********	4	103	2.22	57.22
	60	****	2	105	1.11	58.33
	65	****	2	107	1.11	59.44
	70	**	1	108	0.56	60.00
T - 6 final	35		0	108	0.00	60.00
	40	**	1	109	0.56	60.56
	45		0	109	0.00	60.56
	50	********	4	113	4.22	62.78
	55	**********	5	118	2.78	65.56
	60	********	4	122	2.22	67.78
	65	********	4	126	2.22	70.00
	70		0	126	0.00	70.00
M - 6 final	35		0	126	0.00	70.00
	40		0	126	0.00	70.00
	45	**	1	127	0.56	70.56
	50	********	4	131	2.22	72.78
	55	**********	7	138	3.89	76.67
	60	****	2	140	1.11	77.78
	65	******	3	143	1.67	79.44
	70	**	1	144	0.56	80.00
P - 6 final	35	**	1	145	0.56	80.56
	40	**	1	146	0.56	81.11
	45	****	2	148	1.11	82.22
	50	**********	5	153	2.78	85.00
	55		0	153	0.00	85.00
	60	******	3	156	1.67	86.67
	65	********	4	160	2.22	88.89
	70	****	2	162	1.11	90.00
C - 6 final	35		0	162	0.00	90.00
	40	****	2	164	1.11	91.11
	45	****	2	166	1.11	92.22
	50	********	4	170	2.22	94.44
	55	******	3	173	1.67	96.11
	60	**********	5	178	2.78	98.89
	65		0	178	0.00	98.89
	70	****	2	180	1.11	100.00

圖 6　黑鯛飼以含不同品牌酵母粉之配合飼料 8 週後之體重分佈圖

Fig. 6　Frequency bar chart of weight of black porgy fed diet containing different kinds of yeast powder after 8 weeks.

表16　黑鯛飼以不同品牌酵母粉飼料8週後體重量之T檢測

Table 16　T tests (LSD) for weight of black porgy fed diet containing different kinds of yeast powder after 8 weeks.

DIET Comparison	Lower Confidence Limit	Difference Between Means	Upper Confidence Limit	
7 — 8	— 4.374	0.620	5.614	
7 — 9	— 4.009	0.985	5.979	
7 — 10	— 3.222	1.772	6.766	
7 — 6	— 2.323	2.671	7.665	
7 — 1	4.920	9.914	14.908	***
7 — 3	4.953	9.947	14.941	***
7 — 5	5.063	10.057	15.051	***
7 — 2	5.101	10.095	15.089	***
7 — 4	5.102	10.096	15.089	***
8 — 7	— 5.614	— 0.620	4.374	
8 — 9	— 4.629	0.365	5.359	
8 — 10	— 3.842	1.152	6.146	
8 — 6	— 2.943	2.051	7.045	
8 — 1	4.300	9.294	14.288	***
8 — 3	4.333	9.327	14.321	***
8 — 5	4.443	9.437	14.431	***
8 — 2	4.481	9.475	14.469	***
8 — 4	4.482	9.476	14.469	***
9 — 7	— 5.979	— 0.985	4.009	
9 — 8	— 5.359	— 0.365	4.629	
9 — 10	— 4.207	0.787	5.781	
9 — 6	— 3.308	1.686	6.680	
9 — 1	3.935	8.929	13.923	***
9 — 3	3.968	8.962	13.956	***
9 — 5	4.078	9.072	14.066	***
9 — 2	4.116	9.110	14.104	***
9 — 4	4.117	9.111	14.104	***
10 — 7	— 6.766	— 1.772	3.222	
10 — 8	— 6.146	— 1.152	3.842	
10 — 9	— 5.781	— 0.787	4.207	
10 — 6	— 4.095	0.899	5.893	
10 — 1	3.148	8.142	13.136	***
10 — 3	3.181	8.174	13.168	***
10 — 5	3.291	8.285	13.279	***
10 — 2	3.329	8.323	13.317	***
10 — 4	3.329	8.323	13.317	***

表16　黑鯛飼以不同品牌酵母粉飼料8週後體重量之T檢測（續一）

Table 16　T test (LSD) for weight of black porgy fed diet containing different kinds of yeast powder after 8 weeks.

DIET Comparison	Lower Confidence Limit	Difference Between Means	Upper C Confidence Limit	
6 — 7	— 7.665	— 2.671	2.323	
6 — 8	— 7.045	— 2.051	2.943	
6 — 9	— 6.680	— 1.686	3.308	
6 — 10	— 5.893	— 0.899	4.095	
6 — 1	2.249	7.243	12.237	***
6 — 3	2.282	7.276	12.269	***
6 — 5	2.392	7.386	12.380	***
6 — 2	2.430	7.424	12.418	***
6 — 4	2.431	7.424	12.418	***
1 — 7	—14.908	— 9.914	— 4.920	***
1 — 8	—14.288	— 9.294	— 4.300	***
1 — 9	—13.923	— 8.929	— 3.935	***
1 — 10	—13.136	— 8.142	— 3.148	***
1 — 6	—12.237	— 7.243	— 2.249	***
1 — 3	— 4.961	0.033	5.027	
1 — 5	— 4.851	0.143	5.137	
1 — 2	— 4.813	0.181	5.175	
1 — 4	— 4.812	0.182	5.176	
3 — 7	—14.941	— 9.947	— 4.953	***
3 — 8	—14.321	— 9.327	— 4.333	***
3 — 9	—13.956	— 8.962	— 3.968	***
3 — 10	—13.168	— 8.174	— 3.181	***
3 — 6	—12.269	— 7.276	— 2.282	***
3 — 1	— 5.027	— 0.033	4.961	
3 — 5	— 4.883	0.111	5.104	
3 — 2	— 4.846	0.148	5.142	
3 — 4	— 4.845	0.149	5.143	
5 — 7	—15.051	—10.057	— 5.063	***
5 — 8	—14.431	— 9.437	— 4.443	***
5 — 9	—14.066	— 9.072	— 4.078	***
5 — 10	—13.279	— 8.285	— 3.291	***
5 — 6	—12.380	— 7.386	— 2.392	***
5 — 1	— 5.137	— 0.143	4.851	
5 — 3	— 5.104	— 0.111	4.883	
5 — 2	— 4.956	0.038	5.032	
5 — 4	— 4.956	0.038	5.032	

表 16　黑鯛飼以不同品牌酵母粉飼料 8 週後體重量之 T 檢測（續二）

Table 16　T tests (LSD) for weight of black porgy fed diet containing different kinds of yeast powder after 8 weeks.

DIET Comparison	Lower Confidence Limit	Difference Between Means	Upper Confidence Limit	
2 — 7	—15.089	—10.095	—5.101	***
2 — 8	—14.469	— 9.475	—4.481	***
2 — 9	—14.104	— 9.110	—4.116	***
2 —10	—13.317	— 8.323	—3.329	***
2 — 6	—12.418	— 7.424	—2.430	***
2 — 1	— 5.175	— 0.181	4.813	
2 — 3	— 5.142	— 0.148	4.846	
2 — 5	— 5.032	— 0.038	4.956	
2 — 4	— 4.993	0.001	4.994	
4 — 7	—15.089	—10.096	—5.102	***
4 — 8	—14.469	— 9.476	—4.482	***
4 — 9	—14.104	— 9.111	—4.117	***
4 —10	—13.317	— 8.323	—3.329	***
4 — 6	—12.418	— 7.424	—2.431	***
4 — 1	— 5.176	— 0.182	4.812	
4 — 3	— 5.143	— 0.149	4.845	
4 — 5	— 5.032	— 0.038	4.956	
4 — 2	— 4.994	— 0.001	4.993	

NOTE: a. This test controls the type I comparisonwise error rate not the experimentwise error rate.

b. Alpha = 0.05　Confidence = 0.95　df = 168　MSE = 57.58927
Critical Value of T = 1.97419　Least Significant Difference = 4.9939

c. Comparisons significant at the 0.05 level are indicated by " *** ".

d. *1 No 1 — 10 defined as :

1 : initial weight of T — 0 class　6 : final weight of T — 0 class
2 : initial weight of T — 6 class　7 : final weight of T — 6 class
3 : initial weight of M — 6 class　8 : final weight of M — 6 class
4 : initial weight of P — 6 class　9 : final weight of P — 6 class
5 : initial weight of C — 6 class　10 : final weight of C — 6 class

表17 黑鯛飼以不同品牌酵母粉飼料經8週後體重之Duncan's multiple range檢測

Table 17 **Duncan's multiple range test for weight of black porgy fed diet containing different kinds of yeast powder after 8 weeks.**

Duncan Grouping	Mean	N	DIET
A	56.443	18	7
A			
A	55.823	18	8
A			
A	55.458	18	9
A			
A	54.671	18	10
A			
A	53.772	18	6
B	46.529	18	1
B			
B	46.497	18	3
B			
B	46.386	18	5
B			
B	46.348	18	2
B			
B	46.348	18	4

NOTE: a. This test controls the type I comparisonwise error rate, not the experimentwise error rate.

b. Alpha = 0.05 df = 168 MSE = 57.58927

Number of Means	2	3	4	5	6
Critical Range	5.0251271	5.2842294	5.4509538	5.5762049	5.6816111
Number of Means	7	8	9	10	
Critical Range	5.7677628	5.8382562	5.8964663	5.9450642	

c. Means with the same letter are not significantly different.

d. *1 No 1 — 10 defined as :

1 : initial weight of T—0 class 6 : final weight of T—0 class
2 : initial weight of T—6 class 7 : final weight of T—6 class
3 : initial weight of M—6 class 8 : final weight of M—6 class
4 : initial weight of P—6 class 9 : final weight of P—6 class
5 : initial weight of C—6 class 10 : final weight of C—6 class

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摘 要

本試驗以台糖公司所生產之飼料用蔗糖酵母粉爲主體，研究其應用在水產飼料中之最適添加量，並與其他種類之酵母粉比較，藉以了解此等酵母粉對魚類成長、飼料效率、蛋白效率、魚體重量組成之影響。

經以本省重要之海水養殖魚類——黑鯛作爲試驗魚，經 8 週之飼育試驗，添加 6 %台糖酵母粉飼料之飼料係數約爲 3.16 ～ 3.56 ，較未添加者 3.86 ～ 4.58 爲佳。其蛋白效率比爲 0.74 ～ 0.89 ，較未添加者 0.58 ～ 0.66 爲優。此含量之飼料較其他含量者，成長較佳，體重組成亦較均勻。

飼料中添加 6 %蔗糖酵母粉飼育黑鯛，初期之成長率雖較添加啤酒酵母者差，但長期飼育時，則仍以蔗糖酵母爲佳。添加甜菜酵母或啤酒酵母者，雖亦有促進黑鯛成長之功效，但體重之組成之均勻度，却不如添加 6 %蔗糖酵母之飼料。

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