Microbial Treatment of Liquid from Mackerel Waste Juice*¹

Md. Abul Hossain,*² Masayuki Furuichi,*² and Yasuo Yone*²

(Received March 11, 1988)

Yeast *Saccharomyces cerevisiae* IFO 2114 was cultured in 25 l of 75% sea water containing liquid obtained from mackerel waste juice and molasses (WY) for 48 h, and (1) nitrogen and phosphorus contents in WY medium and (2) proximate and fatty acid compositions of the harvested yeast (WY yeast) were determined. The amount of harvested WY yeast was sufficient to feed rotifers (150×10^3 indiv./ton) for a day. Furthermore, the yeast reduced nitrogen and phosphorus contents in the medium to a level which was considered to be safe to discard. On the other hand, WY yeast was higher than yeast cultured in MY medium and baker's yeast and far lower than ω yeast and marine chlorella in lipid content and percentage of $\omega 3$ HUFA in total fatty acids.

In the previous study,¹⁾ yeast *Saccharomyces cerevisiae* IFO 2114 showed the best growth in 75% sea water containing 2.5% liquid from mackerel waste juice and 1.0% molasses (WY medium). Therefore, in the present study, in order to investigate the contribution of yeast culture to reduction of an environmental pollution caused by the discarding of the liquid, the yeast culture in sea water with the liquid was conducted on a large scale and nitrogen and phosphorus contents in the medium after cultivation were determined. Furthermore, the comparisons of proximate and fatty acid compositions were made among the yeasts cultured in WY medium (WY) and MY medium (MY),¹⁾ commercial baker's yeast (BY), ω -yeast (Kyowa Hakko Kogyo Co. Ltd., ω Y),²⁾ and marine chlorella *Chlorella minutissima*.

Materials and Methods

Liquid

The liquid obtained from mackerel waste juice in the previous study¹⁾ was used after sterilization.

Yeast Seed

Saccharomyces cerevisiae IFO 2114 cultured on a MY agar slant medium was inoculated into 500 ml of MY broth medium in a 1 l flask and was cultured at 28–30°C for 36 h by shaking in a water bath with reciprocal shaker.

Propagation and Harvest

Two 30 l polyvinyl tanks which were fitted up with a 100 watts heater and a motorized propeller of 2,000 rpm capacity were used for the propagation of yeast. Twenty five litres of MY medium was added in one tank and the same volume of 75% sea water containing 2.5% liquid and 1.0% molasses (WY medium) was added in the other. Yeast seed was inoculated at a rate of 5.0 million cells/ml to both tanks, respectively, and was cultured at 30°C for 48 h under stirring and strong aerating.

After culturing, yeast cells were counted by a hemacytometer. Then, the aeration and stirring were stopped for 4–5 h to deposit the cells at the bottom of culture tanks. The cells were siphoned out and centrifuged at 2,000 rpm for 10 min. Siphoning was done repeatedly until almost no cells were found in the culture medium microscopically. Finally harvested cells were weighed.

Analytical Methods

The determinations of nitrogen and phosphorus contents in media before and after cultivations of the yeast were done by the same methods as mentioned in the previous paper.¹⁾ The proximate and fatty acid compositions of cultured yeast were determined by the same methods as described in the previous studies,^{3,4)} except the column temperature of 175°C in fatty acid analysis.

*¹ Contribution from Fish. Res. Lab., Kyushu University, No. 174. Studies on Utilization of Fish Waste —8.

*² Fishery Research Laboratory, Kyushu University, Tsuyazaki, Fukuoka 811–33, Japan (モハメド アブル ホセイン, 古市政市, 米 康夫: 九州大学農学部附属水産実験所).

Results and Discussion

Growth of Yeast and Changes of Nitrogen and Phosphorus Contents in Medium

As shown in Table 1, WY yeast showed lower density and harvest than those of MY yeast. However, the amount of yeast required for 10⁶ rotifers is 1–1.5 g for a day. Therefore, the amount of yeast cultured in 25 l WY medium for 48 h (about 218 g) is sufficient as a feed for rotifers in 1 ton tank for a day or more, if rotifer density doesn't exceed 150 indiv./ml.³⁾

Table 1. Growth of yeast and changes of nitrogen and phosphorus contents in medium

Medium		MY	WY*
Density of yeast	at start	5.0	5.0
($\times 10^6$ cells/ml)	after 48 h	69.1	50.5
Yeast harvested	wet wt.	408.9	217.8
(after 48 h, g)	dry wt.	80.8	54.9
Total nitrogen	at start	188.2	162.1
($\mu\text{g atom/l}$)	after 48 h	20.3	11.2
Total phosphorus	at start	222.5	117.6
($\mu\text{g atom/l}$)	after 48 h	29.0	14.9

* Diluted sea water with liquid from mackerel waste (2.5%) and molasses (1.0%).

On the other hand, the nitrogen and phosphorus in MY and WY culture media decreased remarkably. Namely, the decreases of nitrogen were 89.2 and 93.1% of the initial contents, respectively, and the phosphorus were 87.0 and 87.3%.

These findings indicate that yeast utilizes the nitrogen and phosphorus in the liquid of fish waste as nutrient sources and that the yeast culture can decrease the pollution caused by the release of waste juice.

Proximate and Fatty Acid Compositions of Yeast Cultured

The proximate composition of WY yeast was different from those of BY yeast, MY yeast and ω yeast (Table 2). Namely, WY yeast showed low protein and high lipid contents as compared with BY and MY yeasts, but the protein content was higher than ω yeast and the lipid content was far lower. The fatty acid compositions of yeasts and marine chlorella are shown in Table 3. The percentage of $\omega 3$ highly unsaturated fatty acids with more than 20 carbons ($\omega 3$ HUFA) in total fatty acids of WY yeast was high as compared with those of MY and BY yeasts, but it was con-

Table 2. Proximate compositions of baker's yeast (BY), ω -yeast (ω Y), and yeasts cultured in MY and WY media

Yeast	BY	MY	WY	ω Y
Moisture (%)	66.8	76.8	75.5	61.9
Lipid* (%)	2.2	1.9	2.5	13.2
	(6.6)	(8.2)	(10.2)	(34.6)
Protein* (%)	17.0	11.4	10.9	15.4
	(51.2)	(49.1)	(44.5)	(40.4)
Ash* (%)	1.8	2.0	2.0	2.1
	(5.4)	(8.6)	(8.2)	(5.5)

* Values in parenthesis indicate % dry matter basis.

Table 3. Fatty acid compositions in lipids of yeasts cultured in MY and WY media, baker's yeast (BY), ω -yeast (ω Y) and marine chlorella

Fatty acid	Yeast				chlorella
	BY	MY	WY	ω Y	
12:0	0.1*	0.6	0.3	0.4	1.0
13:0	0.1	0.5	0.3	0.2	0.9
14:0	0.6	6.6	8.7	4.6	5.0
15:0	0.5	1.5	1.3	0.5	0.8
16:0	8.7	28.0	22.7	13.3	18.9
16:1 ω 7	22.7	14.8	7.0	4.8	22.2
18:0	7.8	6.4	7.0	2.7	0.3
18:1 ω 9	40.6	13.7	20.4	14.7	4.6
18:2 ω 9	0.9	tr	0.7	tr	—
18:2 ω 6	5.6	3.8	1.3	1.4	2.1
18:3 ω 3	tr	0.7	tr	1.2	—
20:1	3.2	1.9	1.2	7.3	—
20:1 ω 9	—	—	9.8	—	—
20:1 ω 7	0.8	0.1	0.2	tr	—
20:2 ω 9	1.0	0.3	0.1	2.1	—
20:2 ω 6	—	—	—	0.9	—
20:3 ω 3	—	—	—	0.3	0.8
20:4 ω 3	0.5	0.1	0.5	1.6	6.9
20:5 ω 3	—	0.9	1.4	10.6	28.9
22:1	0.5	1.8	8.7	8.2	—
22:4 ω 6	—	0.8	—	—	—
22:5 ω 6	—	—	2.0	2.6	—
22:5 ω 3	—	—	0.2	1.9	—
22:6 ω 3	—	—	0.6	15.3	—
$\Sigma \omega 3$ HUFA	0.5	1.0	2.7	29.7	36.6

* % in total fatty acids.

siderably lower than those of ω yeast and marine chlorella.

From these results, the nutritive value of yeast cultured in sea water containing the liquid from mackerel waste and molasses for 48 h (WY) seems to be higher than that of commercial baker's yeast, because of higher $\omega 3$ HUFA content. However, it is doubtful whether WY yeast is suitable to feed rotifers or not.

References

- 1) M. A. Hossain, M. Furuichi, and Y. Yone: *Nippon Suisan Gakkaishi*, **54**, 469–471 (1988).
- 2) O. Imada, Y. Kageyama, T. Watanabe, C. Kitajima, S. Fujita, and Y. Yone: *Nippon Suisan Gakkaishi*, **45**, 955–959 (1979).
- 3) Y. Yone, M. A. Hossain, M. Furuichi, and F. Kato: *Nippon Suisan Gakkaishi*, **52**, 549–552 (1986).
- 4) M. A. Hossain, M. Furuichi, and Y. Yone: *Nippon Suisan Gakkaishi*, **53**, 1629–1632 (1987).
- 5) T. Watanabe, T. Tamiya, A. Oka, M. Hirata, C. Kitajima, and S. Fujita: *Nippon Suisan Gakkaishi*, **49**, 471–479 (1983).