Propagation, Proximate and Fatty Acid Compositions of Rotifer *Brachionus plicatilis* Fed on Yeast Cultured in Sea Water Containing Liquid from Mackerel Waste Juice*¹

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(Received March 19, 1988)

Rotifer was fed on yeast (WY) cultured sea water containing liquid from mackerel waste juice, and its growth was compared with rotifer fed on commercial baker's yeast (BY). Furthermore, proximate and fatty acid compositions of rotifer reared with WY yeast were compared with those of rotifer reared with BY yeast, ω -yeast (ω Y) or marine chlorella. A similar density and harvest of rotifer were obtained by cultivation with both WY and BY yeasts. Rotifer fed on WY yeast showed higher ash content than that of rotifer fed on BY yeast, ω -yeast or marine chlorella, but similar moisture, protein, and lipid contents to the groups fed on BY yeast and marine chlorella. On the other hand, rotifer reared with ω -yeast showed high lipid and low protein contents as compared with those of rotifer reared with WY yeast, BY yeast or marine chlorella. The percentage of ω 3 HUFA in total fatty acids of lipid from rotifer reared with WY yeast was similar to that of BY group, but lower than that of ω Y and marine chlorella groups.

In the previous studies,^{1,2)} it was found that yeast *Saccharomyces cerevisiae* IFO 2114 grew well in 75% sea water containing 2.5% liquid (water soluble fraction) of juice from pressed mackerel waste and 1% molasses (WY medium),¹⁾ and enough yeast to feed rotifers in 1 ton tank (150-200 indiv./ml) for a day or more propagated with a moderate density in 15 l culture medium. However, the ω 3 HUFA*³ content of yeast (WY) cultured in the WY medium was far lower than that of ω -yeast (Kyowa Hakko Kogyo Co. Ltd., ω Y)³⁾ and marine chlorella *Chlorella minutissima*. Accordingly, it is doubtful whether WY yeast is suitable to feed rotifer or not.

In the present investigation, the growth of rotifer fed on WY yeast was compared with that of rotifer fed on commercial baker's yeast (BY). Furthermore, proximate and fatty acid compositions of rotifer fed on WY yeast were compared with those of rotifer fed on BY yeast, ω -yeast or marine chlorella.

Materials and Methods

Liquid

The water soluble fraction (liquid) of juice from pressed mackerel waste was obtained by the same

method as that described in the previous paper.¹⁾

Yeast Culture

Yeast *Saccharomyces cerevisiae* IFO 2114 was cultured in 75% sea water containing 2.5% liquid and 1% molasses in a 30 l tank under the same optimum conditions as those described in the previous paper.²⁾

Rotifer Seed

Rotifer *Brachionus plicatilis* fed on BY yeast was used as a seed. The density of rotifer seed was approximately 157 indiv./ml, with 33% fecundity (% of individual with egg).

Cultivation and Feeding

Two transparent polyvinyl tanks of 1 ton capacity were used to rear rotifer with WY or BY yeasts in a vinyl house. The tanks were filled with sand and cotton filtered sea water and aerated. Water temperature was maintained at 24-26°C. Rotifer seed in 51 l was strained out through 60 μ mesh plankton net and a half of the strained rotifer was divided into 2 tanks with equal wet weight, and consequently each tank got approximately 2 indiv./ml of rotifer. The remainder half of the strained rotifer was washed with water and cen-

*¹ Contribution from Fish. Res. Lab., Kyushu University, No. 175. Studies on Utilization of Fish Waste-9.

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*³ ω 3 highly unsaturated fatty acids.

Table 1. Growth and fecundity of rotifer fed on baker's yeast (BY) and yeast cultured in sea water containing liquid and molasses (WY)

Days	Yeast fed (g)		Density of rotifer (Indiv./ml)		Fecundity* (%)		Water temperature (°C)	
	BY	WY	BY	WY	BY	WY	BY	WY
0	40	40	2	2	33	33	23.9	24.0
1	40	40	17	15	26	21	25.0	25.0
2	40	40	21	20	17	19	25.5	25.2
3	40	40	31	32	27	31	25.7	25.8
4	50	50	40	37	25	28	25.5	25.6
5	75	75	64	69	32	38	26.0	26.0
6	120	120	103	131	35	42	26.1	26.0
7	180	180	156	175	49	41	26.2	25.9
8	220	220	212	209	35	48	26.1	26.0
9	350	350	290	303	40	37	26.0	26.0
10	420	420	351	378	29	31	26.1	26.1

* % of individual with egg.

trifuged at 2,000 rpm for 10 min, and weighed to calculate total amount of rotifer added to each tank.

A certain amount of yeast (WY or BY) was fed daily to rotifer twice a day depending on its density, as shown in Table 1. The density and fecundity of rotifer were counted daily after adding a few drops of formaline with a stereomicroscope and a plankton counting plate. The cultivation was continued for 11 days. Feces and suspended materials in the rearing tank were strained out through a polyvinyl sponge-mat hanged inside of a tank, and the sponge-mat was washed daily. After cultivation rotifer was harvested, washed, centrifuged and weighed.

Analytical Methods

Rotifer seed reared with BY yeast was further fed on ω -yeast (ω Y) or marine chlorella (C) for 10 days. Rotifers of ω Y and C were presented to the determination of proximate compositions together with WY and BY rotifers. The analytical methods were the same as those described in the previous study.⁴⁾ The fatty acid compositions of lipids in rotifers fed on yeasts and marine chlorella were also determined by the method mentioned previously,⁵⁾ except for 175°C column temperature in GLC operating conditions.

Results and Discussion

Growth

Both rotifers fed on WY and BY yeasts showed similar density and fecundity, as shown in Table 1. The harvest (total weight) of both rotifers at

Table 2. Proximate composition of rotifer fed on baker's yeast (BY), WY, ω -yeast (ω Y) and marine chlorella (C)

Composition	Feeds			
	BY	WY	ω Y	C
Moisture (%)	89.5	89.3	87.1	90.2
Lipid* (%)	1.9 (18.1)	2.1 (19.6)	3.7 (28.7)	2.2 (22.4)
Protein* (%)	7.0 (66.7)	7.2 (67.3)	7.1 (55.0)	6.9 (70.4)
Ash* (%)	0.5 (4.8)	1.1 (10.3)	0.6 (4.7)	0.6 (6.1)

* Values in parenthesis indicate weight % in dry matter basis.

the end of rearing were 410 g (WY yeast) and 395 g (BY yeast), respectively.

Proximate Composition

The proximate composition of rotifer fed on WY yeast showed higher ash content than that of rotifers fed on BY yeast, ω -yeast and marine chlorella, but similar moisture, protein and lipid contents to those of groups fed on BY yeast and marine chlorella (Table 2). On the other hand, rotifer reared with ω -yeast showed high lipid and low protein contents as compared with those of rotifers reared with WY yeast, BY yeast and marine chlorella.

Fatty Acid Composition

As shown in Table 3, the percentage of ω^3 HUFA in total fatty acids of lipid from rotifer reared with WY yeast was similar to that of BY group, but lower than those of rotifers reared with ω -yeast and marine chlorella.

Table 3. Fatty acid compositions in lipids of rotifers fed on baker's yeast (BY), WY, ω -yeast (ω Y) and marine chlorella (C)

Fatty acid	Rotifer fed on			
	BY	WY	ω Y	C
12:0	0.7	0.2	0.3	1.5
13:0	0.5	0.2	0.2	1.5
14:0	1.6	1.6	3.1	3.9
15:0	0.7	0.8	0.9	1.8
16:0	6.3	7.1	11.1	21.5
16:1 ω 7	18.3	17.5	13.7	10.2
18:0	5.4	5.7	6.8	3.7
18:1 ω 9	31.0	31.6	24.9	8.9
18:2 ω 6	8.9	7.9	2.6	4.9
18:2 ω 4	0.8	1.1	0.4	0.9
18:3 ω 3	1.2	1.4	1.3	1.4
20:1	4.5	5.5	6.7	2.6
20:2 ω 9	tr	0.8	0.4	0.7
20:2 ω 6	2.6	2.6	0.1	tr
20:3 ω 3	0.5	0.9	0.5	1.8
20:4 ω 3	1.1	1.2	1.2	4.4
20:5 ω 3	1.1	1.2	5.0	13.5
22:1	2.5	2.9	4.7	2.4
22:4 ω 6	1.1	0.7	1.5	2.4
22:5 ω 6	2.3	1.5	1.2	7.1
22:5 ω 3	—	0.4	1.6	—
22:6 ω 3	—	—	4.7	—
$\Sigma\omega$ 3 HUFA	2.7	3.7	13.0	19.7

In the present study, no difference in growth was found between the rotifers reared with WY

and BY yeasts. The proximate composition of rotifer fed on WY yeast was also similar to that of BY and marine chlorella groups. These findings indicate that WY yeast can be used as a feed for rotifer. However, the ω 3 HUFA content of rotifer fed on WY yeast was markedly low, which was due to the low content of ω 3 HUFA in WY yeast. The nutritive value of rotifer as a feed for fish larvae depends on the ω 3 HUFA content of rotifer.⁶⁾ Accordingly, it is necessary that WY yeast is supplemented with ω 3 HUFA or cultured secondarily with marine chlorella before it is fed to rotifer.

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