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CHANGES IN BODY PARAMETERS (LENGTH AND WEIGHT) OF THE FRY OF SELECTED FISH SPECIES UNDER THE EFFECT OF PRESERVATIVES

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A B S T R A C T. The effect of the preservatives (non-buffered and buffered formalin) on the changes of the length and weight of fry of carp, trout, pikeperch and pike was determined after 1, 2, 3, 4 and 14 days of preservation. The degree of Lt changes of fry preserved in non-buffered formalin was between 1.64% (pikeperch) and 5.01% (trout). Changes of the weight under the effect of this preservative were between 11.89% (pikeperch) and 17.07% (pike). The percentage changes of the length of fish preserved in buffered formalin were similar to changes of those preserved in non-buffered formalin, while the changes of the weight were definitely smaller.

Key words: PRESERVATION, FRY, CARP, TROUT, PIKEPERCH, PIKE.

INTRODUCTION

The objective of preservation is to stop post-mortem processes and to preserve organ and tissues so that their structure would resemble as accurately as possible the structure of alive matter. However, the preservation process is always connected with more or less deep changes of organism structure. The degree of these changes differs, depending on physical and chemical properties of the organism as well as on the composition of the preserving agents and the time of preservation.

The most common preservatives used in ichthyological studies are: formalin, AFA liquid and ethyl alcohol. Formalin is used most frequently. It has a lot of advantages such as: quick infiltration of tissues, low price and avaliblity on the market. However, it causes changes of the length and weight, amounting of from a few even to over a dozen percent (Chi Fu Yeh i Hodson 1975, Demska-Zakęś et al. 1992, Szczerbowski et al. 1992). Formalin available on the market is always polluted with different substances such as formic acid and methyl alcohol, so it has acidic pH

and affects the quality of preservation. It seems that utilisation of neutralised formalin would give better results of preservation.

It is very difficult to compare the results of several studies because of the variety of preservatives used , their concentration and different time of preservation. At the same time, correction factors allowing the results of studies to be more realistic were not worked out. It has to be stressed that the most of the studies on the effect of preservatives on fish point to changes in the length of body (Mamcarz 1984). So far there have been very little publications stressing the effect on weight.

In consequence of that it was decided to study changes of the length and weight of several fish species kept in formalin for 14 days and the effect of alternative preservative (buffered formalin) on the above mentioned changes. The relation between a fish size and a degree of swelling or shrinking would also be studied. The correction factors for the length and weight of preserved fish would be calculated.

MATERIALS AND METHODS

The studied materials were fry of rainbow trout (*Oncorhynchus mykiss Walb*), carp (*Cyprinus carpio L.*), pike (*Esox lucius L.*) and pikeperch (*Stizostedion lucioperca L.*). All of the species were represented by two size groups (A and B). The fry sample (10 specimen from every experimental group) was collected during its rearing in controlled conditions.

Fry length was measured from the jaw tip to the end of the caudal fin - longitudo totalis (Lt) with the accuracy up to 0.01 cm. Fish weight was determined with a laboratory scale, up to 0.01g.

Fish fry was killed right before the measurements. After that they were preserved in 4% formalin diluted with distilled water (FN) and in 4% formalin buffered with phosphate buffer (sodium phosphate II alkalinic 8g, unisodium phosphate 2g, 450 ml distilled water) (FB).

The observation of changes of the body parameters were undertaken after 1,2,3,4 and 14 days.

The average percent of changes of the body length in particular preserving agents were calculated based on this formula:

$$\%\ Lt\ changes = \frac{average\ (Lt)\ of\ alive\ fish - average\ length\ (Lt)\ of\ fish\ after\ preservation}{average\ length\ (Lt)\ of\ alive\ fish}$$

TABLE 1

Average body length (Lt) and weight (W) changes of the two size groups (A and B) of the fry during preservation with non-buffered formalin

* - alive fish weighed and measured

	Trout			Carp			Pike			Pikeperch		
	A	B	$\bar{x}$	A	B	$\bar{x}$	A	B	$\bar{x}$	A	B	$\bar{x}$
0*	3.57	4.47		4.86	5.51		2.23	5.46		4.53	6.97	
Lt (cm)	±0.23	±0.19		±0.24	±0.28		±0.12	±0.34		±0.28	±0.15	
after n 1	3.39	4.26		4.80	5.35		2.18	5.38		4.46	6.89	
days	±0.22	±0.20		±0.23	±0.27		±0.12	±0.34		±0.29	±0.18	
2	3.38	4.27		4.81	5.35		2.17	5.37		4.45	6.86	
	±0.22	±0.22		±0.23	±0.27		±0.11	±0.33		±0.29	±0.16	
3	3.38	4.26		4.79	5.35		2.17	5.36		4.46	6.86	
	±0.22	±0.22		±0.22	±0.27		±0.12	±0.34		±0.28	±0.16	
4	3.38	4.27		4.79	5.35		2.17	5.34		4.45	6.86	
	±0.22	±0.22		±0.23	±0.28		±0.11	±0.33		±0.28	±0.17	
14	3.38	4.26		4.78	5.33		2.17	5.36		4.46	6.85	
	±0.22	±0.22		±0.23	±0.28		±0.11	±0.33		±0.29	±0.16	
% of changes												
after 14 days	-5.32	-4.70	-5.01	-1.65	-3.27	-2.46	-2.69	-1.83	-2.26	-1.55	-1.72	-1.64
0*	0.42	1.00		1.61	2.70		0.055	0.99		0.54	1.85	
W (g)	±0.10	±0.14		±0.21	±0.54		±0.01	±0.19		±0.11	±0.16	
after n 1	0.49	1.13		1.81	3.03		0.067	1.16		0.63	2.11	
days	±0.11	±0.17		±0.25	±0.58		±0.01	±0.22		±0.13	±0.15	
2	0.49	1.13		1.81	3.05		0.069	1.15		0.62	2.06	
	±0.11	±0.16		±0.25	±0.58		±0.01	±0.21		±0.13	±0.16	
3	0.49	1.12		1.81	3.05		0.068	1.12		0.62	2.08	
	±0.11	±0.16		±0.24	±0.58		±0.01	±0.21		±0.13	±0.18	
4	0.49	1.12		1.81	3.05		0.067	1.12		0.61	2.05	
	±0.11	±0.16		±0.24	±0.58		±0.01	±0.21		±0.12	±0.17	
14	0.49	1.12		1.81	3.05		0.066	1.13		0.61	2.05	
	±0.11	±0.16		±0.24	±0.57		±0.01	±0.21		±0.13	±0.17	
% of changes												
after 14 days	16.67	12.00	14.34	12.42	12.59	12.51	20.00	14.14	17.07	12.96	10.81	11.89

Percent of changes in the fish weight was calculated similarly.

To represent the possibility of using calculated correction coefficients for the fish body length and weight, the Foulton's condition coefficients (K-1, K-2, K-3) for several samples of pikeperch fry preserved with FN and FB were calculated.

The length and weight of fry body measured when alive was taken into the consideration when coefficient K-1 was calculated. K-2 was calculated on measure-

ments of the same fish after the preservation, and for K-3 correction coefficient was used for Lt and W ($\bar{x}$ from table 1 and 2)

RESULTS

After 24 hours of preservation with FN of the rainbow trout fry (the A group) the average length (Lt) change was 5,04%, and after 14 days - 5,32%. The body weight was 16. 67% bigger, both after the first and the 14th day. The body length of the B group after one day of preservation decreased 0.21 cm (4.70%). After 14 days per cent of Lt changes had the same value and the body weight was 0.12 (12.00%) higher than the initial value (tab.1). The average per cent of changes of the body length for both groups was 5.01% and for the body weight was 14.34% (Fig. 1).

For the fish preserved with FB, 4.83% of length changes Lt and 7.09% of weight changes were observed. For the smaller specimens the body length increased 5.07% smaller and the body weight decreased 7. 32%. For the fry from the B group, 4.58% of the body length changes and 6.86% of the body weight changes were noted.

For the carp fry from the group A, average percent of body length changes were 1.65% (FN) and 2.00% (FB) after 14 days of preservation and of the body weight 12.42% and 6.74% respectively. At the same time, for fish from the group B the body length decreased 3.27% (FN) and 4.29% (FB) and the weight increased 12.59% and 9.31% bigger (tab. 1 and 2). Average percent of the body length changes for inter - group was 2.46% for the fish preserved with FN and the weight changes was 12.51% (Fig. 1). For the fish preserved with FB the average percent of changes was 3.15% and 8.03% respectively (Fig. 2).

For the pike fry the body length decreased 2. 69% smaller for the A group and 1.83% for the B group after 14 days of preservation. The average percent of the body length changes was 2.26% for both groups (Fig. 1). However, the average percent of the body length changes was 17.07% for studied size range of pike fry, and for the fish from the A group it was 20.00% and from the B group 14.14% (tab. 1). The changes of the body length were 3.59% for the fish from the A group preserved with FB. At the same time, changes of length Lt for the bigger fry were 1.85%. On the average for both groups the body length decreased by approximately 2.68%, while the body weight increased by 7.57% (Fig. 2) For the A group the average change of the body weight was 7.69%, and for the group B 7.44% (tab. 2).

TABLE 2

Average body lenght (Lt) and weight (W) changes of the two size groups of the fry during preservation with buffered formalin

* - alive fish weighed and measured alive

	trout			carp			pike			pikeperch		
	A	B	$\bar{x}$	A	B	$\bar{x}$	A	B	$\bar{x}$	A	B	$\bar{x}$
0*	3.55	4.59		4.99	5.36		2.23	5.40		4.37	7.22	
Lt (cm) af-	±0.23	±0.26		±0.29	±0.16		±0.10	±0.39		±0.31	±0.43	
ter n days 1	3.39	4.39		4.90	5.12		2.15	5.32		4.34	7.16	
	±0.22	±0.24		±0.28	±0.17		±0.09	±0.39		±0.28	±0.41	
2	3.38	4.38		4.90	5.13		2.16	5.32		4.34	7.12	
	±0.22	±0.25		±0.29	±0.15		±0.08	±0.39		±0.29	±0.41	
3	3.37	4.38		4.86	5.13		2.15	5.31		4.35	7.12	
	±0.21	±0.25		±0.31	±0.16		±0.09	±0.39		±0.29	±0.41	
4	3.38	4.38		4.87	5.15		2.15	5.30		4.33	7.12	
	±0.22	±0.26		±0.31	±0.15		±0.09	±0.39		±0.29	±0.42	
14	3.37	4.38		4.89	5.13		2.15	5.30		4.34	7.11	
	±0.22	±0.26		±0.30	±0.15		±0.09	±0.39		±0.29	±0.41	
% of changes												
after 14 days	-5.07	-4.58	4.83	-2.00	-4.29	-3.15	-3.59	-1.85	-2.68	-0.69	-1.52	-1.11
0*	0.41	1.02		1.78	2.47		0.052	0.94		0.48	2.11	
W (g)	±0.09	±0.14		±0.31	±0.31		±0.005	±0.17		±0.09	±0.38	
after n 1	0.44	1.10		1.89	2.65		0.055	1.02		0.53	2.26	
days	±0.09	±0.15		±0.34	±0.33		±0.004	±0.18		±0.10	±0.39	
2	0.45	1.10		1.90	2.68		0.057	1.01		0.53	2.31	
	±0.09	±0.15		±0.35	±0.33		±0.006	±0.18		±0.10	±0.39	
3	0.45	1.09		1.89	2.69		0.057	1.02		0.53	2.30	
	±0.09	±0.15		±0.34	±0.34		±0.006	±0.18		±0.10	±0.39	
4	0.44	1.09		1.88	2.69		0.057	1.01		0.53	2.29	
	±0.09	±0.14		±0.34	±0.34		±0.005	±0.18		±0.10	±0.39	
14	0.44	1.09		1.90	2.70		0.056	1.01		0.53	2.29	
	±0.09	±0.14		±0.34	±0.34		±0.005	±0.18		±0.10	±0.38	
% of changes												
after 14 days	7.32	6.86	7.09	6.74	9.31	8.03	7.69	7.44	7.57	10.42	8.53	9.48

For the smaller pikeperch fry the decrease of the body length by 1.55% was noted after 14 days of preservation, and the increase of the body weight by 12.96% (tab. 1). For the B group specimens the changes were similar - 1.72% (Lt) and 10.81% (the body weight). The average percent of changes for the body length was 1.64% and for the body weight - 11.89% for both groups (Fig. 1).

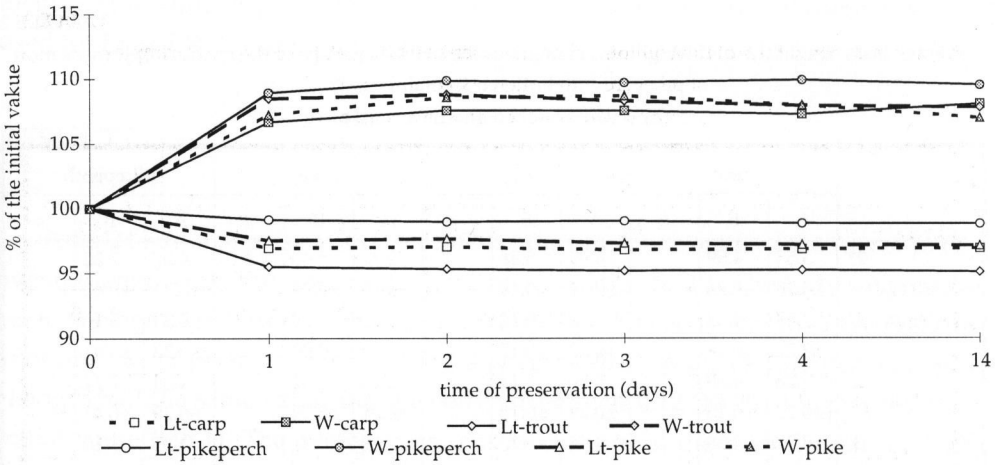

Fig. 1. Body length (Lt) and weight (W) changes of the studied fish species fry (groups A and B together) preserved with 4% non-buffered formalin

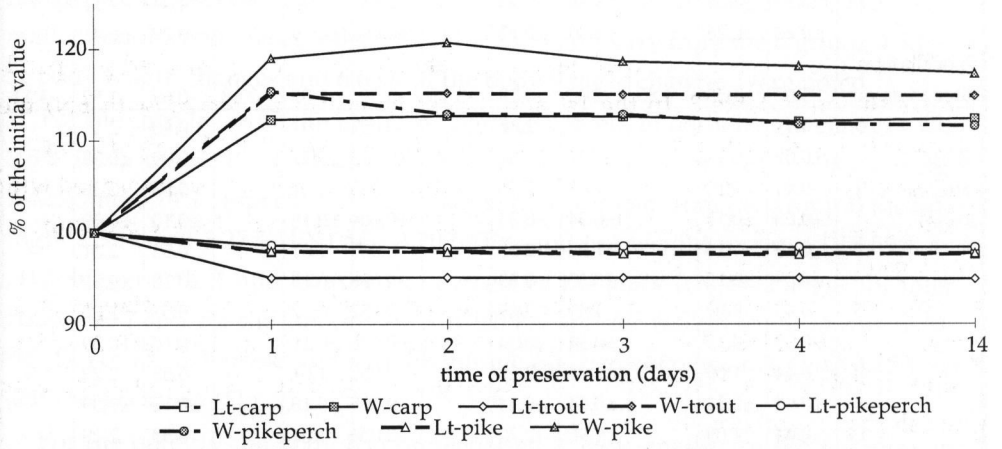

Fig. 2. Body length (Lt) and weight (W) changes of the studied fish species fry (groups A and B together) preserved with 4% buffered formalin

The body length of the pikeperch from the group A was 99.31% of the initial value after 14 days of preservation, and for the bigger fish it was 98.48%. For both studied groups the percents of changes was 1.11% (Lt) and 9.48% (the body weight) (Fig. 2). For the fry from the A group the increase of the body weight of 10.42% was noted after the first and the subsequent days of preservation. For the bigger fish the body weight increased on the average by 8.53% (tab. 2).

TABLE 3

Average values of the Foulton's condition coefficients calculated for several samples of pikeperch fry (full explanation is in the text)
* - percent value of K-2 and K-3 in relation to K-1

	K-1	K-2	%*	K-3	%*
1st sample (FN)	0.55 ±0.01	0.63 ±0.01	114.5	0.54 ±0.01	98.2
2nd sample (FN)	0.57 ±0.02	0.68 ±0.02	119.3	0.57 ±0.02	100.0
3rd sample (FB)	0.55 ±0.01	0.62 ±0.01	112.7	0.55 ±0.01	100.0
4th sample (FB)	0.57 ±0.02	0.64 ±0.03	112.3	0.56 ±0.02	98.2

The Foulton's condition coefficients calculated for alive and preserved pikeperch fry are shown in table 3. In the 1st and 2nd sample (fish preserved with FN) the increase of the K-2 coefficient in comparison to the K-1 was 0. 08 (14.5%) for the 1st sample and 0.11 (19.3%) for the 2nd. In the sample 3rd and 4th for fish preserved with FN the K-2 coefficient was 0.62 which was 112,7% of K-1 value (for the 3rd sample) and 0.64 (112.3%) for the 4th.

By using correction factors for the length and weight (tab 1, 2) for pikeperch fry preserved with FN the Foulton coefficient K-3 was 98.2% (0.54) and 100% (0. 57) of the values calculated for alive fish. The deviation of K-3 value from K-1 was the same for the fish preserved with FB.

DISCUSSION

Analysing the changes of body parameters of the studied preserved fish species it was observed that the most important deviations from the initial values were taking place during the first 24 hours (Fig. 1 and 2). All the other changes were minor and could be the result of measurement error. Parker (1963), Stobo (1972) and Lockwood (1973) as well as Dąbrowski and Bardega (1982), Glenn and Mathias (1987) had the similar observations.

Decrease of the body length with an increase of the weight was observed for all studied species preserved in both tested preservatives. But the deviation from the initial value of Lt and W was different not only for particular species but also for particular size groups.

The biggest change of the body length was noted for the smaller rainbow trout fry preserved in non-buffered formalin (5.32%). The smallest were for the pikeperch fry form the A group (1.55%). For the smaller pike fry as well as for the rainbow trout fry the deviation was bigger, while for the carp and pikeperch it was the opposite.

It is commonly stated that together with the increase of fish size the Lt changes are decreasing (Clutter and Whitesel 1956, Theilacker 1980, Glenn and Mathias 1987). Parker (1963) thinks that particularly for the small fish shortening of the body length caused by formalin is intensified by increased post-mortem changes.

In this study this effect was not observed. It can be presumed that the degree of body length changes depends more on the physical and chemical properties of the organism on the particular ontogenesis stage typical for the particular fish species. The tendencies for body length changes with non-buffered formalin were not accidental. The same dependence was obtained for the studied size groups of particular fish species with the use of buffered formalin.

For FB the biggest Lt deviation from its initial value was for the rainbow trout fry (4.83%) and the smallest was for the pikeperch. The same species preserved with non - buffered formalin also had the biggest and the smallest changes of Lt, although these changes were bigger than with FB - 5.01% for the trout and 1.64% for the pikeperch. The average Lt deviation for the trout fry were similar to *Clupea pallasi* larvae (Schnack and Rosenthal 1978) and *Oncorhynchus nerka* fry changes (Clutter and Whitesel 1956). However, the average per cent of Lt changes of pikeperch fry is similar to the values obtained for a year and two years old *Oncorhynchus nerka* preserved during 25 days (Clutter and Whitesel 1956). Examples quoted above are the studies done with 4% formalin. However if the 4% formalin was used and the same samples were kept in ethanol or the 10% formalin was used for the preservation, it is difficult to compare the results (Barsukov and Svetovidov 1966, Van Oosten 1929, Hile 1936 cit. after Mamcarz 1984), Engel 1974, Johnson and Svanson 1974, Chi Fu Yeh and Hodson 1975.

It was observed that by using the non-buffered formalin the highest increase of body weight tock place for pike (17.07%), especially the smaller fry of this species

(20.00%). The same was also noted for the smaller rainbow trout fry and pikeperch, while for the pikeperch the smallest changes were noted for the weight (11.89%) and the body length.

For the carp fry the deviations of the weight for both size groups were less differentiated than for the other species and a little higher for bigger fish, as the opposite for trout, carp and pikeperch. Similar tendencies were observed in samples preserved with buffered formalin. It has to be stressed that these changes were much smaller than with the FN. The highest per cent of changes after 14 days of preservation with FB was for the pikeperch (9.48%) and the smallest was for the rainbow trout (7.09%). The average deviation of the weight from the initial value for pikeperch was 7.57% and was 2.5 times smaller than in samples preserved with FN.

The changes of preserved fish body size have an impact on some indices, for example the condition coefficient (Engel 1974, Mamcarz 1984). According to Parker (1963) this coefficient for preserved fish can be 97 to 135% of alive fish value.

In the conducted studies the deviation of condition coefficient from the real values for the pikeperch fry were 116.9% for the fish preserved with FN and 112.5% for the ones preserved with FB.

Several authors were trying to find the proper correction factor which would make the results of studies more real. However, the changes of body parameters have different range for particular fish species preserved with formalin. According to this, correction factors can be worked out only for the particular species. By using the coefficients for the body length and weight for the pikeperch fry, the Foulton's condition coefficients were calculated at the level of 98.2 - 100% of the value calculated for alive fish.

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STRESZCZENIE

ZMIANY PARAMETRÓW CIAŁA (DŁUGOŚCI I MASY) NARYBKU WYBRANYCH GATUNKÓW RYB POD WPŁYWEM ŚRODKÓW KONSERWUJĄCYCH

Ustalono wpływ środków konserwujących (formaliny niebuforowanej i buforowanej) na zmiany długości i masy ciała narybku karpia, pstrąga, sandacza, szczupaka po 1, 2, 3, 4 i 14 dniach konserwacji. Stopień zmian długości całkowitej Lt narybku utrwalonego w formalinie niebuforowanej wahał się od 1,64% (sandacz) do 5,01% (pstrąg). Zmiany masy ciała ryb pod wpływem tego utrwalacza kształtowały się na poziomie 11,89% (sandacz) i 17,07% (szczupak).

W formalinie buforowanej procentowe zmiany długości ciała były zbliżone do wartości uzyskanych dla ryb utrwalonych w formalinie niebuforowanej. Natomiast zmiany masy ciała u wszystkich badanych gatunków były zdecydowanie mniejsze.

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