EVALUATION OF SLAUGHTERING VALUE OF COMMON CARP FROM DIALLEL CROSSING

HODNOCENÍ VÝTĚŽNOSTI KAPRA OBECNÉHO Z DIALELNÍHO KŘÍŽENÍ

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ABSTRACT: A four-year test of growth performance and offspring survival from diallel crossing of four common carp strains was terminated by biometrical evaluation and assessment of slaughtering value of edible parts in the respective strains according to Czech Standard No. 46 6802. Analysis of variance test revealed that the diallel crossing and thus the groups created had a highly significant effect on live weight ($P < 0.0005$) and processed body weight ($P < 0.0033$). No significant effect was found for the slaughtering value of edible parts ($P < 0.1219$). A comparative test of live weight and processed body weight revealed the highest mean live weight at $P < 0.05$ for Synthetic C435 Strain (2 697 g) and for C435 x ROP crossbred (2 734 g). Similarly, when evaluating the processed body weight, the highest mean weights were registered at $P < 0.05$ for BV x C435 (1 689 g), ROP x C435 (1 662 g), C435 x ROP (1 606 g) and ROP x BV (1 700 g) crossbreds and for C435 Strain (1 671 g). For the slaughtering value of edible parts, the highest percentage at $P < 0.05$ was registered for C435 x KOI, C435 x BV, BV x KOI, BV x C435, ROP x KOI, ROP x C435, ROP x BV crossbreds and for BV strain with values ranging from 63.14% to 65.39%.

Keywords: common carp *Cyprinus carpio*; slaughtering; diallel crossing

ABSTRAKT: Čtyřletý test se sledováním růstových schopností a přežití potomstva z dialelního křížení čtyř linií kapra obecného byl ukončen biometrickým hodnocením a testem výtěžnosti jedlých částí u sledovaných skupin podle ČSN 46 6802. Analýzou variance bylo zjištěno, že dialelní křížení (a jím vytvořené linie) mělo vysoce významný vliv na dosaženou živou hmotnost ($P < 0,0005$) a hmotnost trupu ($P < 0,0033$). Nebyl potvrzen vliv dialelního křížení, a jím vytvořených linií, na výtěžnost jedlých částí ($P < 0,1219$). Srovnávací test živých hmotností a hmotností opracovaného trupu ukázal, že nejvyšší hodnoty průměrné živé hmotnosti ($P < 0,05$) byly zjištěny u syntetické linie C435 (2 697 g) a u křížence C435 x ROP (2 734 g). Obdobně v případě hodnocení hmotnosti opracovaného trupu byly nejvyšší průměrné hmotnosti ($P < 0,05$) zjištěny u kříženců BV x C435 (1 689 g), ROP x C435 (1 662 g), C435 x ROP (1 606 g), ROP x BV (1 700 g) a u linie C435 (1 671 g). V případě výtěžnosti jedlých částí byl nejvyšší procentuální podíl ($P < 0,05$) zjištěn u kříženců C435 x KOI, C435 x BV, BV x KOI, BV x C435, ROP x KOI, ROP x C435, ROP x BV a u linie BV s hodnotami od 63,14 % do 65,39 %.

Klíčová slova: kapr obecný *Cyprinus carpio*; výtěžnost; dialelní křížení

INTRODUCTION

Breeding work in common carp culture can be dated back to 1574. Attention was paid to characteristics of regional breeds and strains mainly during the period of population genetics development in this country before World War II (Linhart and Flajšhans, 1996). Present state of common carp strains was reported by Pokorný *et al.* (1995). He described Ropsha Scaly Carp, Synthetic C435 Strain and South Bohemian Mirror Carp as characteristic strains of the 1990's.

The Ropsha Scaly Carp Strain (ROP), a dominant homozygote in scaliness genotype (SSnn) is characteristic by its lower body frame, regular scaling and lower Fulton's coefficient, with the following morphological characteristics: index of highbackedness (IH) 3.0–3.2, index of widebackedness (IW) 20.0–21.5, index of head length (IHL) 21.5–24.7, index of tail part length (ITPL) 17.9–23.0 and Fulton's coefficient (FC) 2.8–3.2. The slaughtering value according to CS No. 46 6802 without gonads ranged in 61.3–65.1% and with gonads in 61.7–69.1%. On the contrary, both the Synthetic C435 Strain and South Bohemian Mirror Carp (BV) are strains recessively homozygous in the genotype of scaliness (ssnn). The South Bohemian Mirror Carp was characterized morphologically as follows:

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IH 2.6–2.8, IW 18.4–20.5, IHL 24.8–26.6, ITPL 17.1–18.4, FC 2.4–3.2. The slaughtering value according to CS No. 46 6802 without gonads ranged in 60.6–63.7% and with gonads in 61.3–68.8%. The Synthetic C435 Strain was not characterized morphologically. Its slaughtering value according to CS No. 46 6802 without gonads ranged in 57.9–63.6% and with gonads in 62.5–68.7% (Pokorný *et al.*, 1995). The morphological characteristics of Koi carp from our culture is not known.

The goal of this study was to perform the final evaluation of the diallel crossing and of the slaughtering value of edible parts. The study is associated with previously published data on the growth and survival of common carp in a diallel crossing test (Gela and Linhart, 1996).

MATERIAL AND METHODS

For complete diallel crossing, the following common carp strains kept at the University of South Bohemia České Budějovice, Research Institute of Fish Culture and Hydrobiology at Vodňany, Department of Fish Genetics and Breeding were used: Ropsha Scaly Carp (ROP), Synthetic C435 Strain (C435), South Bohemian Mirror Carp (BV) and Japanese ornamental nishiki – koi carp (KOI). Strains were characterized according to Pokorný *et al.* (1995). Complete diallel crossing possessed 16 offspring groups, i.e. 4 purebreds and 12 crossbreds (Table 1). Artificial propagation, culture in the respective growing seasons, evaluation of growth, survival and heterosis effect was described by Gela and Linhart (1996).

Determination of slaughtering value

After autumn harvest of four years old carp, fish were morphologically characterized by biometric examination. Random samples of 10 fish from each offspring group were processed. The slaughtering value was assessed in the respective purebreds (BV, C435, ROP) and crossbreds (C435 x KOI, C435 x BV, BV x KOI, BV x C435, KOI x C435, ROP x KOI, ROP x C435, ROP x BV, C435 x ROP) according to Czech Standard No. 46 6802, reporting the slaughtering value as percentage of weight of the processed body without head, intestines, gonads, fins and scales in live fish weight. For the given weight class of common carp (Extra and the 1st Class), the minimum value is 57%. At the final testing, the following biometric traits were registered: fish live weight, total length, body length, length of body without the tail part, head length, body height and body width. Furthermore, other weight characteristics were registered as fish weight without fins, fish weight without scales, total weight of intestines, gonad weight, head weight, head weight without gills and processed body weight. Head was separated from the body by a circular cut in front of the pectoral fin girdle so that the fin girdle remained at the body. Pharyngeal teeth and occipital bone remained at the head (Pokorný, 1988). Blood and body fluids were included into the total weight of intestines. Gonad development was assessed macroscopically. Gonadosomatic index (GSI) was assessed as a ratio of gonad weight to fish live weight. Biometric traits were used for the following computations:

Index of highbackedness (IH) = body length / body height;

Index of widebackedness (IW) = 100 x body width / body length;

Index of head length (IHL) = 100 x head length / body length;

Index of volumetric value (IVV) = fish live weight (kg) x 100 / body length x body height x body width;

Index of tail part length (ITPL) = tail part length x 100 / body length;

Tail part length (TPL) = body length – length of body without the tail part

Fulton's coefficient (FC) = fish live weight / body length^3.

Statistical evaluation

Results are presented as mean values with standard deviations and/or standard errors. Analysis of variance test (ANOVA) with LSD test at $P < 0.05$ and assessment of diallel test effect and strain effect on the results were used in some cases. For statistical assessment of the percentage of slaughtering value, the original values were square rooted. Probability of $P < 0.05$ was taken as significant.

RESULTS

Results of biometrical characterization from fish of the diallel strain crossing with computations of indices and other values are given for mirror carp purebreds/ /crossbreds in Table 2 and for scaly ones in Table 3.

Table 1. Diallel crossing design with parental strains and offspring

♀ sex ♂	ROP	KOI	C435	BV
ROP	ROP	ROP x KOI	ROP x C435	ROP x BV
KOI	KOI x ROP	KOI	KOI x C435	KOI x BV
C435	C435 x ROP	C435 x KOI	C435	C435 x BV
BV	BV x ROP	BV x KOI	BV x C435	BV

Table 4 summarizes statistical evaluation of live weights, processed body weights and % of slaughtering value.

Statistical assessment revealed that diallel crossing and thus the purebreds/crossbreds have affected the live weight ($P < 0.0005$), as well as the processed body weight ($P < 0.0033$). No effect was found for the slaughtering value of edible parts ($P < 0.1219$).

A comparative test of live weight and processed body weight revealed the highest mean live weight for Synthetic C435 Strain (2 697 g) and for C435 x ROP crossbred (2 734 g). Similarly, when evaluating the processed body weight, the highest significant mean weights were registered for BV x C435 (1 689 g), ROP x C435 (1 662 g), C435 x ROP (1 606 g) and ROP x BV (1 700 g) crossbreds and for C435 Strain (1 671 g). For the slaughtering value of edible parts, the highest significant percentage at $P < 0.05$ was registered for C435 x KOI, C435 x BV, BV x KOI, BV x C435, ROP x KOI, ROP x C435, ROP x BV crossbreds and for BV strain with values ranging from 63.14% to 65.39%.

Results of biometrical characterization of the fish under study and computations of indices are presented below. The BV x ROP crossbred was not characterized due to 100% mortality of alevins during the nursery period.

Mirror carps (ssnn)

C435 x KOI crossbred

Four years old carp of 2 249 g mean live weight had the slaughtering value of 65.3%, GSI of ovaries was 9.4%. No males were found in the sample and no gonads were found in two specimens.

C435 x BV crossbred

Mean live weight was 2 271.5 g. Highly favorable slaughtering value of 63.14% was found compared to C435 and BV purebreds. High GSI was calculated for both females (8.85%) and males (10.07%). IH reached 2.48. Gonads were fully developed in all specimens and corresponded to fish age and seasonal time.

BV x KOI crossbred

Mean live weight of the crossbred was 1 954.0 g. Slaughtering value was 64.3%, GSI of females 5.92% and that of males 11.02%. Gonads were developed in all specimens, one ovary only was found in one female.

BV x C435 crossbred

Mean live weight of the crossbred was 2 662.8 g. Compared to both BV and C435 purebreds, this crossbred had a higher slaughtering value of edible parts, reaching 63.5%. A significant GSI was registered for both females (9.57%) and males (10.0%). IH was 2.56. Gonads were fully developed in all specimens and corresponded to fish age and seasonal time.

KOI x C435 crossbred

Mean live weight of the crossbred was 1 865.0 g. Slaughtering value was 62.32%, GSI of females 11.16% and that of males 7.95%. The gonads were not detected macroscopically in three specimens.

C435 purebred

Along with the higher mean live weight of specimens (2 695.6 g), slaughtering value of 62.07% was found lower compared to crossbreds, although exceeding the minimal value given in CS No. 46 6802. Female GSI of 14.33% indicated a possibility of high fecundity at the age of 4 years. Male GSI of 7.4% corresponded to fish age and season time. IH was 2.64. Gonads were developed in all specimens.

BV purebred

Four years old carp of 2 336.67 g mean live weight had the slaughtering value of 63.85%. GSI of females was 7.5% and that of males was 9.02%. IH was 2.67. Gonads were developed in all specimens.

KOI Purebred and KOI x BV Crossbred were not tested for slaughtering value.

Scaly carps (SSnn, Ssnn)

ROP x KOI crossbred

Along with the mean live weight of 2 267.86 g the slaughtering value was 64.63%, female GSI was 7.63% and male GSI was 9.51%. The gonads were not detected macroscopically in two specimens. IH of 2.93 showed a maternal effect.

ROP x C435 crossbred

Mean live weight was 2 640.0 g, slaughtering value was 63.03%, female GSI was 9.58% and male GSI was 8.1%. Gonads were fully developed in all specimens.

C435 x ROP crossbred

Mean live weight was 2 730.0 g, slaughtering value was 58.92%, i.e. 3.15% less than in C435 purebred and 2.68% less than in Ropsha carp purebred. Female GSI was 11.75% and male GSI was 10.72%. One female was found with one ovary only. Gonads of other specimens were fully developed.

ROP x BV crossbred

Mean live weight of the crossbred was 2 648.13 g. Slaughtering value was 64.2%, female GSI reached

Table 2. Mirror carp biometric data with calculation of index values (TPL – tail part length, IH – index of highbackedness, IW – index of widebackedness, IVV – index of volumetric value, IHL – index of head length, ITPL – index of tail part length, FC – Fulton's coefficient)

Biometric and index values		C435 x KOI		C435 x BV		BV x KOI		BV x C435		KOI x C435		C435		BV	
		mean	S.D.	mean	S.D.	mean	S.D.	mean	S.D.	mean	S.D.	mean	S.D.	mean	S.D.
Live weight	(kg)	2.249	0.37	2.27	0.41	1.954	0.40	2.66	0.50	1.865	0.38	2.70	0.27	2.34	0.47
Total body length	(mm)	483.4	29.48	473.82	3.99	477.5	31.94	503.78	24.21	466.8	43.59	515.89	16.63	494.00	38.05
Body length	(mm)	404	23.93	394.9	21.26	401.1	32.72	423.22	22.39	394.9	40.34	429.44	16.28	415.22	31.86
Body length without tail	(mm)	335.5	18.73	329.6	18.35	332	25.16	351.11	17.16	327	31.05	356.56	15.48	344.22	26.42
Head length	(mm)	104.2	5.90	104.2	7.11	101.3	9.17	112.11	10.73	105.3	7.14	108.67	5.07	105.89	10.67
Body height	(mm)	154.1	11.12	159	13.09	142.6	13.68	165.33	12.69	135	13.03	162.67	5.59	155.56	14.22
Body width	(mm)	82.5	5.95	83.6	6.35	76.6	6.85	88.00	7.40	74.9	5.83	90.33	4.53	82.44	5.34
Weight without fins	(g)	2 189	357.78	2 211.5	404.46	1 904	384.02	2 301.78	987.40	1 733.5	437.19	2 626.67	270.00	2 281.11	455.97
Weight without scales	(g)	2 177.2	358.82	2 200.5	403.03	1 885	383.54	2 577.78	484.40	1 711.5	424.51	2 607.78	269.79	2 256.56	451.61
Total weight of entrails	(g)	343.7	95.69	392.2	72.12	312.8	77.64	424.44	91.97	243	74.21	506.67	130.36	356.00	63.44
Head weight	(g)	376.5	54.83	390.5	67.92	321.5	84.49	405.33	172.99	318	66.00	438.33	42.65	407.78	88.60
Head weight without gills	(g)	316.1	45.45	302.5	53.29	463.3	632.30	382.22	90.90	261	61.00	358.89	43.86	345.33	78.36
Processed body weight	(g)	1 470.7	251.45	1 439	285.28	1 257	274.18	1 689.44	318.86	1 164.8	320.69	1 671.1	160.07	1 496.67	309.99
TPL		68.5	6.7	65.3	9.48	69.10	9.76	72.11	6.17	67.90	10.08	72.89	3.66	71.00	6.18
IH		2.67	0.14	2.48	0.16	2.81	0.35	2.56	0.12	2.93	0.17	2.64	0.10	2.67	0.12
IW		20.43	1.01	21.17	1.02	19.10	1.43	20.79	0.95	18.97	1.44	21.03	1.05	19.86	1.00
IVV		7 164.0	1 741.9	7 651.0	2 369.4	5 321.3	1 804.5	9 152.1	2 626.2	4 775.4	1 156.6	92 271	1 241.6	7 227.4	1 973.4
IHL		25.82	1.13	26.39	1.12	25.27		26.49	1.29	26.66	1.96	25.30	0.93	25.50	1.02
ITPL		16.96	0.99	16.54	2.09	17.23	1.49	17.04	0.77	17.19	1.10	16.97	0.87	17.10	0.61
FC		3.41	2.7	3.69	3.13	3.03	4.78	3.51	2.40	3.03	7.13	3.40	1.42	3.27	2.10
GSI of males	(%)	2.74	0.14	10.07	1.37	11.02	3.99	10.00	1.41	7.95	0.35	7.43	1.08	9.02	1.19
GSI of females	(%)	9.44	1.60	8.85	3.10	5.92	3.21	9.57	1.74	11.16	3.83	14.33	1.58	7.50	2.77
Slaughtering value	(%)	65.39	2.69	63.14	2.13	64.30	3.74	63.46	1.35	62.32	9.65	62.07	3.42	63.85	1.37

Table 3. Scaly carp biometric data with calculation of index values (TPL – tail part length, IH – index of highbackedness, IW – index of widebackedness, IVV – index of volumetric value, IHL – index of head length, ITPL – index of tail part length, FC – Fulton's coefficient)

Biometric and index values		ROP x KOI		ROP x C435		C435 x ROP		ROP x BV		ROP	
		mean	S.D.	mean	S.D.	mean	S.D.	mean	S.D.	mean	S.D.
Live weight	(kg)	2.27	0.70	2.64	0.33	2.73	0.74	2.65	0.63	2.35	0.58
Total body length	(mm)	495.43	27.57	534.10	12.80	519.67	43.97	539.63	40.97	529.56	32.72
Body length	(mm)	424.57	30.23	450.90	9.75	437.44	41.60	457.50	36.74	448.78	30.35
Body length without tail	(mm)	347.86	23.98	370.70	9.18	358.33	33.97	374.63	30.09	367.89	27.00
Head length	(mm)	99.00	12.62	106.60	5.82	107.67	8.75	107.00	9.15	103.22	6.74
Body height	(mm)	148.43	29.32	153.90	13.84	160.67	16.55	153.50	13.49	136.89	9.41
Body width	(mm)	80.14	12.92	86.40	6.19	89.00	9.84	83.50	7.67	82.89	8.80
Weight without fins	(g)	2 210.71	685.58	2 573.80	331.93	2 643.33	732.61	2 240.00	975.61	2 279.44	568.88
Weight without scales	(g)	2 119.29	650.81	2 465.30	311.98	2 525.00	704.25	2 466.25	596.88	2 194.78	544.41
Total weight of entrails	(g)	312.57	84.19	424.90	92.33	503.44	180.22	368.88	116.33	419.56	153.61
Head weight	(g)	340.71	105.85	390.00	52.44	422.78	103.23	405.63	87.56	345.78	80.65
Head weight without gills	(g)	292.14	93.54	324.00	46.89	350.00	84.08	341.63	75.97	275.44	67.04
Processed body weight	(g)	1 467.14	463.77	1 662.00	199.04	1 606.11	434.77	1 700.00	409.38	1 440.56	319.09
TPL		76.71	7.61	80.20	3.55	79.11	8.98	82.88	7.49	80.89	3.62
IH		2.93	0.43	2.95	0.26	2.73	0.13	2.98	0.09	3.28	0.16
IW		18.78	1.86	19.16	1.32	20.35	1.02	18.25	0.80	18.44	0.92
IVV		6 902.59	3 931.51	7 929.14	1 971.14	9 183.81	3 618.49	7 575.82	2 472.37	6 078.57	2 424.53
IHL		23.25	1.58	23.64	1.12	24.67	1.41	23.42	1.41	23.01	0.76
ITPL		18.05	0.91	17.79	0.76	18.08	1.00	18.11	0.66	23.01	0.76
FC		2.88	3.84	2.87	2.92	3.21	2.56	2.71	1.39	2.56	1.46
GSI of males	(%)	9.51	3.36	8.10	1.27	10.73	0	8.35	1.37	8.86	1.27
GSI of females	(%)	7.63	3.56	9.58	2.77	11.75	4.26	5.96	2.51	11.88	2.86
Slaughtering value	(%)	64.63	2.88	63.03	2.25	58.92	3.29	64.19	2.08	61.60	2.57

5.96% and male GSI was 8.35%. The gonads were not detected macroscopically in one specimens, while in all other specimen they were found fully developed.

KOI x ROP crossbred

At the mean live weight of 2 381.43 g, slaughtering value was 55.07%, female GSI was 11.69% and male GSI was 9.66%. This crossbred was the only one that did not meet the minimum slaughtering value required by the Czech Standard No. 46 6802. Gonads were fully developed in all specimens.

ROP purebred

These fish gained had the live weight of 2 237 g and a very good level of slaughtering value 65.34%. GSI of females was lower (6.39%) than that of males (8.28%). IH was 3.16, which was typical of this imported strain.

DISCUSSION

A four-year test of growth performance and survival of 12 common carp purebred/crossbred strains (Gela and Linhart, 1996) was terminated by biometrical characterization and by a test of slaughtering value of edible parts according to CS No. 46 6802. A low number of fish in samples, ranging from 8 to 10 specimens, was a negative factor of the test of slaughtering value. Analysis of variance test showed a highly significant effect of diallel crossing and thus of the respective purebred/crossbred strains on the final live weight, as well as on the processed body weight. On the contrary, no such effect was found for the slaughtering value of edible parts. This meant that the variation within the strains and between the strains was similar and that the strains did not influence the percentage of slaughtering value.

A comparative test of live weights and of processed body weights showed that the significantly highest mean live weight was registered for synthetic C435 mirror carp strain and for a C435 x ROP scaly crossbred where C435 was the maternal strain. In addition to these strains, assessment of the processed body weight showed positive results for another strains, viz. BV x C435 mirror crossbred, ROP x C435 and ROP x BV scaly crossbreds. The latter had the insignificantly highest processed body weight due to even 5% lesser female GSI, compared to all other strains. This crossbred may seem applicable for culture of big market carp of 2.5–3 kg weight, mostly for filleting purposes,

Table 4. Evaluation of slaughtering value from diallel crossing in common carp. Groups with a common superscript do not differ significantly ($P < 0.05$)

Offspring lines	Gain live weight (g)	Processed body weight	% of slaughtering value
	mean ± S.E.	mean ± S.E.	mean ± S.D.
C435 x KOI	2 249 abc ± 154.74	1 470 bc ± 103.46	65.39 b ± 2.69
C435 x BV	2 273 abcde ± 154.74	1 439 abc ± 103.46	63.14 b ± 2.13
BV x KOI	1 954 ab ± 154.74	1 244 ab ± 103.46	64.30 b ± 3.74
BV x C435	2 662 cdef ± 163.11	1 689 c ± 109.05	63.46 b ± 1.35
KOI x C435	1 878 a ± 147.54	1 173 a ± 98.64	62.32 ab ± 9.65
C435	2 697 def ± 163.11	1 671 c ± 109.05	62.07 ab ± 3.42
BV	2 340 bcdef ± 163.11	1 386 abc ± 109.05	63.85 b ± 1.37
ROP x KOI	2 270 abcd ± 184.95	1 467 abc ± 123.65	64.63 b ± 2.88
ROP x C435	2 640 cdef ± 154.74	1 662 c ± 103.46	63.03 b ± 2.25
C435 x ROP	2 734 df ± 163.11	1 606 c ± 109.05	58.92 a ± 3.29
ROP x BV	2 650 cdef ± 173.00	1 700 c ± 115.67	64.19 b ± 2.08
ROP	2 349 bcdef ± 163.11	1 441 abc ± 109.05	61.60 ab ± 2.57

as the crossbred seems to have the highest proportion of flesh. Both the female/male GSI influenced the slaughtering value of edible parts, as well as it might be affected by the female/male ratio in the random sample. In contrary to males, females mature 1 year later and they reach higher live weight (Hollebecq, Haffray, 1995). We can state that the female/male ratio in this test was rather balanced and that the higher value of processed body weight was influenced above all by low GSI and thus by a lower maturity stage in four years old ROP x BV crossbred.

Results of the biometrical characterization and of the slaughtering value complemented the recent data of Pokorný *et al.* (1995). In some strains the results differed from the reference, as it can be exemplified on C435 and ROP strains which had the index of high-backedness 2.64 ± 0.1 and 3.28 ± 0.16, respectively, compared to 2.1–2.3 and 3.0–3.2 mentioned for the respective strains by Pokorný *et al.* (1995). In the percentage of slaughtering value with gonads we have never reached a higher record than 65.4% contrary to values of 68.8% for BV, 68.7% for C435 or 69.1 % for ROP (Pokorný *et al.*, 1995). For ROP, the lowest data of slaughtering value were recorded (61.6 ± 2.57%) compared to purebred mirror carp strains, as well as to the reference (61.7–69.1%, Pokorný *et al.*, 1995). The higher values given in the reference are probably characteristic of younger fish.

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REFERENCES

Gela D., Linhart O. (1996): Diallel crossing in growth and survival tests of common carp (*Cyprinus carpio* L.). Bull. VÚRH Vodňany, *32*: 148–161.

Hollebecq M. G., Haffray P. (1995): Amélioration génétique. In: Billard R. (ed.): Les carpes biologie et élevage. Paris, INRA: 125–147.

Linhart O., Flajšhans M. (1996): Genetics research of common carp, tench and wels, and conservation of fish gene resorces and breeding reserves in the Czech Republic. In: Flajšhans M. (ed.): Proc. Scientific Papers to the 75th Anniversary of Foundation of the Research Institute of Fish Culture and Hydrobiology, Vodňany: 22–33.

Pokorný J. (1988): Výtěžnost a podíl hlavních částí těla u některých aborigenních a importovaných populací kapra. Bull. VÚRH Vodňany, *24*: 10–17.

Pokorný J., Flajšhans M., Hartvich P., Kvasnička P., Pružina I. (1995): Atlas kaprů chovaných v České republice. Praha, Victoria Publishing, a.s. 69 p.

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