花鱊和唇鱊的含肉率及肌肉营养成分分析

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摘要: 利用国内外通用的营养测试方法测定了花鱊(*Hemibarbus maculates*)和唇鱊(*Hemibarbu labeo*)的含肉率和肌肉营养成分。结果表明: 花鱊和唇鱊含肉率分别是 70.61%、71.52%; 花鱊肌肉(鲜样)中蛋白质(18.41%)和脂肪含量(2.46%)显著高于唇鱊的, 而花鱊的灰分含量要显著低于唇鱊; 水分含量分别是 78.35%、78.51%, 两者无显著差异。花鱊和唇鱊肌肉中脂肪酸种类丰富, 饱和脂肪酸(SFA)4 种, 不饱和脂肪酸(UFA)7 种; 其中单不饱和脂肪酸(MUFA)4 种, 多不饱和脂肪酸(PUFA)3 种; 其中 DHA 含量高达 5.00%和 14.32%。花鱊和唇鱊肌肉中的氨基酸总量分别是 63.07%和 67.63%, 呈味氨基酸分别为 25.96%和 26.30%。缬氨酸、蛋氨酸和胱氨酸为限制性氨基酸。

关键词: 花鱊; 唇鱊; 含肉率; 肌肉营养成分
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花鱊(*Hemibarbus maculatus*)和唇鱊(*Hemibarbu labeo*)隶属鲤科, 鱊亚科, 鱊属, 花鱊俗称杨花鱼, 唇鱊俗称竹鱼。除了新疆、青藏高原和西部高原外, 其广泛分布于我国的各大水系。一般生活在流速较大, 沙石底质的水域中下层, 以水栖昆虫的幼虫及蠕虫等底栖动物为主要饵料。目前, 已有不少学者从形态、分类、分布[1]、繁殖和早期发育[2—7]等方面对花鱊和唇鱊进行了研究, 但是对其含肉率和肌肉组成成分的分析比较迄今未见报道。为此, 作者测定分析了瓯江唇鱊和花鱊的含肉率和肌肉营养成分和营养品质, 旨在充实鱼类营养学资料, 为唇鱊和花鱊人工饲料的研制和推广养殖提供理论依据。

1　材料与方法

1.1　材料鱼　2006 年 3 月从浙江省丽水市莲都区碧湖鱼塘随机采集二冬龄唇鱊 13 尾, 体重(40.17±6.04) g, 体长(13.59±2.38) cm。同期, 从浙江省丽水市云和县紧水滩水库网箱采集二冬龄花鱊 13 尾, 体重(48.54±5.23) g, 体长(16.81±1.48) cm。

1.2　分析方法

含肉率的测定　吸干鱼体表水分, 依此测定体长、体重。按常规方法解剖分离性腺、内脏、鳃、皮肤和鳞、鳍和骨骼等非肉质部分, 分别称重。骨骼在称重前要进行处理, 将全部骨骼在水中煮, 水沸腾后, 取出骨骼, 清洗除去附作物, 自然干燥, 称重。用减重法计算出鱼肉部分重量。鱼肉部分重量占鱼体重百分比称为含肉率[8]。

样品制备　取 10 尾花鱊和唇鱊的背部鱼肉捣碎, 混合均匀, 保存在－86 ℃超低温冰箱(型号为 TH-86-340-LA)中备用。

常规营养成分测定方法　水分测定采用恒温烘干法 (100—105 ℃)[9], 蛋白质测定采用半微量凯氏定氮法[9], 灰分测定采用马福炉灼烧法(550 ℃)至恒重测定[9], 脂肪测定采用甲醇一氯仿法作为溶剂的索氏抽提法[10]。

脂肪酸的测定　在常温下, 称取适量的肌肉样品, 放入组织捣碎机中搅碎, 干燥样品用苯-石油醚(体积比为 1∶1) 提取脂肪后, 用 0.4 mol/L 氢氧化钾-甲醇液酯化 30min, 然后经热水浴浓缩, 再加水分层, 取上层液在 Thermo Quest GC/MS 型气相色谱-质谱联用仪上测定分析, 按面积归一化法计算脂肪酸各组分的含量[11]。

氨基酸的测定　采用盐酸水解法对样品进行预处理: 将样品烘干→索氏抽提法脱脂→烘干粉碎→放入试管, 加入 6.0 mol/L 分析纯盐酸, 经超声和抽

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真空后封口→110℃烘箱内水解24h→放入蒸发皿蒸干→移入容量瓶定容过滤→上机分析。所用仪器为日立835-50型氨基酸自动分析仪。

1.3 营养品质评价方法 根据FAO/WHO(粮食与农业组织/世界卫生组织)1973年建议的氨基酸评分标准模式(%, dry)[12]和全鸡蛋蛋白质的氨基酸模式(%, dry)[13]分别按以下公式计算氨基酸评分(AAS)和化学评分(CS):

$$AAS = aa / AA\ (FAO/WHO)$$

$$CS = aa / AA\ (Egg)$$

式中: aa为实验样品氨基酸含量(%), AA(FAO/WHO)为FAO/WHO评分标准模式中同种氨基酸含量(%), AA(Egg)为全鸡蛋蛋白质中同种氨基酸含量(%)。

1.4 数据处理 采用SPSS 11.5软件对实验数据进行相关小样本均数差异显著性T-检验, $p<0.05$为差异显著性标准。

2 结 果

2.1 花鳉和唇鳉的含肉率

从表1可见,唇鳉的含肉率略高于花鳉,两者含肉率差异不显著。

表1 花鳉和唇鳉的含肉率及肌肉营养成分(平均值±标准误)

Tab. 1 Dressing rate and Nutritional composition of muscle in *Hemibarbus maculate* and *Hemibarbus labeo* (Mean±SD. %, wt)

种 类 Species	含肉率 Dressing rate (n=3)	肌肉营养成分 Approximate composition of muscle (n=10)			
		水分 Moisture	粗蛋白 Crude protein	粗脂肪 Crude lipid	灰分 Ash
花鳉 *Hemibarbus maculate*	70.61±1.21	78.35±0.21	18.41±0.42[a]	2.46±0.08[a]	0.75±0.05[a]
唇鳉 *Hemibarbus labeo*	71.73±3.07	78.51±0.30	17.73±0.34[b]	1.96±0.10[b]	1.69±0.09[b]

2.2 常规营养组分含量

表1显示,花鳉和唇鳉肌肉中蛋白、脂肪和灰分含量差异显著,水分含量差异不显著。花鳉鱼肉的蛋白质和脂肪含量比唇鳉分别高0.68%($p<0.05$)和0.50%($p<0.05$),而灰分含量较之低0.94%($p<0.05$)。

2.3 脂肪酸组成

花鳉和唇鳉肌肉中主要含有11种脂肪酸(表2),饱和脂肪酸(SFA)4种,不饱和脂肪酸(UFA)7种;其中单不饱和脂肪酸(MUFA)4种,多不饱和脂肪酸(PUFA)3种。花鳉和唇鳉多不饱和脂肪酸分别占肌肉脂肪酸的19.50%、30.46%。花鳉的单不饱和脂肪酸中,$C_{18:1}$含量最高,为38.09%,其次为$C_{16:1}$和$C_{18:1n7}$,$C_{22:1}$含量最低;唇鳉的单不饱和脂肪酸中,$C_{18:1}$含量最高,为25.31%,其次为$C_{16:1}$和$C_{18:1n7}$,$C_{22:1}$含量最低。唇鳉的油酸($C_{18:1}$)和单不饱和脂肪酸(∑MUFA)总量的含量比花鳉分别低12.78%($p<0.05$)和12.66%($p<0.05$),但肉豆蔻酸($C_{14:0}$)、($C_{15:0}$)、硬脂酸($C_{18:0}$)、芥酸($C_{22:1}$)、亚油酸($C_{18:2}$)、二十二碳六烯酸($C_{22:6}$(DHA))和多不饱和脂肪酸(∑PUFA)总量的含量分别高0.58%($p<0.05$)、0.07%($p<0.05$)、0.76%($p<0.05$)、0.65%($p<0.05$)、2.51%($p<0.05$)、9.32%($p<0.05$)和10.96%($p<0.05$)。

表2 花鳉和唇鳉肌肉中脂肪酸组成(平均值±标准误, n=10)

Tab. 2 Fatty acid composition of muscle in *Hemibarbus maculates* and *Hemibarbus labeo* (Mean±SD, n=10)

脂肪酸 Fatty acids	花鳉 *Hemibarbus maculate*	唇鳉 *Hemibarbus labeo*
肉豆蔻酸($C_{14:0}$)	1.61±0.06[b]	2.19±0.06[a]
十五烷酸($C_{15:0}$)	0.42±0.01[b]	0.49±0.01[a]
棕榈酸($C_{16:0}$)	21.29±0.54	21.58±0.33
硬脂酸($C_{18:0}$)	4.78±0.12[b]	5.54±0.04[a]
饱和脂肪酸(∑SFA)	28.10±0.70	29.80±0.35
棕榈油酸($C_{16:1}$)	9.62±0.25	8.85±0.23
油酸($C_{18:1}$)	38.09±0.45[a]	25.31±0.03[b]
油酸($C_{18:1n7}$)	3.17±0.06	3.40±0.11
芥酸($C_{22:1}$)	1.53±0.02[b]	2.18±0.07[a]
单不饱和脂肪酸(∑MUFA)	52.40±0.66[a]	39.74±0.38[b]
亚油酸($C_{18:2}$)	10.61±0.04[b]	13.12±0.06[a]
花生四烯酸($C_{20:4}$)	3.89±0.30	3.02±0.08
二十二碳六烯酸($C_{22:6}$(DHA))	5.00±1.12[b]	14.32±0.70[a]
多不饱和脂肪酸(∑PUFA)	19.50±1.37[b]	30.46±0.72[a]

2.4 氨基酸组成

从表3可见,唇鳉肌肉中(干物质)氨基酸总量、必需氨基酸总量、半必需氨基酸总量、非必需氨基酸

总量和呈味氨基酸总量分别比花鳽的高 4.57%、2.21%、1.40%、0.95%和 0.34%。花鳽比唇鳽肌肉中 TEAA/TTAA 和 TEAA/TNEAA 分别低 0.35%和 4.28%。除了天门冬氨酸和甘氨酸之外, 花鳽肌肉中(干物质)氨基酸的氨基酸含量全都低于唇鳽。

通过评价 AAS, 可以确定花鳽和唇鳽的第一限制性氨基酸为缬氨酸, 第二限制性氨基酸为蛋氨酸+胱氨酸。而评价 CS, 花鳽和唇鳽的第一限制性氨基酸蛋氨酸+胱氨酸, 第二限制性氨基酸为缬氨酸。

表 3　花鳽和唇鳽肌肉中氨基酸组成

Tab. 3　Composition of amino acid of muscle in *Hemibarbus maculates* and *Hemibarbus labeo* (n= 10)

氨基酸 Amino acids	花鳽 *Hemibarbus maculate*	唇鳽 *Hemibarbus labeo*
天门冬氨酸(Asp)	6.86	6.72
苏氨酸(Thr)	3.15	3.26
丝氨酸(Ser)	2.88	2.92
谷氨酸(Glu)	11.55	11.88
脯氨酸(Pro)	2.39	2.75
甘氨酸(Gly)	3.60	3.47
丙氨酸(Ala)	3.95	4.23
胱氨酸(Cys)	0.34	0.48
精氨酸(Arg)	3.38	4.10
缬氨酸(Val)	2.81	3.11
蛋氨酸(Met)	1.89	2.03
异亮氨酸(Ile)	2.96	3.29
亮氨酸(Leu)	5.54	6.01
酪氨酸(Tyr)	2.24	2.45
苯丙氨酸(Phe)	2.80	3.10
组氨酸(His)	1.47	2.05
赖氨酸(Arg)	5.26	5.78
氨基酸总量	63.07	67.63
呈鲜味氨基酸总量	25.96	26.30
必须氨基酸总量(TEAA)	27.29	29.50
半必须氨基酸总量(TTAA)	4.85	6.25
非必须氨基酸总量(TNEAA)	30.93	31.88
TEAA/TTAA	43.27%	43.62%
TEAA/TNEAA	88.23%	92.53%

3　讨　论

含肉率是衡量鱼类品质、生产性能的重要指标之一, 它因鱼的种类、品种、生活环境、饲料的不同而异。唇鳽和花鳽的含肉率与厚颌鲂[14] (*Megalobrama pellegrini*) (72.72%) 和黑尾近红鳽[15] (*Ancherythroculter nigrocauda* Yih et wu) (70.74%) 相近, 均高于鳜鱼[16] (*Siniperca chuatsi*) (67.62%)、黄颡鱼[17] (*Pelteobagrus fulvidraco*) (67.53%) 和异育银鲫[18] (*Allogyogenetics silver crucian carp*) (51.94%)。这说明唇鳽和花鳽是含肉率较高的鱼类。

鱼肉的营养价值主要决定于鱼肉蛋白质和脂肪含量的多少。唇鳽和花鳽的粗蛋白除了比光倒刺鳽[19] (*Spinibarbus holland*) (20.60%) 低外, 比厚颌鲂[14] (16.82%)、鳜鱼[20] (16.75%) 和鳙鱼[21] (*Aristichthys nobilis*) (16.95%) 都高。花鳽的粗脂肪含量要高于厚颌鲂[14] (2.10%)、鳜鱼[20] (1.50%)、鳙鱼[21] (0.74%) 和唇鳽 (1.96%), 低于光倒刺鳽[19] (3.05%)。而鱼肉的蛋白和脂肪含量与鱼类的生活环境, 个体大小和饲料状况有很大关系。所以可以说 30—80 g 的唇鳽和花鳽具有较高的营养价值。

食物蛋白质营养价值的高低, 主要取决于所含必需氨基酸的种类、数量和组成比例。根据测定氨基酸含量和 FAO/WHO 评分标准模式分别计算出花鳽和唇鳽的氨基酸评分 (AAS)、化学评分 (CS) (表 4)。从表 4 可见, 根据氨基酸评分时, 花鳽和唇鳽肌肉的第一限制氨基酸是缬氨酸, CS 评价则是蛋氨酸与胱氨酸。其他各必需氨基酸的 AAS 接近或大于 1, CS 均大于 0.5。动物蛋白质的鲜美在一定程度取决于其鲜味氨基酸 (Glu、Asp、Gly、Ala) 的含量。鲜味氨基酸中的 Glu、Asp 为呈鲜味的特征性氨基酸, 其中 Glu 的鲜味最强; 而 Gly、Ala 是呈甘味的特征性氨基酸。唇鳽和花鳽的鲜味氨基酸总量除低于鳜鱼[21] 外, 均高于异育银鲫[17] 和鳙鱼[21]。这说明唇鳽和花鳽是营养丰富, 口味鲜美的鱼类。

表 4　花鳽和唇鳽肌肉中必需氨基酸组成的评价

Tab. 4　Essential amino acid profile of muscle in *Hemibarbus maculates* and *Hemibarbus labeo*

必需氨基酸 Essential amino acid	氨基酸含量(mg/g 蛋白)		AA 分 AAS		化学分 CS	
	花鳽	唇鳽	花鳽	唇鳽	花鳽	唇鳽
亮氨酸	65.2	72.8	93.1	104.1	75.8	84.7
异亮氨酸	34.8	39.9	87.1	99.6	64.5	73.8
缬氨酸	33.1	37.7	66.1	75.4	50.1	57.1
苏氨酸	37.1	39.5	92.6	98.8	78.8	84.1
赖氨酸	61.9	70.1	112.5	127.4	88.4	100.1
蛋氨酸+胱氨酸	26.2	30.4	75.0	86.9	46.0	53.4
苯丙氨酸+酪氨酸	59.3	67.3	98.8	112.1	63.8	72.3

脂肪是加热产生香气成分不可缺少的物质，尤其是高含量的PUFA能显著地增加香味，同时在一定程度上反映肌肉的多汁性[22]。花鳉和唇鳉是多不饱和脂肪酸占鱼肉脂肪酸的19.50%和30.46%。鱼类通过食物链的富集作用，可以把EPA与DHA在体内积聚起来，随着其药理作用和临床应用的研究发现，EPA和DHA已被称为人和动物生长发育的必需脂肪酸[23]。花鳉和唇鳉的DHA质量分数分别为5.00%和14.32%，高于鲤鱼[21]（*Cyprinus carpio*）（0.29%）、鳙鱼（0.072%）[21]、斑驳尖塘鳢[24]（*Oxyeleotris marmoratus*）（4.74%）、中华绒螯蟹[25]（*Eriocheir sinensis*）（2.87%）、低于紫红笛鲷[26]（*Lutjanus argentimaculatus*）（28.3%）白斑篮子鱼[26]（*Siganus canaliculatus*）（23.9%）、点篮子鱼[26]（*Siganus guttatus*）（13.4%）、黄点鲹[26]（*Caranx fulvoguttatus*）（27.6%）和牙鲷[27]（*Diplodus sargus*）（27.50%）。这说明花鳉和唇鳉有较高的食用价值与保健作用。

参考文献：

[1] Mao J R, Xu S S. Zhejiang Province annals: Freshwater fishes [M]. Hangzhou: Zhejiang Science and Technology Publishing House. 1991, 116 [毛节荣，徐寿山. 浙江动物志-淡水鱼类. 杭州：浙江科学技术出版社. 1991, 116]

[2] Gan G M, Zhang Y G. The solicitation mechanism of the cortical reaction in *Hemibarbus labeo* egg [J]. *Acta Hydrobiologica Sinica*, 2005, **29**(5): 479—487 [甘光明，张耀光. 唇鳉受精卵的皮层反应及其引发机制. 水生生物学报, 2005, **29**(5): 479—487]

[3] Gan G M, Zhang Y G, Zhang X F, *et al*. Cytological study on fertilization in of *Hemibarbus labeo* [J]. *Acta Hydrobiologica Sinica*, 2006, **30**(3): 284—290 [甘光明，张耀光，张贤芳，等. 唇鳉受精的细胞学研究. 水生生物学报, 2006, **30**(3): 284—290]

[4] Lu H F, Li Z Q, Fang M J, *et al*. A primary study on the biological characteristics and artificial breeding of *Hemibarbus maculates* Bleeker in pond [J]. *Journal of Zhejiang Ocean University* (Natureal Science), 2004, **23**(3): 211—213 [陆红法，李智强，方美娟，等. 花鳉的生物学特性和人工繁殖初步研究. 浙江海洋学院学报, 2004, **23**(3): 211—213]

[5] Lin Z H, Lei H Z, Lin Z Y, *et al*. Sexual dimorphism and female reproductive output of *Hemibarbus maculates* [J]. *Journal of Shanghai Jiaotong University* (Agriculture Science), 2005, **23**(3): 284—288 [林植华，雷焕宗，林植云，等. 花鳉的两性异形和雌体繁殖输出. 上海交通大学学报(农业科学版), 2005, **23**(3): 284—288]

[6] Gong S Y, Jiang H, Xu Y M. The feeding habits of the *Hemibarbus maculates* in lake Nan Hu, Wu Chang [J]. *Journal of Huazhong Agricultural University*, 1989, **8**(4): 395—398 [龚世园，江辉，徐印鸣. 武昌南湖花婿食性的研究. 华中农业大学学报, 1989, **8**(4): 395—398]

[7] Gong S Y, Ku Y M, Liang K X. A study of individual fecundity of the *Hemibarbus maculates* (bleeker) in south lake Wuchang [J]. *Journal of Huazhong Agricultural University*, 1990, **9**(2): 204—208 [龚世园，库夭梅，梁开学. 武昌南湖花鲷个体升生殖力的研究. 华中农业大学学报, 1990, **9**(2): 204—208]

[8] Xie G, Qi B L, Zeng C, *et al*. Muscle content and analysis of biochemical composition of muscle in CATLA [J]. *Journal of Fisheries of China*, 1997, **21**(1): 63—67 [谢刚，祁宝伦，曾超，等. 卡特拉鱼含肉率和肌肉生化成分的分析. 水产学报, 1997, **21**(1): 63—67]

[9] Williams S (Eds.), Official methods of analysis of the association of official analytical chemists [Z]. 14th edn. Arlington, VA, 114

[10] Floch J, Lees M, Sloane Stanley G H. A simple method for the isolation and purification of total lipids from animal tissues [J]. *J Biol Chem*, 1957, **226**: 497—509

[11] Chen Y X, Du N S, Lai W. Lipid composition in hepatopancreas of Chineses mitten crab *Eriocheir sinensis* at different stages [J]. *Acta Zoologica Sinica*, 1998, **44**(4): 420—429 [成永旭，堵南山，赖伟. 不同阶段中华绒螯蟹肝胰腺的脂类及脂肪酸组成. 动物学报, 1998, **44**(4): 420—429]

[12] Pellet P L, Yong V R. Nutritional evaluation of protein foods [M]. Tokyo: the United National University. 1980, 26—29

[13] Qiaoben F I (Translated by Cai W Q). Fisheries feed [M]. Beijing: Agriculture Publishing Company. 1980, 114—115 [桥本芳郎(蔡完其译). 养鱼饲料学. 北京：农业出版社. 1980, 114—115]

[14] Tan D Q, Wang J W, Dan S G, *et al*. The ratio of muscle to body and analysis of the biochemical composition of muscle in *Megalobrama pellegrini* [J]. *Acta Hydrobiological Sinica*, 2004, **28**: 17—22 [谭德清，王剑伟，但胜国，等. 厚颌鲂含肉率及生化成分的分析. 水生生物学报, 2004, **28**: 17—22]

[15] Tan D Q, Wang J W, Dan S G. The ratio of flesh to body and analysis on nutritive composition of muscle in *Ancherythroculter nigrocuda* [J]. *Acta Hydrobiological Sinica*, 2004, **28**: 240—246 [谭德清，王剑伟，但胜国. 黑尾近红鲌含肉率及肌肉营养成分分析. 水生生物学报, 2004, **28**: 240—246]

[16] Yan A S, Xiong C X, Qian J W, *et al*. A study on the rate of flesh content of mandarin fish and nutritional quality of the flesh [J]. *Journal of Huazhong Agrialture University*, 1995, **14**: 80—84 [严安生，熊传喜，钱健望，等. 鳜鱼含肉率及鱼肉营养价值得研究. 华中农业大学学报, 1995, **14**: 80—84]

[17] Huang F, Yan A S, Xiong C X, *et al*. Evaluation of the nutrition and the rate of flesh in the whole body of *pelteobagnus fulvidraco* rich [J]. *Freshwater Fisheries*, 1999, **29**(10): 3—6 [黄峰，严安生，熊传喜，等. 黄颡鱼含肉率及营养评价. 淡水渔业, 1999, **29**(10): 3—6]

[18] Yan A S, Xiong C X, Zhou Z J, *et al*. Evaluation of the nutrition and the rate of flesh in the whole body of *Carassius auratu* [J]. *Reservoir Fisheries*, 1998, **97**: 16—19 [严安生，熊传喜，周志军，等. 异育银鲫得含肉率及营养评价. 水利渔业, 1998, **97**: 16—19]

[19] Chen Y M, Huang G, Cai Z D, *et al*. Analysis of nutritional composition and the rate of flesh in the whole body of *Spinibarbus hollandi* Oshinla [J]. *Reservoir Fisheries*, 2001, **21**(2): 22—24 [陈意明，黄钧，蔡子德，等. 光倒刺鲃的含肉率和肌肉营养成分分析. 水利渔业, 2001, **21**(2): 22—24]

[20] Liang Y Q, Cui X Q, Liu Y L. Evaluation of nutive quality and analysis

of the nutritive compositions in the muscle of mandarin fish [J]. *Acta Hydrobiological Sinica*, 1998, **22**(4): 386－388 [梁银铨, 崔希群, 刘友亮. 鳜肌肉生化成分分析和营养品质评价. 水生生物学报, 1998, **22** (4): 386－388]

[21] Chen S L, Liu X F, Hu C L, *et al*. Nutrition and energetic of the Chinese herbivorous fishes of important food values I. Chemical composition and energy content of Ctenopharyngodon idellus, Megalobrama amblycephala and Parabramis pekinensis [J]. *Oceanologia et Limnologia Sinica*, 1992, **23**(2): 193－205 [陈少莲, 刘肖芳, 胡传林, 等. 我国淡水优质草食性鱼类的营养和能学研究 I. 草鱼、团头鲂、长春鳊的生化成分和能值. 海洋与湖沼, 1992, **23**(2): 193－205]

[22] Mao G X, Zhao W L. Composition on muscle quality of Longchang, Taihu, and new Taihu goose [J]. *Aminal Science and Veterinary Medicine*, 2000, **17**(1): 16－19 [毛国祥, 赵万里. 新太湖鹅、太湖鹅和隆昌鹅肌肉品. 动物科学与动物医学, 2000, **17**(1): 16－19]

[23] Zhang Q, Wang Y L. Extraction and analysis of fat of *S. aaus* Linnaeus and *H. japonicus* Kaup [J]. *Chinese Journal of Analytical Chemistry*, 1996, **24**(2): 139－143 [张强, 王永利. 尖海龙与日本海马脂肪的提取分析. 分析化学, 1996, **24**(2): 139－143]

[24] Bing X W, Zhang X Z. Evaluation of nutritional composition and nutritive quality of the muscle of *Oxyeleotris marmoratus* Bleeker [J]. *Periodical of Ocean University of China*, 2006, **36**(1): 107－111 [邢旭文, 张宪中. 斑驳尖塘鳢肌肉营养成分与品质的评价. 中国海洋大学学报, 2006, **36**(1): 107－111]

[25] Ying X P, Yang W X, Zhang Y P. Comparative studies on fatty acid composition of the ovaries and hepatopancreas at different physiological stages of the Chinese mitten crab [J]. *Aquaculture*, 2006, **256** (1－4): 617－623

[26] Ogataa H Y, Ematab A C, Garibayb E S, *et al*. Fatty acid composition of five candidate aquaculture species in Central Philippines [J]. *Aquaculture*, 2004, **236**(1－4): 361－375

[27] Cejas J R, Almansa E, Villamandos J E, *et al*. Lipid and fatty acid composition of ovaries from wild fish and ovaries and eggs from captive fish of White Sea bream (*Diplodus sargus*) [J]. *Aquaculture*, 2003, **216**(1－4): 299－313

THE DRESSING RATE AND NUTRITIONAL COMPOSITION OF MUSCLE IN SPOTTED STEED (*HEMIBARBUS MACULATES*) AND SKIN CARP (*HEMIBARBU LABEO*)

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Abstract: *Hemibarbus maculates* and *H. labeo*, as two kinds of important economic freshwater fish, are widely distributed over all the river systems except for the Xinjiang, Tibet and western plateau. Presently, researchers have carried out some research works concerning morphology, taxonomy, breeding and culture of *Hemibarbus maculates* and *H. labeo*, however, few reports about the dressing rate and nutritional composition of muscle were not found. Therefore, it is necessary to determine these data for enriching the fish nutrition data and providing theoretical foundation about feed development and culture promotion. In this study, measurements on the dressing rate in whole body and analysis of nutritional composition of muscle in *Hemibarbus maculates* and *H. labeo* were made. Twenty-six pond-cultured samples were collected from the Bihu pond at Lishui town of Zhejiang Province in China in March, 2006 and the dressing rate in whole body and nutritional composition of muscle were determined using 13 samples. The fatty acids composition of and the composition of amino acids (AA) of muscles were examined with 10 individuals. The result showed that the dressing rate in the spotted steed and skin carp were 70.61% and 71.52% respectively, thus there were not significant differences between them by *t*-test.

Analysis results of the nutritional composition were: moisture of muscle was 78.35%, crude protein 18.41%, crude lipid 2.46%, ash 0.75% in the spotted steed. In the skin carp, moisture of muscle was 78.51%, crude protein 17.73%, crude lipid 1.96%, ash 1.69%. The content of crude protein and crude lipid in the spotted steed were higher than those in the skin carp ($p < 0.05$), whereas the ash content was lower ($p < 0.05$). The result indicated that there was no significant difference in the content of moisture in both spotted steed and skin carp.

There are 11 kinds of fatty acids found in the muscle of spotted steed and skin carp, of which 4 kinds of saturated fatty acid (SFA), 7 kinds of unsaturated fatty acid (UFA) (including 4 kinds of monounsaturated fatty acid (MUFA) and 3 kinds of polyunsaturated fatty acid (PUFA)). Remarkably, Docosahexaenic Acid (DHA) content occupies 5.00% and 14.32% in the spotted and skin carp, respectively. The percentage of PUFA in the muscle fatty acids of spotted steed and skin carp were 19.50% and 30.46%, respectively. As for the MUFA, the content of $C_{18:1}$ in the muscle of spotted steed and skin carp was the maximum (38.09% and 25.31% in percentage, respectively), while the content of $C_{22:1}$ was the minimum (1.53% and 3.18% in per-

centage, respectively).

To provide scientific basis for evaluating protein quantity in fish muscle to guide the utilization of protein resources, AA grade point to the fish muscle was also examined. By the nutritional evaluation for the AA in muscle to human needs, the total content of AA in the muscle of spotted steed and skin carp were 63.07% and 67.63% respectively. As to the delicious AA, the contents were 25.96% and 26.30%, respectively. As for the amino acids score (AAS), the first limited AA was valine and second limited AA were methlonine and cystine in both *Hemibarbus maculates* and *H. labeo*; the first limited amino acids were methlonine and cystine, second limited AA was valine based on chemical score (CS).

From the above analysis and evaluation, we concluded that it was necessary to spread spotted steed and skin carp in Zhejiang Province due to their economic value and more nutrition as well as health consideration.

Key words: *Hemibarbus maculates* (Bleeker); *Hemibarbus labeo* (Pallas); Dressing rate; Nutritional composition