读书报告

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Earthworm Meal as Fishmeal Replacement in Plant based Feeds for Common Carp in Semi-intensive Aquaculture in Rural Northern Vietnam

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Abstract

It was evaluated whether earthworm meal can fully replace fishmeal in supplemental feeds for common carp (*Cyprinus*

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前言

1、研究背景

全球鱼类消费量一半来自水产养殖

水产养殖业的发展增加对鱼粉的需求

鱼粉价格昂贵、产量有限

寻找鱼粉替代蛋白源十分迫切

2、待解决的实际问题

情况

以杂食性普通鲤鱼为主要鱼种的池塘半集约化养殖方式引入北美，带来了比传统养殖更高的鱼类产量和经济净效益

问题

饲料配方中含有昂贵的进口鱼粉，这使得小规模农户通常不能或不愿意购买配方饲料

2、实验目的

蚯蚓被描述为蛋白质含量和蛋白质质量高的资源，已有研究将蚯蚓粉作为鱼粉的替代品

本研究的目的是评估在天然食物资源充足的情况下，蚯蚓粉作为普通鲤鱼的补充饲料替代鱼粉的适宜性。

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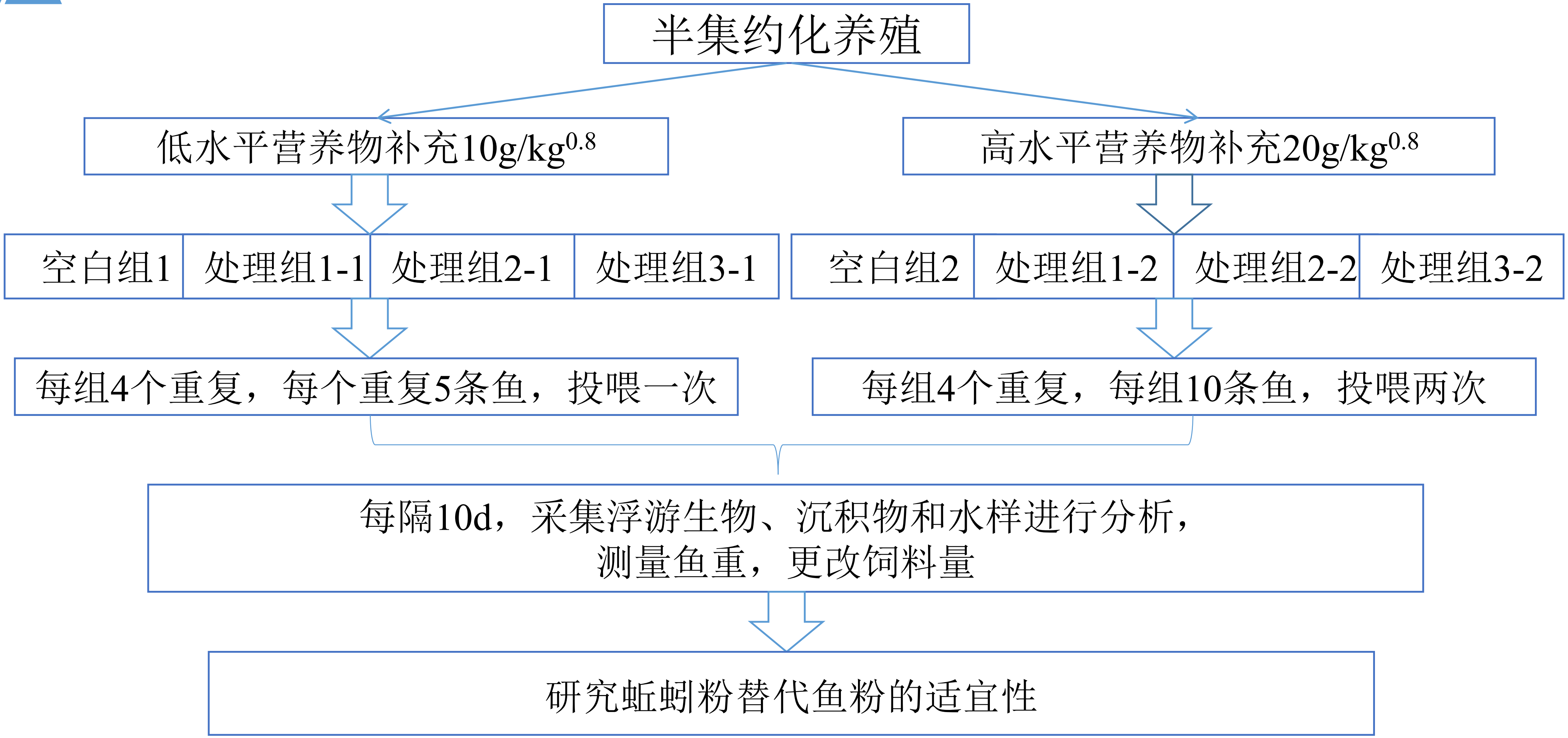
材料和方法

材料方法


半集约化养殖
低水平营养物补充10g/kg0.8
高水平营养物补充20g/kg0.8
空白组1
处理组1-1
处理组2-1
处理组3-1
空白组2
处理组1-2
处理组2-2
处理组3-2
每组4个重复，每个重复5条鱼，投喂一次
每组4个重复，每组10条鱼，投喂两次
每隔10d，采集浮游生物、沉积物和水样进行分析，
测量鱼重，更改饲料量
研究蚯蚓粉替代鱼粉的适宜性

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结果

1、饲料配方

Table 1. Chemical composition and energy content of single feed ingredients and final composition of trial feeds

Feed ingredient	DM [% FM]	CA [% DM]	CP [% DM]	CL [% DM]	GE [MJ/kg DM]	Feed 1 [% DM]	Feed 2 [% DM]	Feed 3 [% DM]
Fishmeal	92.0	29.9	63.4	6.9	16.3	18	9	0
Earthworm meal	89.8	8.0	44.3	8.8	20.8	0	13	26
Heated Soy bean meal	94.6	5.0	40.0	19.4	22.6	32	32	32
Corn Meal	89.9	0.7	9.0	4.5	17.7	30	30	30
Rice bran	90.5	13.0	8.0	2.7	17.6	7	6	5
Cassava meal	90.4	2.0	1.2	0.5	16.8	6	6	4
Vitamin mix	90.0	0.0	0.0	0.0	0.0	1	1	1
Mineral mix	90.0	100.0	0.0	0.0	0.0	1	1	1
Rice straw	93.2	11.7	8.3	1.4	15.5	4	1.5	1
Sunflower oil	98.0	0.0	0.0	100.0	nd	1	0.5	0
Total						100	100	100

CA: crude ash; CL: crude lipid; CP: crude protein; DM: dry matter; FM: fresh matter; GE: gross energy

2、饲料成分

Table 2. Chemical and essential amino acid composition of trial feeds and requirements of juvenile common carp

Component	Unit	Requirement *	Feed 1	Feed 2	Feed 3
DM	% of FM	na	90.8	90.0	88.4
CA	% of DM	na	10.9	8.5	6.5
CP	% of DM	32°	29.7	30.9	31.0
CL	% of DM	na	12.2	11.9	11.0
P	% of DM	0.70	0.32	0.25	0.17
TI	% of DM	na	0.29	0.24	0.23
GE	MJ/kg DM	13.4°	20.1	20.6	20.7
Thr	% of CP	4.7	3.7	3.7	4.0
Val	% of CP	4.4	4.0	4.2	4.3
Met	% of CP	2.2	1.5	1.5	1.5
Ile	% of CP	3.1	3.4	3.7	3.9
Leu	% of CP	4.4	6.9	7.0	7.6
Phe	% of CP	4.1	4.1	4.2	4.5
His	% of CP	1.6	2.1	4.2	2.3
Lys	% of CP	6.9	4.5	4.6	4.8
Arg	% of CP	5.3	6.0	5.6	5.9
Trp	% of CP	0.9	0.9	1.0	1.1

* (NRC, 2011), ° digestible protein/energy

Arg: Arginine;CA: crude ash; CL: crude lipid; CP: crude protein; DM: dry matter; FM: fresh matter; GE: gross energy; His: Histidine; Ile: Isoleucine; Leu: Leucine; Lys: Lysine; Met: Methionine; P: phosphorus;Phe: Phenylalanine;Thr: Threonine; TI: Trypsin-Inhibitor;Trp: Tryptophan; Val: Valine.

3、水样检测结果

Table 3. Water quality parameters (mean±SD) over the experimental period

Parameter	Unit	Mean±SD
NO_2-N	mg L^{-1}	0.04±0.01
NO_3-N	mg L^{-1}	0.43±0.15
TAN	mg L^{-1}	0.15 ±0.07
UIA-N	µg L^{-1}	6.2±1.8
TN	mg L^{-1}	1.81 ±0.29
PO_4-P	mg L^{-1}	0.01±0.01
TP	mg L^{-1}	0.16±0.11
SDD	cm	34.7±2.0
pH		7.7±0.1
Temperature	°C	31.9±0.9
$O^2_{6\ am}$	mg L^{-1}	1.9±0.5
$O^2_{12\ am}$	mg L^{-1}	6.3±1.7
$O^2_{6\ pm}$	mg L^{-1}	7.9±1.2
TSS	mg L^{-1}	32.4±5.9
TSS_{org}	mg L^{-1}	14.6±1.7
TSS_{inorg}	mg L^{-1}	17.8±5.1

NH_3-N: un-ionized ammonia nitrogen; NO_2-N: nitrite nitrogen; NO_3-N: nitrate nitrogen; $O^2_{6\ am,\ 12\ am,\ 6\ pm}$: oxygen averaged over all measured depths at the respective day time; PO_4-P: ortho-phosphate phosphorus; SDD: Secchi disk depth; TAN: total ammonia nitrogen; TN: total nitrogen; TP: total phosphorus; TSS: total suspended solids; TSS_{org}: organic fraction of TSS; TSS_{inorg}: inorganic fraction of TSS

4、微生物干物质检测结果

Table 4. Dry matter (DM) of different size groups of zooplankton and zoobenthos (mean± SD) per unit pond area as an estimate of the natural food available for stocked common carp

	Size class	DM per unit pond area [mg/m^2]
Zooplankton	> 60 µm	772±187
	> 200 µm	364±88
Zoobenthos	> 0.5 cm	52±53

5、鱼体成分

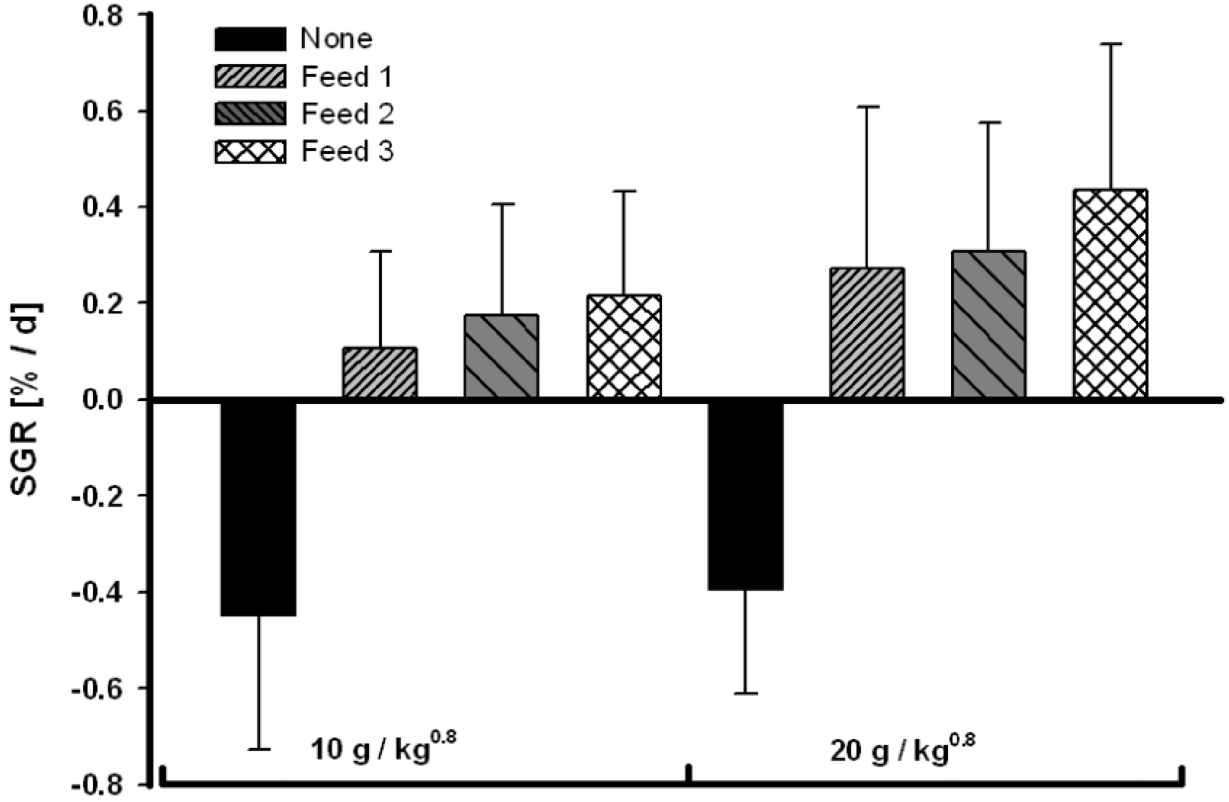
Table 5. Proximate body composition of trial fish fed the three test diets 1, 2 and 3 in which fishmeal protein was replaced by 0%, 50% and 100% earthworm meal protein, respectively. In four replicate each, these test diets were fed to groups of common carp at 0, 10 and 20 $g/kg^{0.8}$ metabolic body mass at stocking densities of five and ten fish per net cage

Daily feeding	$[g\ kg^{-0.8}]$	0		10			20		
Stocking	$[Fish\ cage^{-1}]$	5	10	5	5	5	10	10	10
Feed		No	No	1	2	3	1	2	3
DM	% of FM	13.6 ± 1.7^{e}	17.4 ± 1.0^{d}	23.5 ± 0.1^{c}	24.7 ± 1.4^{b}	24.2 ± 0.5^{b}	$28.8\pm2.8^{a,b}$	$27.6\pm4.7^{a,b}$	28.8 ± 1.2^{a}
CA	% of DM	30.1 ± 5.2^{a}	24.2 ± 3.5^{a}	15.3 ± 1.1^{b}	14.9 ± 1.3^{b}	14.5 ± 1.0^{b}	11.8 ± 0.9^{b}	11.6 ± 0.6^{b}	10.8 ± 0.5^{b}
CP	% of DM	$67.1\pm5.3^{a,c,d}$	73.9 ± 2.6^{a}	71.1 ± 1.2^{a}	$71.5\pm2.8^{a,c}$	69.3 ± 2.1^{a}	$62.8\pm1.6^{b,c}$	$61.0\pm2.0^{b,d}$	$60.1\pm1.6^{b,d}$
CL	% of DM	0.9 ± 0.3^{c}	1.3 ± 1.0^{c}	9.8 ± 1.5^{b}	11.4 ± 3.5^{b}	12.6 ± 2.2^{b}	23.4 ± 2.7^{a}	25.2 ± 2.9^{a}	24.6 ± 1.7^{a}
GE	$MJ\ kg^{-1}$	15.3 ± 1.4^{c}	16.9 ± 1.3^{c}	21.5 ± 0.6^{a}	21.7 ± 0.6^{a}	$22.0\pm0.4^{a,d}$	$24.4\pm0.7^{a,b}$	$24.8\pm1.1^{b,d}$	$24.8\pm0.2^{b,d}$

Mean values in the rows that do not share the same superscript(s) differ significantly in the pond management effect at $P\leq0.05$.
CA: crude ash; CL: crude lipid; CP: crude protein; DM: dry matter; FM: fresh matter; GE: gross energy

1、补充饲料组的干物质比空白组高，且随蚯蚓粉替代比例升高而升高；
2、高水平投喂组粗蛋白显著降低，低水平投喂组没有显著变化；
3、补充饲料组粗脂肪和总能都高于空白组，但组间无明显差异

6、特定生长率



1、各组生长率较低，可能是因为受到捕食者或垂钓者的惊吓或者是野杂鱼进入网箱抢食
2、空白组呈负生长，说明天然食物资源不足以供应鲤鱼生长；
3、接受补充饲料组生长率随蚯蚓粉替代比例增加而升高，说明蚯蚓粉作为补充饲料能更好适应鲤鱼的生长

Figure 1. Specific growth rate (SGR; y-axis) of common carp receiving four feeds (None: no supplemental feeding and supplemental feeds 1, 2, and 3 in which fishmeal derived protein is replaced by 0%, 50%, and 100% earthworm meal protein, respectively) plotted against level of supplemental feeding (none, 10 g/kg$^{0.8}$ metabolic body mass, and 20 g/kg$^{0.8}$ metabolic body mass) and stocking density (5 and 10 fish per net cage).

SGR [% / day] = 100 * ((ln $_{\text{final body mass}}$ (g) – ln $_{\text{initial body mass}}$ (g)) / time (days))

7、生长率与浮游生物干物质的相关性

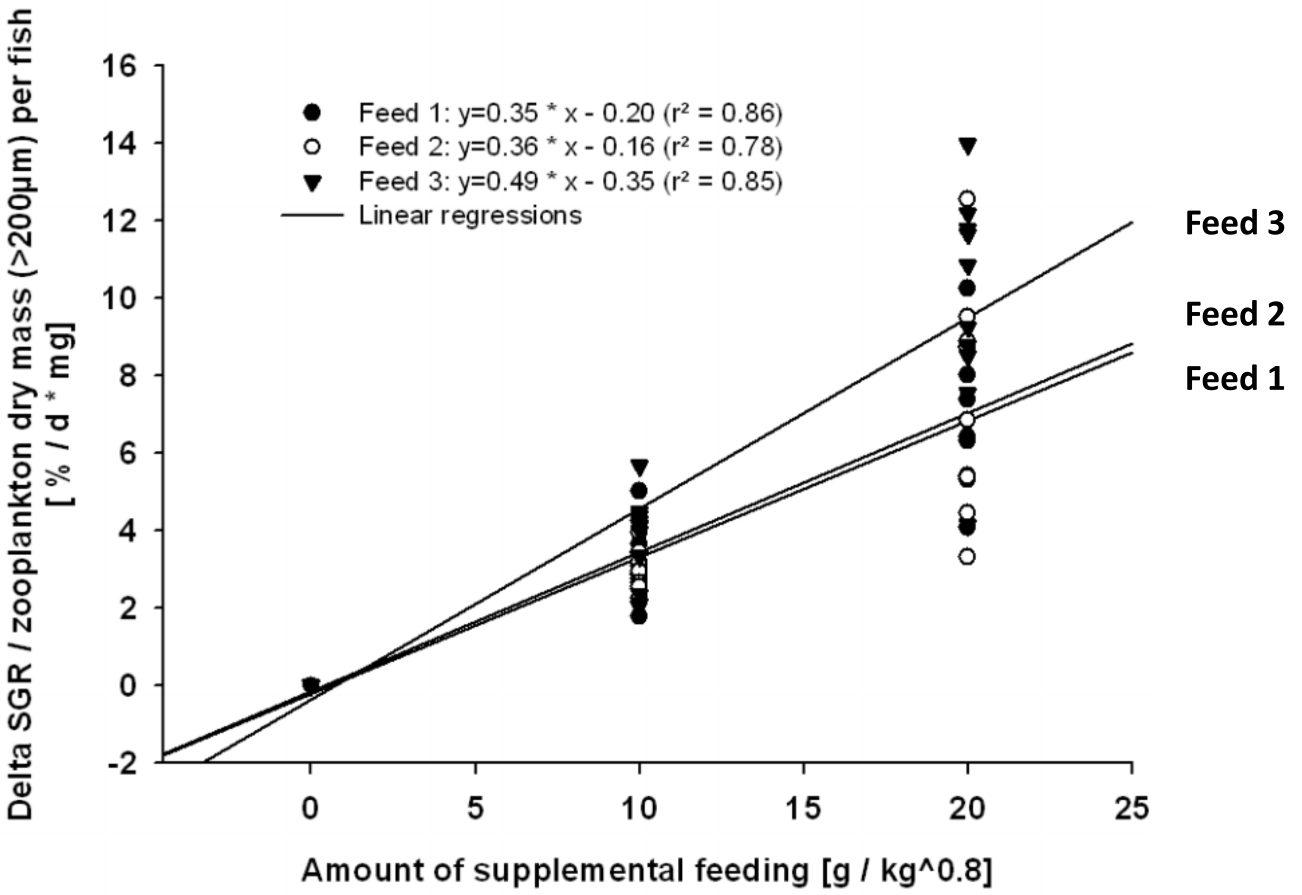


Figure 2. Delta SGR per zooplankton dry mass per fish (%/ d * mg; y-axis) of common carp receiving three supplemental feeds (1, 2, and 3 in which fishmeal derived protein is replaced by 0%, 50%, and 100% earthworm meal protein, respectively) plotted against level of supplemental feeding (none, 10 g/kg$^{0.8}$ metabolic body mass, and 20 g/kg$^{0.8}$ metabolic body mass). Equations and r^2 given in the legend are describing the linear regression and the fitting accuracy of the respective feed.

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讨论

蚯蚓的研究现状

在大马哈鱼中，较低水平的鱼粉被蚯蚓粉替代可以提高生长性能，但较高水平的鱼粉会产生越来越多的负面影响(Stafford和Tacon, 1984)。

(2010)食用新鲜蚯蚓的生长速度明显高于食用冷冻蚯蚓的生长速度。

冷冻或冷冻干燥的蚯蚓粉对鳟鱼适口性差，因其体表液中含溶血因子，但这种蚯蚓的分离蛋白似乎适合作为食物和饲料资源（Medina et al.， 2003）

蚯蚓体腔液在其免疫反应中起重要作用，并影响其他经体腔液处理的动物的免疫反应。在鱼类和其他脊椎动物中，具有明显的毒性作用(Kobayashi等人，2001;Ohta等人，2003年)，但有对无脊椎动物的影响较小(Kobayashi等人，2001)

蚯蚓的研究现状

Tacon等(1983)提出蚯蚓的预处理方法为去除体腔液、在干燥过程中进行热处理或用热水烫漂。然而，并没有在所有蚯蚓物种中检测到有毒的体腔液(Kauschke et al.， 2007)。

根据保存方法的不同，本研究中使用的*Perionyx excavates*对鱼类生长有负面影响(Nguyen et al.， 2010)，这表明该蚯蚓物种也有抗营养因子。

在本研究中，由于蚯蚓在晒干过程中经过了一定的热处理，且蚯蚓在日粮中所占的比例较低，因此，对普通鲤鱼的生长影响不大。

结论

池塘里天然食物资源的丰富度和可利用性不足以养殖没有补充饲料的鲤鱼

蚯蚓可以作为补充饲料的蛋白源，利用废物和副产物来培育蚯蚓，能增加小规模农户的经济产量

谢谢！