



## RESEARCH ARTICLE

# REVISED Fermented medicinal herbs improve hematological and physiological profile of Striped catfish (*Pangasianodon hypophthalmus*) [version 3; peer review: 1 approved, 2 approved with reservations]

Previously titled: Fermented medicinal herbs improve the hematological and physiological profile of Striped catfish (*Pangasionodon hypophthalmus*)

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**V3** First published: 14 Jun 2021, 10:466  
<https://doi.org/10.12688/f1000research.52640.1>  
 Second version: 11 Nov 2021, 10:466  
<https://doi.org/10.12688/f1000research.52640.2>  
 Latest published: 19 Apr 2022, 10:466  
<https://doi.org/10.12688/f1000research.52640.3>


## Abstract

This study sought to determine the effect of fermented medicinal herbs (FMH), *i.e.* cutchery (*Kaempferia galanga*), turmeric (*Curcuma longa*) and curcuma (*Curcuma xanthorrhiza*) in combination with molasses and probiotic drink (Yakult), administered orally on the hematological and physiological profile of striped catfish (*Pangasia nodon hypophthalmus*). A complete randomized design (CRD) experiment was used with four levels of treatments, namely P0 (control), P1 (FMH 100 mL/kg), P2 (FMH 200 mL/kg) and P3 (FMH 300 mL/kg) of feed. The fish were kept in a farm in cages at 75 fish/m<sup>3</sup> and fed with the experimental diets for 60 days. The results revealed that FMH (P2) dietary administration improved hematological and physiological profile of catfish, *i.e.* total erythrocytes of  $2.81 \times 10^6$  cells/mm<sup>3</sup>, hematocrit values of 39.00%, hemoglobin levels of 10.73 g/dL, total leukocytes of  $11.41 \times 10^4$  cells/mm<sup>3</sup>, blood glucose 97.33 mg/dL, and total serum protein 4.10 mg/dL compared to controls with  $1.89 \times 10^6$  cells/mm<sup>3</sup>, 32.33 %, g/dL,  $9.67 \times 10^4$  cells/mm<sup>3</sup>, 67.33 mg/dL, and total serum protein of 3.10 mg/dL, respectively. Moreover, the diet improved special growth rate, feed conversion ratio, feed efficiency and the survival rate of catfish. The hematological and physiological profile of catfish improvement are considered to be due to the content of secondary metabolites of FMH, namely curcuminoids, vitamin C, essential oils, tannins, and flavonoids, which trigger immunostimulation. The presence of curcuminoids provide an

## Open Peer Review

Approval Status   

	1	2	3
<b>version 3</b> (revision) 19 Apr 2022			 view
<b>version 2</b> (revision) 11 Nov 2021			 view
<b>version 1</b> 14 Jun 2021	 view	 view	

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antioxidant effect on cell membranes reducing erythrocyte cell membrane damage due to oxidation. Similarly, flavonoids are natural antioxidants, which are credited with the ability of reducing free radicals and anti-free radicals.

### Keywords

Medicinal herb, Catfish, Immunostimulant, Hematology, Physiology, Immunity



This article is included in the [Agriculture, Food and Nutrition](#) gateway.

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**Competing interests:** No competing interests were disclosed.

**Grant information:** Funding was provided by community Research and Development institute Universitas Riau, DRPM DIKTI (807/UN.19.5.1.3/ PT.01.03/2019).

*The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.*

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**How to cite this article:** Syawal H, Kurniawan R, Effendi I and Austin B. **Fermented medicinal herbs improve hematological and physiological profile of Striped catfish (*Pangasi anodon hypophthalmus*) [version 3; peer review: 1 approved, 2 approved with reservations]** F1000Research 2022, 10:466 <https://doi.org/10.12688/f1000research.52640.3>

**First published:** 14 Jun 2021, 10:466 <https://doi.org/10.12688/f1000research.52640.1>

**REVISED Amendments from Version 2**

Changes to the manuscript include:

- The SGR formula to  $SGR = \frac{LnWt - LnWo}{t} \times 100$
- The addition of standard deviation in Table 2 and Table 3.
- An explanation of FCR and feed efficiency that affect fish growth, as well as regarding the effect of fermented herbs on increasing blood glucose.

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## Introduction

Attention in aquaculture in developing countries has focused on the use of nonspecific immunostimulants and plant products, which could have a beneficial effect in fish disease control. Interest in medicinal plants for application to aquaculture follows their use in human medicine and agriculture as proven prophylactic and therapeutic agents.<sup>1–3</sup> For example, garlic (*Allium sativum*) and ginger (*Zingiber officinale*)<sup>4</sup> have histories of dietary and medicinal applications as anti-infective agents. Evidence of their value include inhibition towards pathogens of relevance to aquaculture, including bacteria,<sup>5–7</sup> viruses,<sup>8–10</sup> and protozoa.<sup>11,12</sup>

Some researchers have reported the impact of herbal supplemented diets on hematology and innate immunity of fish.<sup>13,14</sup> For example, Chinese herbs (*Lonicera japonica* and *Ganoderma lucidum*) enhanced the non-specific immune response of tilapia (*Oreochromis niloticus*), leading to protection against *Aeromonas hydrophila*.<sup>15</sup> Similarly, the dietary administration of rose hip and safflower stimulated growth performance, hematological, biochemical parameters and innate immune responses of beluga (*Huso huso*)<sup>16,17</sup> The supplemented probiotic stimulated growth performance and feed utilization of keureling fish *Tor tambra*. Medicinal herb has weaknesses, one of which is a strong aroma and bitter taste, so it is not liked by fish. Therefore, it is necessary to carry out fermentation. Against this background, fermented medicinal herbs (FMH) in combination with molasses and probiotic drink (Yakult) have been used successfully as dietary supplements on a small number of rural catfish farms in Sumatra, Indonesia, for approximately two years. Anecdotal evidence has suggested that fish grow better and faster, appear to be healthier, and the flesh tastes better after cooking. Fish, which have received these diets, have been examined for potential improvements to hematology and physiology.

## Methods

### Experimental diet

This research was conducted on floating net cages in the Reservoir of the Faculty of Fisheries and Marine Affairs by using a completely randomized design with four treatments and three replications, namely P0 (control), P1 (FMH 100 mL/kg feed), P2 (FMH 200 mL/kg), and P3 (FMH 300 mL/kg). All steps in this experiment were carried out within the international ethical guidelines provided by ARRIVE guidelines.

### Fish

A total of 2700 fingerling catfish used had an average length of 9 cm and an average weight of 6 g. Catfish were obtained from local farmers in Kampar Regency and distributed randomly into cages measuring 1 × 1.5 × 1 m with a density of 75 individuals/m<sup>3</sup>. The cages were constructed of polyethylene nets with a mesh size of 7 × 7 mm. Water was free-flowing, and the temperature ranged 27.5–29.5°C.

All fish were acclimatized for seven days before use. The fish samples were selected based on their performance. The fish that showed active swimming, no wounds or external parasites. To measure the growth of the fish, every 10 days a random weighing of the fish was carried out.

### Use of dietary supplements

The dietary supplements were chosen because of their availability, and use in local, Sumatran, aquaculture. Thus, fermented medicinal herbs (FMH) consisting of cutchery (*Kaempferia galanga*), turmeric (*Curcuma longa*) and curcuma (*Curcuma zanthorrhiza*) together with molasses, probiotic drink (Yakult), fresh water and yeast (*Saccharomyces cerevisiae*) were used (Table 1). Fresh turmeric, cutchery, and curcuma were washed, thinly sliced, mixed and milled. Then, 300-g quantities were transferred to 3 L of water, boiled for 30 min, and cooled to room temperature. The mixture was then squeezed and filtered to obtain the liquid fraction, which totalled 2.7 L. This was mixed with 175 mL of molasses, 65 mL of probiotic drink and 50 g of yeast. Then, the mixture was stirred until homogeneous and poured into 5-L capacity jerry cans, which were tightly closed. Fermentation was allowed to occur for 7–10 days until the aroma changed from a curcuma smell to a strong alcoholic odour, and gas was no longer produced. The gas produced

**Table 1. Composition of medicinal herb mixture.**

Items	Amount
Fresh tumeric rhizome (g)	100
Fresh cutchery rhizome (g)	100
Fresh curcuma rhizome (g)	100
Molasses (mL)	175
Probiotic drink (mL)	65
Mineral water (mL)	3000
Yeast (mg)	50

during fermentation was released daily by opening the lids for a few seconds. FMH was added to 1-kg quantities of pelleted feed (Hi-Pro-Vite 781 PT. Central Proteina Prima Tbk) to achieve 0 (control; P0), 100 mL/kg (P1), 200 mL/kg (P2) and 300 mL/kg (P3) The feed was administered three times a day to achieve 5% of body weight for 60 days, which reflected the period that the diets have been used on fish farms. Survival rates were calculated using the following formula,  $SR = Nt/No \times 100\%$ , where SR = survival (%), Nt = number of live fish at the end of the study, and No = number of live fish at the beginning of the study.

#### Examination of fish blood

Fish blood was removed at 0, 30 days and 60 days. Thus, the fish were anesthetized with clove oil at a dose of 0.05 mL/L. Blood was withdrawn from the caudal vein using 1-mL syringes that had been rinsed with 10% EDTA, collected in microtubes (Axygon) and stored at room temperature until use. The fish that have been blood drawn are then awakened by placing them in a container filled with aerated water. The fish were returned to the cages after they were seen breathing and swimming normally.

To determine the number of erythrocytes, blood in 0.1-mL quantities was mixed thoroughly with 1.0 mL of Hayem solution comprising sodium sulfate, sodium chloride and mercuric chloride.<sup>19</sup> Then, the number of erythrocytes was determined by use of a hemocytometer at a magnification of  $\times 40$  with calculation according to the formula of Blaxhall and Daisley.<sup>19</sup> The method of Blaxhall and Daisley<sup>19</sup> was used to estimate the total number and types (*i.e.* lymphocytes, monocytes, neutrophils, and platelets) of leucocytes. For this, blood was dripped onto a hemocytometer slide, covered with a coverslip, and examined microscopically with a magnification of  $\times 40$ . The total number of leukocytes was calculated using the following formula:  $\sum \text{Leukocytes} = \sum n \times 50 \text{ cells/mm}^3$ , where  $\sum n$  = total number of leukocytes in four large boxes, and 50=dilution factor. Calculation of hemoglobin levels was carried out using Sahli's method.<sup>20</sup> To determine hematocrit level, blood was drawn into a hematocrit capillary tube the end of which was blocked with crystoseal.<sup>19</sup> Then the capillary tube was centrifuged for 3 min at 11000 rpm in a microhematocrit centrifuge Model SH120-1. The hematocrit was measured as a percentage of the hematocrit value in the microhematocrit reader

Blood glucose was measured using GlucoDr (allmedicus) with a range of 20–600 mg/dL. Glucose testing was carried out in the morning before the fish were fed.<sup>21</sup> Total serum protein was measured by the method of Anderson and Siwicki.<sup>22</sup> Blood was centrifuged at 3,500 rpm for 15 min to completely separate the serum, which was transferred to a fresh microtube. Then, 20  $\mu\text{L}$  of serum and 1000  $\mu\text{L}$  of protein test reagent (Reigid Diagnostics) were added to each microtube, with mixing. After incubation for 15 min, the absorbance was read at  $\lambda$  595–610 nm.

#### Growth parameters

- The absolute weight was measured using the formula  $AW = Wt - Wo$ , where AW = absolute weight (g), Wt = average weight at the end of the study (g), and Wo = average length at the beginning of the study (g).
- Specific growth rates were calculated using the formula,  $SGR = \frac{\ln Wt - \ln Wo}{t} \times 100$ , where Wt = larvae weights at the end of the study (g), Wo = larvae weights at the beginning of the study (g), and t = length of study (day).
- Feed conversion was calculated by using the formula,  $FCR = \frac{\Sigma F}{(Bt + Bm) - Bo}$ , where FCR = feed conversion ratio,  $\Sigma F$  = amount of feed fed during experiment (g), Bt = fish biomass weight at the end of maintenance (g), Bo = fish biomass at the beginning of study (g), and Bm = biomass of dead fish during maintenance (g).

- d) Feed efficiency was calculated by using formula,  $FE = (Bt + Bm) - Bo / F \times 100$ , where FE = feed efficiency,  $\Sigma F$  = amount of feed fed during experiment (g), Bt = fish biomass at the end of experiment (g), Bm = biomass of fish that died during the study (g), and Bo = fish biomass at the beginning of the study (g).

### Statistical methods

The experiments employed a completely randomized design (CRD) involving use of SPSS version 22.

### Statement on animal ethics

All animals are treated according to animal welfare guidelines that have been established and approved by the Dean of the Faculty of Fisheries and Marine Sciences, Riau University (Prof. Bintal Amin, serves as the ethical committee who approved the use of vertebrate animals in this experiments with number: 346/UN19.5.1.1.4/KP/2020).

### Results

The fish consumed the experimental diets better than the controls without any evidence of a period of adjustment. Moreover, compared with the controls, the fish receiving the experimental diets were more active, responding quickly to the arrival of the feed. Overall, the FMH diets improved the growth rate of fish significantly ( $p < 0.05$ ). In addition, the provision of the supplements maintained the survival rate of catfish at 100% (Table 2).

FMH diets improved the hematological profile of striped catfish significantly ( $p < 0.05$ ) compared to the experimental controls. Thus, total erythrocyte counts ranged between  $2.45\text{--}2.81 \times 10^6$  cells/mm<sup>3</sup>, hematocrit values were from 35.67 to 39.00%, and hemoglobin levels ranged from 9.2–10.73 g/dL (Table 3). This compares with  $1.89 \times 10^6$  cells/mm<sup>3</sup>, 32.33 %, and 8.80 g/dL, for the controls (Table 3). Consistently, diet P2 exhibited the best level of hematological profiles at both 30 and 60 days after initiating the feeding regime (Table 3). Moreover, the examination of the groups revealed that the fish were in excellent condition, were more agile, and appeared to have a better colour. The internal organs were normal in appearance.

FMH affected the physiological profile of striped catfish significantly ( $p < 0.05$ ) compared with the controls. Thus, blood glucose levels and total serum protein increased from 78.67 to 97.33 mg/dL and 3.70 to 4.10 mg/dL; osmoregulation ranged from 288–327 mOsm/L H<sub>2</sub>O, absolute weight from 89.11–119.08 g, and the survival rate from 96–100% (Table 4).

### Discussion

This study has supported the use of FHM feed supplements in Indonesian aquaculture, and provided evidence for the mode of action. Thus, there were notable improvements in the hematological and physiological profiles of catfish. Indeed, similar results have been reported by other researchers. For example, Lee *et al.*<sup>23</sup> evaluated the dietary supplementation of citrus by-products (CB) fermented with probiotic bacteria on growth performance, feed utilization, innate immune responses and disease resistance of juvenile olive flounder. They noted that innate immunity was significantly enhanced by CBF–BS (CB fermented with *Bacillus subtilis*) supplementation. This study indicated that the fermentation of CB with probiotic had beneficial effects on innate immunity and thereby increased disease resistance. Furthermore, it is also supported by 17 the use of probiotics from herbal ingredients can increase the growth performance and feed efficiency of Keureling.

The important components of FMH are considered to be due to the content of secondary metabolites, namely curcuminoids, vitamin C, essential oils, tannins, and flavonoids, which trigger immunostimulation.<sup>24</sup> The presence of

**Table 2. Growth of striped catfish during the study.**

Treatment	Parameters				
	Absolute weight (g) ± SD	SGR (%/day) ± SD	FCR ± SD	Feed efficiency (%) ± SD	SR (%)
P0	89.11 ± 3.71 <sup>a</sup>	4.45 ± 0.05 <sup>a</sup>	1.57 ± 0.03 <sup>d</sup>	63.81 ± 1.51 <sup>a</sup>	96
P1	108.95 ± 0.09 <sup>b</sup>	4.72 ± 0.03 <sup>b</sup>	1.35 ± 0.01 <sup>c</sup>	73.87 ± 0.30 <sup>b</sup>	100
P2	119.08 ± 1.02 <sup>c</sup>	4.86 ± 0.02 <sup>c</sup>	1.21 ± 0.01 <sup>a</sup>	82.93 ± 0.42 <sup>d</sup>	100
P3	112.02 ± 1.18 <sup>b</sup>	4.77 ± 0.05 <sup>b</sup>	1.25 ± 0.01 <sup>b</sup>	79.99 ± 0.60 <sup>c</sup>	100

Note: Superscript letters on the same line show significantly different results between treatments ( $p < 0.05$ ). SGR: specific growth rate, FCR: feed conversion ratio, SR: survival rate.

**Table 3. Results of measurement of striped catfish hematological profile during the study.** Superscript letters on the same line show significantly different results between treatments ( $p < 0.05$ ). RBC: red blood cell ( $\times 10^6$  cells/mm<sup>3</sup>); WBC: white blood cell ( $\times 10^4$  cells/mm<sup>3</sup>).

Treatment	Parameters									
	RBC $\pm$ SD	Hematocrit (%) $\pm$ SD	Hemoglobin (g/dL) $\pm$ SD	WBC $\pm$ SD	Lymphocyte (%) $\pm$ SD	Monocyte (%) $\pm$ SD	Neutrophile (%) $\pm$ SD	Thrombocyte (%) $\pm$ SD		
Day 30										
P0	1.75 $\pm$ 0.03 <sup>a</sup>	29.00 $\pm$ 1.00 <sup>a</sup>	8.80 $\pm$ 0.20 <sup>a</sup>	9.20 $\pm$ 0.05 <sup>a</sup>	76.67 $\pm$ 0.58 <sup>a</sup>	7.33 $\pm$ 0.58	7.67 $\pm$ 0.58 <sup>b</sup>	8.67 $\pm$ 0.58 <sup>b</sup>		
P1	1.82 $\pm$ 0.01 <sup>b</sup>	35.00 $\pm$ 1.00 <sup>b</sup>	9.27 $\pm$ 0.23 <sup>b</sup>	9.47 $\pm$ 0.11 <sup>b</sup>	78.67 $\pm$ 0.58 <sup>b</sup>	6.67 $\pm$ 0.58	6.33 $\pm$ 0.58 <sup>ab</sup>	8.33 $\pm$ 0.58 <sup>b</sup>		
P2	1.91 $\pm$ 0.02 <sup>c</sup>	37.00 $\pm$ 1.00 <sup>b</sup>	10.73 $\pm$ 0.11 <sup>d</sup>	10.65 $\pm$ 0.05 <sup>d</sup>	81.67 $\pm$ 0.58 <sup>c</sup>	6.33 $\pm$ 0.58	5.33 $\pm$ 0.58 <sup>a</sup>	6.67 $\pm$ 0.58 <sup>a</sup>		
P3	1.85 $\pm$ 0.02 <sup>b</sup>	37.00 $\pm$ 1.00 <sup>b</sup>	9.87 $\pm$ 0.11 <sup>c</sup>	10.31 $\pm$ 0.03 <sup>c</sup>	79.33 $\pm$ 0.58 <sup>b</sup>	6.33 $\pm$ 0.58	6.67 $\pm$ 0.58 <sup>ab</sup>	7.67 $\pm$ 0.58 <sup>ab</sup>		
Days 60										
P0	1.89 $\pm$ 0.07 <sup>a</sup>	32.33 $\pm$ 2.08 <sup>a</sup>	9.20 $\pm$ 0.05 <sup>a</sup>	9.67 $\pm$ 0.14 <sup>a</sup>	77.33 $\pm$ 0.58 <sup>a</sup>	7.33 $\pm$ 0.58	7.33 $\pm$ 0.58 <sup>b</sup>	8.00 $\pm$ 1.00 <sup>b</sup>		
P1	2.45 $\pm$ 0.10 <sup>b</sup>	35.67 $\pm$ 0.58 <sup>b</sup>	9.47 $\pm$ 0.11 <sup>b</sup>	10.04 $\pm$ 0.09 <sup>b</sup>	79.67 $\pm$ 0.58 <sup>b</sup>	6.67 $\pm$ 1.15	6.67 $\pm$ 0.58 <sup>ab</sup>	7.00 $\pm$ 1.00 <sup>ab</sup>		
P2	2.81 $\pm$ 0.02 <sup>c</sup>	39.00 $\pm$ 1.00 <sup>c</sup>	10.65 $\pm$ 0.05 <sup>d</sup>	11.41 $\pm$ 0.09 <sup>d</sup>	82.33 $\pm$ 0.58 <sup>c</sup>	6.00 $\pm$ 1.00	6.00 $\pm$ 1.00 <sup>a</sup>	5.33 $\pm$ 0.58 <sup>a</sup>		
P3	2.53 $\pm$ 0.06 <sup>b</sup>	38.33 $\pm$ 0.58 <sup>c</sup>	10.31 $\pm$ 0.03 <sup>c</sup>	11.14 $\pm$ 0.13 <sup>c</sup>	80.33 $\pm$ 0.58 <sup>b</sup>	6.33 $\pm$ 0.58	6.67 $\pm$ 0.58 <sup>ab</sup>	6.67 $\pm$ 0.58 <sup>ab</sup>		

**Table 4. Physiological profile of striped catfish during the study.** Superscript letters on the same line show significantly different results between treatments ( $p < 0.05$ ). SR: survival rate.

Treatment	Parameters			
	Blood glucose (mg/dL) $\pm$ SD	Serum total protein (mg/dL) $\pm$ SD	Osmoregulation (mOsm/L H <sub>2</sub> O) $\pm$ SD	Absolute weight (g) $\pm$ SD
P0	67.33 $\pm$ 5.03 <sup>a</sup>	3.10 $\pm$ 0.27 <sup>a</sup>	293 $\pm$ 9.86 <sup>a</sup>	89.11 $\pm$ 3.71 <sup>a</sup>
P1	78.67 $\pm$ 4.16 <sup>b</sup>	3.70 $\pm$ 0.10 <sup>b</sup>	289.33 $\pm$ 7.51 <sup>a</sup>	108.95 $\pm$ 0.09 <sup>b</sup>
P2	97.33 $\pm$ 7.02 <sup>c</sup>	4.10 $\pm$ 0.10 <sup>c</sup>	289.67 $\pm$ 18.50 <sup>a</sup>	119.08 $\pm$ 1.02 <sup>c</sup>
P3	96.67 $\pm$ 5.51 <sup>c</sup>	3.97 $\pm$ 0.15 <sup>bc</sup>	327.00 $\pm$ 16.70 <sup>b</sup>	112.02 $\pm$ 1.18 <sup>b</sup>

curcuminoids provide an antioxidant effect on cell membranes reducing erythrocyte cell membrane damage due to oxidation.<sup>25</sup> Similarly, flavonoids are natural antioxidants, which are credited with the ability of reducing free radicals and anti-free radicals.<sup>26</sup>

The benefit of FMH for improved growth performance mirrors previous work by Hoseinifar *et al.*,<sup>27</sup> who reported that dietary application of the phytoimmunostimulant Persian hogweed (*Heracleum persicum*) improved growth significantly. Specifically, the final weight, weight gain, specific growth rate and feed conversion ratio were significantly improved in fish that received dietary *H. persicum* at or above 5 g/kg.<sup>27</sup>

Herbal supplements with different doses had an effect on the value of the catfish feed conversion ratio ( $p < 0.05$ ). The herbal supplement dose of 200 mL/kg of feed gave the best feed conversion ratio value of 1.23. This shows that giving herbal supplements at a dose of 200 mL/kg is more efficient than other doses, because the nutritional content has met the nutritional needs of fish. Increased feed conversion depends on feed quality, good feed quality can be digested and absorbed by the fish body to grow, and good feed nutritional quality is influenced by the high and low levels of protein in the feed.<sup>28</sup>

The content of metabolites such as curcumin and essential oils. Physically and chemically curcumin and essential oils have potential as feed additives in feed with the aim of increasing productivity, product quality, and health. Physiologically, these compounds work synergistically by stimulating the secretion of large amounts of dilute bile, so that the flow to the small intestine becomes larger and the absorption of feed in the small intestine is easier, and works in the process of emptying the gallbladder, so that the fluid products of the cells are produced. Liver increases, thus helping the process of absorption of food essence.<sup>29</sup>

This increase in blood glucose is related to feed quality. This blood glucose can be an immunosuppressor in fish, this is because when glucose levels in the blood are high, the kidneys work harder to maintain body balance.<sup>30</sup> When fish are stressed, fish need a lot of energy to adapt to the stress. The high need for energy to maintain life will stimulate the mobilization of glucose into the blood.<sup>31</sup>

Clearly, this study has demonstrated that dietary FMH, particularly when dosed at 200 mL/kg of feed, improved the hematological and physiological profile of catfish. Also, there was benefit for specific growth rate, feed conversion ratio and survival.

### Data availability

All data underlying the results are available as part of the article and no additional source data are required

### Acknowledgements

We are grateful to University of Riau, Ministry of Research, Technology and Higher Education of Indonesia for financial support.

### References

- Pandey G, Sharma M, Mandloi AK: **Medicinal plants useful in fish diseases.** *Review Article. Plant Archiv.* 2012; **12**: 1–4.  
[PubMed Abstract](#) | [Publisher Full Text](#)
- Pandey G, Sharma M: **Immunostimulant effect of medicinal plants on fish.** *Int. Res. J. Pharm.* 2014; **3**: 112–114.
- Gupta A, Mahajan S, Sharma R: **Evaluation of antimicrobial activity of *Curcuma longa* rhizome extract against *Staphylococcus aureus*.** *Biotechnol. Rep.* 2015; **6**: 51–55.  
[PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
- Nya EJ, Austin B: **Use of garlic, *Allium sativum*, to control *Aeromonas hydrophila* infection in rainbow trout, *Oncorhynchus mykiss* (Walbaum).** *J. Fish Dis.* 2009; **32**: 963–970.  
[PubMed Abstract](#) | [Publisher Full Text](#)
- Christyapita D, Divyagnaneswari M, Michael RD: **Oral administration of *Eclipta alba* leaf aqueous extract enhances the non-specific immune responses and disease resistance of *Oreochromis mossambicus*.** *Fish Shellfish Immunol.* 2007; **23**: 840–852.  
[PubMed Abstract](#) | [Publisher Full Text](#)
- Newaj-Fyzul A, Austin B: **Probiotics, immunostimulants, plant products and oral vaccines, and their role as feed supplements in the control of bacterial fish diseases.** *Fish Dis.* 2014; **38**: 937–955.  
[PubMed Abstract](#) | [Publisher Full Text](#)
- Bilen S, Elbeshti HTAG: **A new potential therapeutic remedy against *Aeromonas hydrophila* infection in rainbow trout (*Oncorhynchus mykiss*) using tetra, *Cotinus caggyria*.** *J. Fish Dis.* 2019; **42**: 1369–1381.  
[PubMed Abstract](#) | [Publisher Full Text](#)
- Asely AME, Shaheen AA, Abbass AA, *et al.*: **Immunomodulatory effect of plant-mixed feed in kuruma shrimp, *Marsupenaeus japonicus*, and its protective efficacy against white spot syndrome virus infection.** *J. Fish Dis.* 2010; **33**: 859–863.  
[PubMed Abstract](#) | [Publisher Full Text](#)

9. Yu Q, Liu M, Xiao H, *et al.*: **The inhibitory activities and antiviral mechanism of *Viola philippica* aqueous extracts against grouper iridovirus infection in vitro and in vivo.** *J. Fish Dis.* 2019; **42**: 859–866.  
[PubMed Abstract](#) | [Publisher Full Text](#)
10. Foysal MJ, Alam M, Momtaz F, *et al.*: **Dietary supplementation of garlic (*Allium sativum*) modulates gut microbiota and health status of tilapia (*Oreochromis niloticus*) against *Streptococcus iniae* infection.** *Aquacult. Res.* 2019; **50**: 2107–2116.  
[Publisher Full Text](#)
11. Amonkar SV, Banerji A: **Isolation and characterization of larvacidal principle of garlic.** *Science.* 1971; **174**(4016): 1343–1344.  
[PubMed Abstract](#) | [Publisher Full Text](#)
12. Soffer SA, Mokhtar GM: **Evaluation of the antiparasitic effect of aqueous garlic (*Allium sativum*) extract in *Hymenolepis nana* and giardiasis.** *J. Egypt. Soc. Parasitol.* 1991; **21**: 497–502.  
[PubMed Abstract](#)
13. Awad E, Austin B: **Use of lupin, *Lupinus perennis*, mango, *Mangifera indica*, and stinging nettle, *Urtica dioica*, as feed additives to prevent *Aeromonas hydrophila* infection in rainbow trout, *Oncorhynchus mykiss* (Walbaum).** *J. Fish Dis.* 2010; **33**: 413–420.  
[PubMed Abstract](#) | [Publisher Full Text](#)
14. Awad E, Awad A: **Role of medicinal plants on growth performance and immune status in fish.** *Fish Shellfish Immunol.* 2017; **67**: 40–54.  
[PubMed Abstract](#) | [Publisher Full Text](#)
15. Yin G, Ardo L, Jeney Z, *et al.*: **Chinese herbs (*Lonicera japonica* and *Ganoderma lucidum*) enhance non-specific immune response of tilapia, *Oreochromis niloticus* and protection against *Aeromonas hydrophila*.** In: *Diseases in Asian Aquaculture VI, Fish Health Section.* (Bondad-Reantaso MG, Mohan CV, Crumlish M, Subasinghe RP eds.). Manila, Philippines: Asian Fisheries Society; 2008; 269–282.
16. Dadras H, Hayatbakhsh MR, Shelton WL, *et al.*: **Effects of dietary administration of rose hip and safflower on growth performance, haematological, biochemical parameters and innate immune response of Beluga, *Huso huso* (Linnaeus, 1758).** *Fish Shellfish Immunol.* 2016; **59**: 109–114.  
[PubMed Abstract](#) | [Publisher Full Text](#)
17. Muchlisin ZA, Murda T, Yulvizar Y, *et al.*: **Growth performance and feed utilization of keureling fish *Tor tambra* (Cyprinidae) fed formulated diet supplemented with enhanced Probiotic.** *F1000Res.* 2017; **6**: 137.  
[PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
18. Windarti W, Amin B, Simarmata AH: **Growth and health status of Pangasionodon hypophthalmus reared under manipulated photo period conditions.** *F1000Research.* 2021; **10**: 154.
19. Blaxhall PC, Daisley KW: **Routine haematological methods for use with fish blood.** *J. Fish Biol.* 1973; **5**: 577–581.  
[Publisher Full Text](#)
20. Patil PJ, Thakare GV, Patil SP: **Variability and Accuracy of Sahli's Method in Estimation of Haemoglobin Concentration.** *Natl J Integr Res Med.* 2013; **4**(1).
21. Philipson HL, Stefani CE, Victoria EP, *et al.*: **Blood sugar measurement in zebrafish reveals dynamics of glucose homeostasis.** *Zebrafish.* 2010; **7**(2).  
[PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
22. Anderson DP, Siwicki AK: **Basic hematology and serology for fish health programs.** *Asian Fisheries Society; Fish Health Section. Symposium 2, Phuket; Thailand.* In: *Diseases In Asia Aquaculture.* 1995; **2**: 185–202.
23. Lee BJ, Kim SS, Song JW, *et al.*: **Effects of dietary supplementation of citrus by-products fermented with a probiotic microbe on growth performance, innate immunity and disease resistance against *Edwardsiella tarda* in juvenile olive flounder, *Paralichthys olivaceus* (Temminck & Schlegel).** *J. Fish Dis.* 2013; **36**: 617–628.  
[PubMed Abstract](#) | [Publisher Full Text](#)
24. Ikawati Z, Yuniarti N, Margono SA: **The analgesic effect of a curcumin analogue 1,5-bis (4'-hydroxy-3'-methoxyphenyl)-1,4-pentadien-3-on (Gamavuton-0) in acute and persistent pain.** *J. Appl. Pharmaceut. Sci.* 2014; **4**: 48–51.
25. Maribito R, Falliti G, Geraci A, *et al.*: **Curcumin protects -sh group and sulphate transport after oxidative damage in human erythrocytes.** *Cell Physiol Biochem.* 2015; **36**: 345–357.  
[PubMed Abstract](#) | [Publisher Full Text](#)
26. Nimse SB, Pal D: **Free radicals, natural antioxidants, and their reaction mechanisms.** *RSC Adv.* 2015; **5**: 27986–28006.  
[Publisher Full Text](#)
27. Hoseinifar HS, Zoheiri F, Lazado CC: **Dietary phytoimmunostimulant Persian hogweed (*Heracleum persicum*) has more remarkable impacts on skin mucus than on serum in common carp (*Cyprinus carpio*).** *Fish Shellfish Immunol.* 2016; **59**: 77–82.  
[PubMed Abstract](#) | [Publisher Full Text](#)
28. Utomo NB, Susan M, Setiawati: **Peran Tepung Ikan dari Berbagai Bahan Baku terhadap Pertumbuhan Lele Sangkuriang *Clarias sp.*** *Jurnal Akuakultur Indonesia.* 2013; **12**(2): 158–168.
29. Suryana M, Syakir YM: **Efektivitas Larutan Herbal dalam Memperbaiki Performa Pertumbuhan dan Nilai Ekonomi Itik.** *Jurnal Pengkajian dan Pengembangan Teknologi Pertanian.* 2017; **20**(2): 101–110.
30. Hardi EH, Sukenda, Harris E, *et al.*: **Efek Infeksi Bakteri *Streptococcus agalactiae* terhadap Kadar Hematokrit dan Glukosa Ikan Nila (*Oreochromis niloticus*).** *Jurnal Ilmu Perikanan Tropis.* 2011; **15**(1): 29–34.
31. Syawal H, Ikhwan Y: **Fisiologi Ikan Jambal Siam (*Pangasius hypophthalmus*) pada Suhu Pemeliharaan yang Berbeda.** *Berkala Perikanan Terubuk.* 2011; **39**(1): 51–57.



# Open Peer Review

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## Version 3

Reviewer Report 20 April 2022

<https://doi.org/10.5256/f1000research.128325.r135069>

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**Mohammed El Basuini** 

Department of Animal Production, Faculty of Agriculture, Tanta University, Tanta, Egypt

The authors have included all the comments properly and no more comments.

**Competing Interests:** No competing interests were disclosed.

**Reviewer Expertise:** Aquaculture; Immunology; Nutrition

**I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.**

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## Version 2

Reviewer Report 06 January 2022

<https://doi.org/10.5256/f1000research.77351.r102340>

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**Mohammed El Basuini** 

Department of Animal Production, Faculty of Agriculture, Tanta University, Tanta, Egypt

More background is required on the application of fermented plant-based diets in aquaculture.

A simple paragraph or summary on the type of fish used in terms of importance, production, or normal distribution.

"fermented medicinal herbs (FMH) in combination with molasses and probiotic drink (Yakult) have been used successfully as dietary supplements on a small number of rural catfish farms in Sumatra, Indonesia, for approximately two years." - Is there any data published?

The chemical composition, especially the percentage of protein and lipid in the feed provided to fish, must be clarified.

The absolute weight equation:  $W_0$  = average **weight** at the beginning of the study (g). Correct it.

SGR equation is not correct. The correct formula is  $SGR = (\ln W_t - \ln W_0) / t$  where:

- SGR = Specific Growth Rate
- Ln = Natural logarithm
- $W_t$  = Weight of fish at the end of the experimental period (T)
- $W_0$  = Weight of fish at the initial of the experimental period
- t = Experimental period in days

Does data meet the assumption of homogeneity of variances? Clarify if the authors ran a homogeneity test. How authors presented their results (Means  $\pm$  SE or SD).

Feed utilization (FCR and feed efficiency) is not described in the result section.

Glucose is an indicator of exposure to stress, as glucose level rises with the level of stress. How do the authors explain the increased glucose level with feed additives?

**Is the work clearly and accurately presented and does it cite the current literature?**

Partly

**Is the study design appropriate and is the work technically sound?**

Yes

**Are sufficient details of methods and analysis provided to allow replication by others?**

Partly

**If applicable, is the statistical analysis and its interpretation appropriate?**

Partly

**Are all the source data underlying the results available to ensure full reproducibility?**

No source data required

**Are the conclusions drawn adequately supported by the results?**

Yes

**Competing Interests:** No competing interests were disclosed.

**Reviewer Expertise:** Aquaculture; Immunology; Nutrition

**I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.**

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**Version 1**

Reviewer Report 31 August 2021

<https://doi.org/10.5256/f1000research.55942.r92787>

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**Saurav Kumar**

Aquatic Environment and Health Management Division, ICAR- Central Institute of Fisheries Education, Mumbai, India

**Title:**

- Correct *Pangasianodon* spelling.

**Abstract:**

- Write only significant results and no need to mention values of estimated parameters in this section.

**Introduction:**

- Author needs to highlight the researchable problem with normal herbal immunostimulant, and why is the fermentation process required for preparing the product?

**Methodology:**

- Fish acclimatization and standard procedure of FHM product preparation need to be mentioned with suitable references.
- Statistical analysis of data needs to be mentioned.

**Results:**

- Why do the significant change in the control group observe in RBC of 30 days sampled fish from 60 days?
- Do the experimental periods have a significant effect on observed parameters?
- Similar changes are also observed in haemoglobin, hematocrite values...

**Discussion:**

- The section is well written however the mechanism need to be illustrated.

**References:**

- Very few recent references and authors need to cite the recent findings.

**Is the work clearly and accurately presented and does it cite the current literature?**

Partly

**Is the study design appropriate and is the work technically sound?**

Yes

**Are sufficient details of methods and analysis provided to allow replication by others?**

Partly

**If applicable, is the statistical analysis and its interpretation appropriate?**

No

**Are all the source data underlying the results available to ensure full reproducibility?**

Partly

**Are the conclusions drawn adequately supported by the results?**

Yes

**Competing Interests:** No competing interests were disclosed.**Reviewer Expertise:** Aquatic Environment and Health Management

**I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.**

Reviewer Report 22 July 2021

<https://doi.org/10.5256/f1000research.55942.r87441>

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**S. M. Sharifuzzaman**

Institute of Marine Sciences, University of Chittagong, Chittagong, Bangladesh

**Some specific comments:**

1) Please revise title as "Fermented medicinal herbs improve hematological and physiological profiles of Striped catfish (*Pangasionodon hypophthalmus*)"

2) "Some researchers have reported the impact of herbal supplemented diets on hematology and innate immunity of fish" - so why were you combining molasses and probiotics? Please explain this in introduction section.

3) What were the probiotics cell numbers in different experimental diets?

4) An additional experiment with medicinal herbs, i.e. cutchery (*Kaempferia galanga*), turmeric (*Curcuma longa*) and curcuma (*Curcuma zanthorrhiza*) devoid of molasses, probiotic drink (Yakult) and yeast (*Saccharomyces cerevisiae*) would be interesting to determine the role of probiotics and prebiotics - the authors are requested to include it.

**Is the work clearly and accurately presented and does it cite the current literature?**

Yes

**Is the study design appropriate and is the work technically sound?**

Partly

**Are sufficient details of methods and analysis provided to allow replication by others?**

Partly

**If applicable, is the statistical analysis and its interpretation appropriate?**

Yes

**Are all the source data underlying the results available to ensure full reproducibility?**

Yes

**Are the conclusions drawn adequately supported by the results?**

Yes

**Competing Interests:** No competing interests were disclosed.

**Reviewer Expertise:** Aquaculture health and nutrition

**I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.**

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