



Siti Aslamyah &lt;sitiaslamyah1@gmail.com&gt;

---

**Fw: Redirecționat: Research Paper Submission**

16 pesan

---

**gavriloaie ionel claudiu** <ionelclaudiu@yahoo.com>  
Balas Ke: gavriloaie ionel claudiu <ionelclaudiu@yahoo.com>  
Kepada: "sitiaslamyah1@gmail.com" <sitiaslamyah1@gmail.com>

12 Oktober 2017 pukul 17.20

Dear Dr. Aslamyah,

We received and already analyzed your paper. It looks suitable for publication in our journal  
The reviewers will provide more specific comments.  
After acception, a publication fee of 200 USD should be paid. But we will discuss later more details about that.

For the moment I only need from you to approve sending the manuscript to reviewers.  
Thank you very much!

Respectfully yours,  
Claudiu Gavrioloaie, PhD  
editor-in-chief AACL Bioflux journal

P.S. Keep in touch with me instead dr. Petrescu-Mag, because I will be your editor. Thank you!

----- Mesaj redirecționat -----

**De la:** Siti Aslamyah <sitiaslamyah1@gmail.com>

**Către:** zoobiomag2004@yahoo.com

**Trimis:** Miercuri, 11 Octombrie 2017 14:55:09

**Subiect:** Research Paper Submission

Dear AACL Bioflux Publisher

We are interesting to publish our research paper in aacl, here we attached the manuscript. Please inform to us for the next progress. Thank You

Regard

Siti Aslamyah

Virus-free. [www.avast.com](http://www.avast.com)



**submit, aslamyah-fermented.doc**  
111K

---

**Siti Aslamyah** <sitiaslamyah1@gmail.com>  
Kepada: gavriloaie ionel claudiu <ionelclaudiu@yahoo.com>

7 November 2017 pukul 10.07

Dear Bioflux Admin

Please inform to us the progress of our manuscript  
Thank You

[Kutipan teks disembunyikan]

---

**gavriloaie ionel claudiu** <ionelclaudiu@yahoo.com>  
Balas Ke: gavriloaie ionel claudiu <ionelclaudiu@yahoo.com>  
Kepada: Siti Aslamyah <sitiaslamyah1@gmail.com>

7 November 2017 pukul 23.06

Dear Dr. Aslamyah,

On October 12 I was sending you a message, asking for your approval for sending the manuscript to the reviewers. I received no answer until today, when you ask me about the status of your paper. It seems you did not see my message from October 12. Please check again your e-mail.

Because I did not have a clear approval from you, your paper is still pending. So, let me know in a very clear way that you agree to have your manuscript sent to reviewers. Without your explicit approvement I cannot do anything.  
Thank you very much!

With best regards,  
Claudiu Gavrioloaie

[Kutipan teks disembunyikan]

---

**Siti Aslamyah** <sitiaslamyah1@gmail.com>  
Kepada: gavriloaie ionel claudiu <ionelclaudiu@yahoo.com>

8 November 2017 pukul 21.34

Dear Claudiu Gavrioloaie, PhD. i apologize about the inconvenience because i did not see your email. i am very glad that our paper suitable for your journal. i approve to sending our manuscript to reviewers. i will wait for the next announcement.

Regard

Siti Aslamyah



Virus-free. [www.avast.com](http://www.avast.com)

[Kutipan teks disembunyikan]

---

**gavriloaie ionel claudiu** <ionelclaudiu@yahoo.com>  
Balas Ke: gavriloaie ionel claudiu <ionelclaudiu@yahoo.com>  
Kepada: Siti Aslamyah <sitiaslamyah1@gmail.com>

8 November 2017 pukul 21.47

Good day,

Thank you very much for the message. The reviewers will start working on the manuscript.  
Keep in touch!

Cordially yours,  
Claudiu Gavriloaie

[Kutipan teks disembunyikan]

---

**Siti Aslamyiah** <sitiaslamyiah1@gmail.com>  
Kepada: gavriloaie ionel claudiu <ionelclaudiu@yahoo.com>

19 November 2017 pukul 09.13

Thank You for the message, Yes ofcourse, we approve it to be processed to the reviewer.

Best Regard

Siti Aslamyiah

[Kutipan teks disembunyikan]

---

**Siti Aslamyiah** <sitiaslamyiah1@gmail.com>  
Kepada: gavriloaie ionel claudiu <ionelclaudiu@yahoo.com>

12 Januari 2018 pukul 03.43

Dear Dr. Gavriloaie Claudiu

If you do not mind, may we know the process of our manuscript please.

thank you.

best regard

[Kutipan teks disembunyikan]

---

**gavriloaie ionel claudiu** <ionelclaudiu@yahoo.com>  
Balas Ke: gavriloaie ionel claudiu <ionelclaudiu@yahoo.com>  
Kepada: Siti Aslamyiah <sitiaslamyiah1@gmail.com>

12 Januari 2018 pukul 19.11

Dear Dr. Aslamyiah,

The revision for your paper entitled "**Fishing technique and environmental factors affecting the size of razor clam *Solen sp. in Indonesia coast***" is almost done. I need a couple of days to put together all the comments and to check the references list.

Thank you!

Cordially yours,  
Claudiu Gavriloaie

[Kutipan teks disembunyikan]

---

**Siti Aslamyiah** <sitiaslamyiah1@gmail.com>  
Kepada: gavriloaie ionel claudiu <ionelclaudiu@yahoo.com>

16 Januari 2018 pukul 16.36

Dear Dr Claudius Gavriloaie

Thank you for reading and replying to the email, but the title should be "effect of fermented seaweed addition on blood glucose level, hepatosomatic index, and gastric evacuation rate of milkfish chanos chanos forsskal larvae.

Thank you

[Kutipan teks disembunyikan]

---

**gavriloaie ionel claudiu** <ionelclaudiu@yahoo.com>  
Balas Ke: gavriloaie ionel claudiu <ionelclaudiu@yahoo.com>  
Kepada: Siti Aslamyiah <sitiaslamyiah1@gmail.com>

16 Januari 2018 pukul 18.01

Dear Dr. Aslamyiah,

I am very sorry for the mistake. Yes, you are right. I am almost done. In an hour you will have the revision.

Thank you!

Cordially yours,  
Claudiu Gavriloaie

[Kutipan teks disembunyikan]

---

**Siti Aslamyah** <sitiaslamyah1@gmail.com>  
Kepada: gavriloaie ionel claudiu <ionelclaudiu@yahoo.com>

17 Januari 2018 pukul 17.45

Dear Gavriloaie ionel claudiu.

I would like thank you very much for revising my manuscript.

But, I am so sorry, could you send me again the manuscript that had revised by you?because there is a mistake when i was download it last morning.

Thank you very for your attention and kindness.

Best Regards,  
Siti Aslamyah

[Kutipan teks disembunyikan]

---

**gavriloaie ionel claudiu** <ionelclaudiu@yahoo.com>  
Balas Ke: gavriloaie ionel claudiu <ionelclaudiu@yahoo.com>  
Kepada: Siti Aslamyah <sitiaslamyah1@gmail.com>

17 Januari 2018 pukul 21.38

Good day,

Yes, of course. Here you have the revised paper and the letter of acceptance.

Keep in touch!

Cordially yours,  
Claudiu Gavriloaie

[Kutipan teks disembunyikan]

---

## 2 lampiran

 **Aslamyah et al - Letter of acceptance.pdf**  
78K

 **Aslamyah et al - review & comments.doc**  
140K

---

**Siti Aslamyah** <sitiaslamyah1@gmail.com>  
Kepada: Akbar Marzuki Tahya <amtahya@gmail.com>

18 Januari 2018 pukul 07.28

----- Pesan terusan -----

Dari: "gavriloaie ionel claudiu" <ionelclaudiu@yahoo.com>

Tanggal: 17 Jan 2018 22:38

Subjek: Re: Fw: Redirectionat: Research Paper Submission

Kepada: "Siti Aslamyah" <sitiaslamyah1@gmail.com>

Cc:

[Kutipan teks disembunyikan]

---

## 2 lampiran

 **Aslamyah et al - Letter of acceptance.pdf**  
78K

 **Aslamyah et al - review & comments.doc**  
140K

---

**Siti Aslamyah** <sitiaslamyah1@gmail.com>  
Kepada: gavriloaie ionel claudiu <ionelclaudiu@yahoo.com>

1 Februari 2018 pukul 10.03

Dear Dr Claudiu

Here we attached the revision based reviewers comments thank you, and hope it will publish as soon as possible.

regard

[Kutipan teks disembunyikan]

---

 **Aslamyah et al - review & comments - Copy.doc**  
139K

---

**gavriloaie ionel claudiu** <ionelclaudiu@yahoo.com>  
Balas Ke: gavriloaie ionel claudiu <ionelclaudiu@yahoo.com>  
Kepada: Siti Aslamyah <sitiaslamyah1@gmail.com>

1 Februari 2018 pukul 17.26

Dear Dr. Aslamyah,

Please highlight with a bright color all the changes you have done in text, as I requested in my previous message. I suggest to use yellow or green or blue colors. After that send me the paper again.

The paper will be uploaded as soon as we get the publication fee. So, this totally depends on how fast you pay the fee.

Do not forget to send me a scan copy of the bank document after the money transfer.

Thank you very much!

Cordially yours,  
Claudiu Gavrioloaie

[Kutipan teks disembunyikan]

---

**Siti Aslamyah** <sitiaslamyah1@gmail.com>  
Kepada: gavriloaie ionel claudiu <ionelclaudiu@yahoo.com>

2 Februari 2018 pukul 11.01

Thank You, Here We attached the paper with highlighted. Please inform to us the payment, if the paper will ready for the process of publication.

regards

[Kutipan teks disembunyikan]

---

 **Aslamyah et al - review & comments - Copy.doc**  
143K



Siti Aslamyah &lt;sitiaslamyah1@gmail.com&gt;

---

**the paper "Effect of fermented seaweed addition ..." - variants of payment**

4 pesan

---

**gavriloaie ionel claudiu** <ionelclaudiu@yahoo.com>  
Balas Ke: gavriloaie ionel claudiu <ionelclaudiu@yahoo.com>  
Kepada: "sitiaslamyah1@gmail.com" <sitiaslamyah1@gmail.com>

2 Februari 2018 pukul 17.30

Dear Dr. Aslamyah,

I received the revised version of the manuscript. I started to edit the final form.

Please pay the publication fee of 200 USD + bank taxes by using only one of the variants below. After the payment, send me a scan copy of the bank document.

I am sending you again the letter of acceptance.  
Thank you very much!

Cordially yours,  
Claudiu Gavriiloaie

**1st variant of payment:**

Beneficiary: Bioflux SRL  
City: Cluj-Napoca,  
Country: Romania, European Union;  
SWIFT CODE of the bank: BTRLRO22  
Account (IBAN):  
USD: RO68BTRL01302202L28614XX (Cluj-Napoca)  
EURO: RO19BTRL01304202L28614XX (Cluj-Napoca)  
Bank:  
BANCA TRANSILVANIA

**Important!** When bank transfer is used to pay a publication fee, please pay attention to which modality of payment you chose! There are three options: Ben, Our, Us. Use always "Us" option (meaning that all the bank transfer costs are in your concern/ authors support them and not the publisher). If you forgot to mention that and you let the bank to set "Ben" or "Our" options, we receive about 60 usd instead of 100 usd or about 140 usd instead of 200 usd. Such payments are not valid and you need to pay again for the rest of the sum and one more transfer charge. We think you do not want that.

**2nd variant of payment:**

via Paypal. If you can process such a payment we can start the online form. For this variant, please contact dr. Petrescu-Mag ([zoobiomag2004@yahoo.com](mailto:zoobiomag2004@yahoo.com)).

---

 **Aslamyah et al - Letter of acceptance.pdf**  
78K

Siti Aslamyah <sitiaslamyah1@gmail.com>  
Kepada: gavrioloaie ionel claudiu <ionelclaudiu@yahoo.com>

9 Februari 2018 pukul 14.00

Dear Dr Claudiu

Here We attached a scan copy of the bank document payment the publication fee our manuscript the title "effect of fermented seaweed addition on blood glucose level, hepatosomatic index, and gastric evacuation rate of milkfish chanos chanos forsskal larvae.

Thank you

[Kutipan teks disembunyikan]

3 lampiran



scan 1.jpeg  
1696K



scan 2.jpeg  
2095K



scan 3.jpeg  
4014K

**gavrioloaie ionel claudiu** <ionelclaudiu@yahoo.com>  
Balas Ke: gavrioloaie ionel claudiu <ionelclaudiu@yahoo.com>  
Kepada: Siti Aslamyah <sitiaslamyah1@gmail.com>

9 Februari 2018 pukul 18.58

Dear Dr. Aslamyah,

I received the documents! My colleague Petrescu-Mag will check the bank account.  
You will receive the final form of the paper as soon as possible.

Thank you!

With best regards,  
Claudiu Gavrioloaie

[Kutipan teks disembunyikan]

---

**Siti Aslamyah** <sitiaslamyah1@gmail.com>  
Kepada: gavrioloaie ionel claudiu <ionelclaudiu@yahoo.com>

11 Februari 2018 pukul 15.07

Dear Dr. Claudiu

I will wait the final form of our paper.  
Thank you very much.

With best regards

Siti Aslamyah

[Kutipan teks disembunyikan]



Siti Aslamyah &lt;sitiaslamyah1@gmail.com&gt;

---

**the final form of the paper - Effect of fermented seaweed addition ....**

4 pesan

**gavriloaie ionel claudiu** <ionelclaudiu@yahoo.com>

25 Februari 2018 pukul 22.10

Balas Ke: gavriloaie ionel claudiu &lt;ionelclaudiu@yahoo.com&gt;

Kepada: "hasni\_yulianti@yahoo.com" &lt;hasni\_yulianti@yahoo.com&gt;, "sitiaslamyah1@gmail.com" &lt;sitiaslamyah1@gmail.com&gt;

Dear Dr. Aslamyah,

Here you have the final form of your paper. I have made many corrections within the references section.


Kindly check the paper carefully and then let me know if you agree with the publication in this form.

Also check the title online: <http://www.abah.bioflux.com.ro/home/volume-10-1-2018/>.

Thank you very much!

Cordially yours,  
Claudiu Gavriiloaie

---

 **2018.226-231.pdf**  
82K**gavriloaie ionel claudiu** <ionelclaudiu@yahoo.com>

28 Februari 2018 pukul 21.15

Balas Ke: gavriloaie ionel claudiu &lt;ionelclaudiu@yahoo.com&gt;

Kepada: "sitiaslamyah1@gmail.com" &lt;sitiaslamyah1@gmail.com&gt;

Dear Dr. Aslamyah,

We need to close the current issue very soon. So, kindly answer the message below in the shortest time.

Thank you very much!

With best regards,  
Claudiu Gavriiloaie

On Sunday, February 25, 2018 4:10 PM, gavriloaie ionel claudiu <ionelclaudiu@yahoo.com> wrote:

Dear Dr. Aslamyah,

Here you have the final form of your paper. I have made many corrections within the references section.

Kindly check the paper carefully and then let me know if you agree with the publication in this form.

Also check the title online: [Volume 11\(1\)/2018 - Bioflux - Aquaculture, Aquarium, Conservation & Legislation](#).


**Volume 11(1)/2018 - Bioflux - Aquaculture,  
Aquarium, Conservation & Legislation**

By simple-webdesign.com  
New issue release

---

[Kutipan teks disembunyikan]

---

 **2018.226-231.pdf**  
82K

---

**Siti Aslamyah** <sitiaslamyah1@gmail.com>  
Kepada: gavriloaie ionel claudiu <ionelclaudiu@yahoo.com>

3 Maret 2018 pukul 21.01

We are apologize for late response.. thank you for the email, we are agree with the paper and please process the paper in publishing step.

Best regards.

[Kutipan teks disembunyikan]

---

**gavriloaie ionel claudiu** <ionelclaudiu@yahoo.com>  
Balas Ke: gavriloaie ionel claudiu <ionelclaudiu@yahoo.com>  
Kepada: Siti Aslamyah <sitiaslamyah1@gmail.com>

4 Maret 2018 pukul 23.09

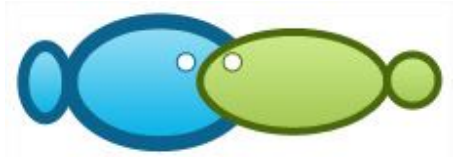
Dear Dr. Aslamyah,

I already uploaded the paper: <http://www.bioflux.com.ro/home/volume-11-1-2018/>.  
Thank you very much for publishing with us!

With best regards,  
Claudiu Gavrioloaie

[Kutipan teks disembunyikan]

OPEN ACCESS



Bioflux (publishing house)  
54 Ceahlau Street,  
Cluj-Napoca 400488,  
Romania, European Union

### Certificate/Letter of acceptance

This certificate shows that your manuscript entitled:  
**Effect of fermented seaweed addition on blood glucose level, hepatosomatic index,  
and gastric evacuation rate of milkfish, *Chanos chanos* larvae**

Authors:  
**Siti Aslamyah, M. Yusri Karim, Badraeni, Akbar M. Tahya**

was accepted for publication in vol 11, issue 1 (2018) of the scientific/academic journal:  
Aquaculture, Aquarium, Conservation & Legislation–  
International Journal of the Bioflux Society.

Thank you for publishing with us!

Cordially yours,

Editor-in-chief:  
Claudiu Gavriiloaie, PhD



# AACL BIOFLUX

Aquaculture, Aquarium, Conservation & Legislation  
International Journal of the Bioflux Society

## Effect of Fermented Seaweed Addition on Blood Glucose Level, Hepatosomatic Index, and Gastric Evacuation Rate of Milkfish *Chanos chanos* Forsskal Larvae

<sup>1</sup>Siti Aslamyah, <sup>1</sup>Muh. Yusri Karim, <sup>1</sup>Badraeni, and <sup>2</sup>Akbar Marzuki Tahya

<sup>1</sup>Study Program of Aquaculture, Faculty of Marine Science and Fisheries, Hasanuddin University, Makassar, Indonesia; <sup>2</sup>Balik Diwa Marine Technology University, Makassar, Indonesia. Corresponding author: Aslamyah, sitiaslamyah1@gmail.com

**Abstract.** Seaweed is a fishery product which can be used as the source of carbohydrate and binder in fish feed composition. However, excessive use of seaweed results in high crude fiber. The effort that is able to conduct is fermentation. The aim of this study was to evaluate a variety of seaweeds fermented using microorganism towards glucose level, hepatosomatic index and gastric evacuation rate to see the impact of seaweed use on fish. Five types of seaweed used were green strain of *Kappaphycus alvarezii*, brown strain of *K. alvarezii*, *Gracillaria gigas*, *Sargassum* sp. and *Caulerpa* sp. The measurement result of blood glucose level, hepatosomatic index, and gastric evacuation rate consistently showed the highest value on the use of seaweed *G. gigas*.

**Key Words:** Fermentation, microorganism, seaweed, feed ingredient, milkfish larvae.

**Introduction.** Milkfish is one of superior brackish water commodities in Indonesia. Many pond fish farmers cultivate this species in traditional system which only relies on live food available in the pond. However, increasing population and increase in demand which are not balanced by the availability of fish farming area makes intensive fish farming system becomes an option. Intensification of milkfish farming business at high stocking density completely depends on artificial food in the form of pellet. This condition causes the feed to be one of production factors that spends the highest cost, reaching approximately 60% of total production cost.

Several studies have been conducted in an effort to suppress the feed cost without reducing the quality of the feed itself. Fish feed quality, in addition to be determined by nutritional content, is also determined by physical quality, particularly the stability in the water. One of ingredients that determine the quality is binder. Additional material used as binder highly determines the stability of feed in the water (Meyer & Zein-Eldin 1972).

One of fishery products containing carbohydrate as well as has a function as binder is seaweed. In general, seaweed consists of water (27.8%), protein (5.4%), carbohydrate (33.3%), fat (8.6%), crude fiber (3%) and ash (22.25%). Besides carbohydrate, protein, fat, and fiber, seaweed also contains enzyme, nucleic acid, amino acid, vitamin (A, B, C, D, E, and K), macro minerals such as nitrogen, oxygen, calcium and selenium and also micro minerals like iron, magnesium and sodium.

In the previous study, we have reported that the use of artificial feed contained fermented seaweed as binder and carbohydrate source showed increasing growth, survival, digestibility level, and body chemical composition of milkfish juvenile (Aslamyah *et al.*, 2016). In this study, results of glycogen level in liver and muscle, blood glucose level, hepatosomatic index, and gastric evacuation rate of milkfish fed artificial feed contained fermented seaweed were reported. This study was aimed specifically to

determine the best quality feed ingredient for milkfish by using seaweed as carbohydrate source and binder.

### **Material and Method.**

**Milkfish juvenile.** Experimental fish used was milkfish (*Chanos chanos forsskal*) juvenile at  $5.57 \pm 0.22$  g in weight. The next procedure was in accordance with the procedure conducted by Aslamyah *et al.* (2016).

**Seaweed.** Seaweeds used in this study were green strain of *K. alvarezii*, brown strain of *K. alvarezii*, *G. gigas*, *Sargassum* sp. and *Caulerpa* sp. obtained from seaweed farmers in Punaga Village, Takalar Regency. Seaweeds were cleaned and dried, and further crushed into flour.

**Fermentation process.** Fermentation process was done by using 3 species of microorganism with fermentation composition as follows a). *Bacillus* sp. bacteria of 2 mL/100 g seaweed powder. b), 1.5% of ragi tape (yeast) as the source of *Rhizopus* sp. c), 1.5% baker's yeast as the source of *Saccharomyces* sp. d), mix of *Bacillus* sp. : *Rhizopus* sp. : *Saccharomyces* sp. at ratio of 1 mL : 1 g : 1 g/100 g seaweed flour and control treatment resulted from fermentation process without using any bacteria. The best fermentation product was applied as fish feed mix to be used in further treatments.

Fermentation was started by weighing each of 100 g seaweed and further seaweeds were put into plastic with sealing. Every package was added with microorganism solved in 20 mL sugar cane drop in each treatment by evenly sprayed it using sprayer. The package was tightly closed and incubated for 72 hours. After 72 hours, seaweed flour was steamed in boiled water for 1-2 minutes to inactivate microorganism activity.

**Blood glucose level.** Observation of blood glucose level on experimental fish was done at the end of study. Milkfish was fasted for 24 hours and further fed to full. Experimental fish was transferred into container of large basin with aeration. Collection of experimental fish blood was started at hour-0 and hour- 1, 2, 4, 5, 6, 8, 10, 12, 14, 16, and 20 post prandial. Sample of experimental fish blood was collected from the gills and vena caudal by using sput of 1 mL volume. Measurement of blood glucose level was performed through colorimetric analysis using reagent kit.

**Hepatosomatic Index.** Hepatosomatic index was calculated by comparing the total weight of fish and the weight of liver. At first, fish was weighed for its weight, after that fish was dissected on ice. Dissection was carefully and at quickly performed. Moreover, the liver was weighed. The value of hepatosomatic index was measured based on the equation below:

$$IH = HP/W$$

Where: IH = Hepatosomatic index  
HP = Hepatosomatic weight (g)  
W = Fish weight (g)

**Gastric evacuation rate.** Observation of gastric evacuation rate was done at the end of study. Furthermore, the measurement method applied was followed the procedure conducted by Lee *et al.* (2000) which has been modified. Milkfish was fasted for 24 hours, and further fed to full. Fish stomach content was obtained after feeding, and later this process was done at interval of one hour. Stomach content collection was stopped when experimental fish stomach was empty. Feed percentage in digestive track was calculated using the formula:

$$\% \text{ LPL} = \frac{\text{Feed in stomach}}{\text{Feed eaten}} \times 100$$

### **Data Analysis**

All data obtained in this study were analyzed through the analysis of variance and further was continued by response test at significance level of 5% using SPSS 12.0 and descriptively, that was by comparing the result obtained between treatments, and also comparing with supporting literature.

**Result and Discussion**  
**Blood Glucose Level**

Blood glucose level of milkfish juvenile immediately increased after fish consumed feed (Figure 1). The highest blood glucose level reached its peak at hour -3 and experienced a decrease at hour-4 until it reached the lowest level at hour-16. The highest glucose level was shown by feed contained *G. gigas* seaweed of 138 mg/dL, followed by the green strain of *K. alvarezii* which amounted to 126 mg/dL, brown strain of *K. alvarezii* of 122 mg/dL, *Sargassum* sp. of 118 mg/dL, and the lowest was found in *Caulerpa* sp. of 86.5 mg/dL.

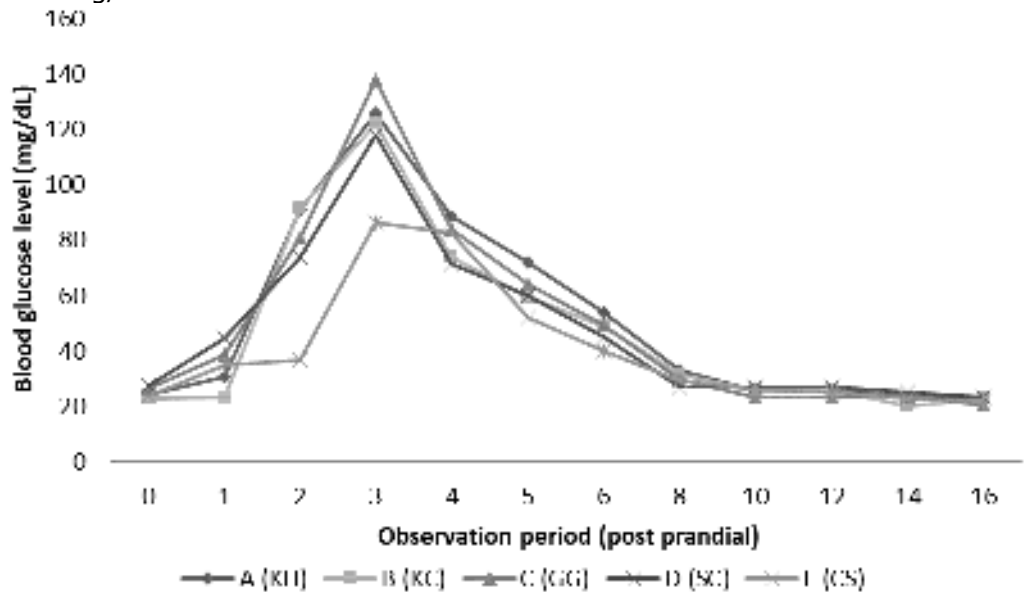


Figure 1. Blood glucose level (mg/dL) of milkfish on each observation period of various fermented seaweed

**Hepatosomatic Index**

Measurement result of hepatosomatic index of experimental fish treated with various fermented seaweeds for 60 days of maintenance, at the beginning and the end of study, is presented in Table 3.

Table 3. Hepatosomatic index of milkfish towards various fermented seaweeds

Treatment	Hepatosomatic index
Initial value	1.19 ± 1.19
A (KAH)	2.03 ± 0.29
B (KAC)	2.02 ± 0.12
C (GG)	2.07 ± 0.15
D (DP)	2.04 ± 0.21
E (CP)	2.05 ± 0.04

Description:

KAH = Green strain of *K. alvarezii*, KAC = Brown strain of *K. alvarezii*, GG = *G. gigas*, SS = *Sargassum* sp. and CP = *Caulerpa* sp.

The measurement result indicated that the highest hepatosomatic index was shown by the feed contained *G. gigas* even though the result of variance analysis revealed that the finding was not significantly different ( $P > 0.05$ ) towards milkfish hepatosomatic at the end of maintenance.

### Gastric evacuation rate

Gastric evacuation rate of experimental fish showed different time periods on each treatment. The fastest gastric emptying was found milkfish given feed contained *Caulerpa* sp. that was at hour-5 post prandial, while gastric evacuation rate in milkfish treated feed contained green strain of *K. alvarezii* strain, brown strain of *K. alvarezii*, *G. gigas*, and *Sargassum* sp. occurred at hour-6 (Table 4).

Table 4. Gastric evacuation rate (%) of milkfish on each observation period of various fermented seaweeds

Hour post prandial (hour)	Gastric evacuation rate (%)				
	A (KH)	B (KC)	C (GG)	D (DP)	E (CP)
0	0	0	0	0	0
1	94.38 ± 0.78	93.94 ± 1.41	93.17 ± 2.41	96.28 ± 1.64	92.05 ± 2.72
2	72.57 ± 8.35	74.36 ± 1.33	79.41 ± 1.92	78.74 ± 0.75	66.44 ± 3.17
3	51.86 ± 1.73	57.57 ± 9.88	55.74 ± 6.39	61.38 ± 7.47	46.94 ± 1.78
4	31.3 ± 7.62	28.54 ± 4.56	38.10 ± 1.3	28.8 ± 2.79	36.50 ± 9.72
5	19.97 ± 3.18	20.63 ± 4.11	27.49 ± 0.8	14.43 ± 3.16	16.44 ± 2.3
6	13.74 ± 1.52	10.81 ± 6.34	14.31 ± 3.91	10.65 ± 1.26	0
7	0	0	0	0	0
8	0	0	0	0	0
9	0	0	0	0	0

Description:

KAH = Green strain of *K. alvarezii*, KAC = Brown strain of *K. alvarezii*, GG = *G. gigas*, SS = *Sargassum* sp. and CS = *Caulerpa* sp.

### Discussion

The use of fermented seaweed as feed ingredient has been widely reported (Aslamyah et al. 2017; Zaki et al. 1994; Norambuena et al. 2015; Ilias et al. 2015). The addition of fermented seaweed in feed for milkfish juveniles as the source of carbohydrate showed an increase in fish blood glucose level which reached its peak at hour-3 postprandial for all types of seaweeds. Nutrient intake is a factor that affects the glucose response (Porchas et al. 2009). Feed contains different fat and protein will result in different blood glucose level as well (Cheng et al. 2006). The highest peak was seen at the use of *G. gigas* seaweed of 138 mg/dL and the lowest was found in *Caulerpa* sp. of 86.5 mg/dL. Those values indicated that the use of *G. gigas* seaweed was able to supply adequate glucose which has a main role in animal bioenergy that will be converted into chemical energy (ATP) released in the form of mechanical energy (Lucas, 1996).

The role of seaweed in improving nutrient absorption (Natify et al. 2015) and metabolism process (Mustafa et al. 1995) was also seen in the increasing hepatosomatic index of milkfish. Hepatosomatic index becomes an indicator of energy status in liver (Hismayasari et al. 2015) and is important in estimating nutritional value in feed (Ighwela et al. 2014). The highest value of hepatosomatic index was found in the use of *G. gigas*, while the lowest was obtained by the green strain of *K. alvarezii* despite overall difference in the value of hepatosomatic index in all types of seaweed did not show a significant difference ( $P > 0.05$ ). It reflected the role of seaweed in increasing hepatosomatic index in milkfish larvae. Result obtained was in line with the finding of study conducted by Mustafa et al. (1995) which found an increase in hepatosomatic index through the use of *Porphyra* in Red sea bream.

Gastric evacuation rate showed stomach emptying at hour-7 in all types of seaweeds, except for in *Caulerpa* sp. namely at hour-6. Feed contained *G. gigas* indicated the most feed consumed at hour-6 which amounted to  $14.31 \pm 3.91$ , while the least was found in *Caulerpa* sp. This finding showed that feed contained *G. gigas* was longer digested in stomach. It was due to the reason that *G. gigas* feed contained more carbohydrate and other nutrient component compared to other types of seaweed by considering the value of blood glucose level and hepatosomatic index which placed *G. gigas* to reach the highest value. Hepatosomatic index also increased along with the increasing intake of feed contained carbohydrate in *Oreochromis niloticus* (Ighwela *et al.* 2014) and *Cyprinus carpio communis* (Ahmad *et al.*, 2012).

## Conclusion

Result of this study showed that the use of *G. gigas* seaweed fermented using mix of microorganisms was the best feed ingredient which was able to fulfill nutrient requirement for the growth of milkfish larvae.

## ACKNOWLEDGEMENT

The authors would like to thank the Directorate General of Higher Education for funding this study through the National Priority Research of Masterplan for Acceleration and Expansion of Indonesia Economic Development (Penelitian Prioritas Nasional Masterplan Percepatan dan Perluasan Pembangunan Ekonomi Indonesia 2011 - 2025, PENPRINAS MP3EI 2011-2025), Fiscal year 2015.

## REFERENCES

- Ahmad M, Qureshi TA, Singh AB. 2012. Effect of dietary protein, lipid and carbohydrate contents on the viscera composition and organ indices of *Cyprinus carpio communis* fingerlings. *African journal of biotechnology*. 11(33):8361-8366
- Aslamyah S, Karim Y, Badraeni. 2017. Fermentation of seaweed flour with various fermentors to improve the quality of fish feed ingredient. *Journal of Indonesian aquaculture*. 16(1): 8-14
- Aslamyah S, Karim Y, Badraeni, Tahya AM. 2016. Seaweed as a source of carbohydrate in the feed of milk fish (*Chanos chanos* forsskal). *International journal of farmtech research*. 9 (11): 64-67
- Cheng A.C, Chen C.Y, Liou C.H and Chang C.F, 2006. Effect of dietary protein and lipids on blood parameters and superoxide anion production in the grouper *Epinephelus coioides* (serranidae: Epinephelinae). *zoological studies*. 45: 492-502.
- Hismayasari I.B, Marhendra APW, Rahayu S, Saidin, supriyadi DS. 2015. Gonadosomatic index (GSI), Hepatosomatic index (HIS) and proportion of oocytes stadia as an indicator of rainbow fish *Melanotaenia boesemani* spawning season. *International journal of fisheries and aquatic studies*. 2(5): 359-362.
- Ighwela KA, Ahmad AB, Munafi ABA. 2014. The selection of viscerosomatic and hepatosomatic indices for the measurement analysis of *Oreochromis niloticus* condition fed with varying dietary maltose level.
- Ilias NN, Jamal P, Jaswir I, Sulaiman S, Zainuddin Z, Azmi AS. 2015. Potentiality of selected seaweed for the production of nutritious fish feed using solid state fermentation. *Journal of engineering science and technology*. Special issue: 30-40
- Lucas A. 1996. Physical concepts of bioenergetic
- Meyer SP, Zein-Eldin ZP. 1972. Binders and Pellet Stability in Development of Crustacean Diets. Reprinted from Proc. 3<sup>rd</sup> Ann. Work-shop-World Maricult. Soc., St. Petterburg, Florida. Jan. 26-28, 1972. Hal. 351-364.
- Mustafa MG, Wakamatsu S, Takeda T, Umino T. 1995. Effect of algae meal as feed additive on growth, feed efficiency, and body composition in reared sea bream. *Fisheries science*. 61(1):25-28.
- Natify W, Droussi M, Berday N, Araba A, Benabid M. 2015. Effect of the sea weed *Ulva lactuca* as a feed additive on growth performance, feed utilization and body

- competition of Nile tilapia. *International journal of agronomy and agricultural research*, 7(3):85-92.
- Norambuena F, Hermon K, Skrzypczyk V, Emery JA, Sharon Y, Beard A, Turchini GM. 2015. Algae in fish feed: performance and fatty acid metabolism in juvenile Atlantic salmon. *Plos one*.
- Porchas MM, Cordova LRM, Enriquez RR. 2009. Cortisol and Glucose: Reliable indicators of fish stress?. *Pan-American Journal of Aquatic Sciences*. 4(2): 158-178.
- Zaki MA, Nour AM, El-din AET. 1994. The use of seaweed meal in feeding common carp (*Cyprinus carpio* L)

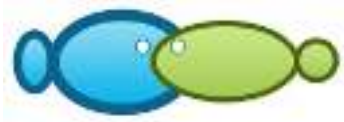
This article is available at: <http://www.bioflux.com.ro/AACL4433-23-23>

Siti Aslamyah, Study Program of Aquaculture, Faculty of Marine Science and Fishery, Hasanuddin University, Jl. Perintis Kemerdekaan KM. 10, Makassar, South Sulawesi, Indonesia, 90245, [hasni\\_yulianti@yahoo.com](mailto:hasni_yulianti@yahoo.com);

Muhammad Yusri Karim, Study Program of Aquaculture, Faculty of Marine Science and Fishery, Hasanuddin University, Jl. Perintis Kemerdekaan KM. 10, Makassar, South Sulawesi, Indonesia, 90245, [yusri\\_karim@yahoo.com](mailto:yusri_karim@yahoo.com);

Badraeni, Study Program of Aquaculture, Faculty of Marine Science and Fishery, Hasanuddin University, Jl. Perintis Kemerdekaan KM. 10, Makassar, South Sulawesi, Indonesia, 90245, [reniarfan@yahoo.com](mailto:reniarfan@yahoo.com);

Akbar Marzuki Tahya, Balik Diwa Marine Technology University, Jl. Perintis Kemerdekaan KM 8 No. VIII, Makassar, South Sulawesi, Indonesia, 90245, [amtahya@gmail.com](mailto:amtahya@gmail.com).



## Effect of fermented seaweed addition on blood glucose level, hepatosomatic index, and gastric evacuation rate of milkfish, *Chanos chanos* larvae

<sup>1</sup>Siti Aslamyah, <sup>1</sup>M. Yusri Karim, <sup>1</sup>Badraeni, <sup>2</sup>Akbar M. Tahya

<sup>1</sup>Study Program of Aquaculture, Faculty of Marine Science and Fisheries, Hasanuddin University, Makassar, Indonesia; <sup>2</sup>Study Program of Aquaculture, Faculty of Animal Husbandry and Fishery, Tadulako University, Palu, Indonesia. Corresponding author: S. Aslamyah, sitiaslamyah1@gmail.com

**Commented [ipbsmart1]:** Our author (Tahya AM) has moved affiliates since 2017, so right now the right affiliates are in line with that written, ie Aquaculture, Tadulako University, Palu, Indonesia.

**Abstract.** Seaweed is a fishery product which can be used as the source of carbohydrate and binder in fish feed composition. However, excessive use of seaweed results in high crude fiber. Fermentation is an effort that can be done. The aim of this study was to evaluate a variety of seaweeds fermented using microorganism towards glucose level, hepatosomatic index and gastric evacuation rate to see the impact of seaweed use on milkfish larvae. The five types of seaweed used were green strain of *Kappaphycus alvarezii*, brown strain of *K. alvarezii*, *Gracilaria gigas*, *Sargassum* sp. and *Caulerpa* sp. The measurement result of blood glucose level, hepatosomatic index, and gastric evacuation rate consistently showed the highest value on the use of seaweed *G. gigas*.

**Key Words:** fermentation, microorganism, seaweed, feed ingredient, milkfish larvae.

**Introduction.** Milkfish (*Chanos chanos*) is one of the superior brackish water commodities in Indonesia. Many pond fish farmers cultivate this species in traditional system which only relies on live food available in the pond. However, increasing population and increase in demand which are not balanced by the availability of fish farming area makes intensive fish farming system becoming an option. Intensification of milkfish farming business at high stocking density completely depends on artificial food in the form of pellet. This condition causes the feed to be one of production factors that spends the highest cost, reaching approximately 60% of total production cost (De Silva & Hasan 2007).

Several studies (Aslamyah et al. 2016; 2017) have been conducted in an effort to suppress the feed cost without reducing the quality of the feed itself. Fish feed quality, in addition to be determined by nutritional content, is also determined by physical quality, particularly the stability in the water. One of the ingredients that determine the quality is the binder. Additional material used as binder highly determines the stability of feed in the water (Meyer & Zein-Eldin 1972).

One of fishery products containing carbohydrate as well as has a function as binder is seaweed. In general, seaweed consists of water (27.8%), protein (5.4%), carbohydrate (33.3%), fat (8.6%), crude fiber (3%) and ash (22.25%). Besides carbohydrate, protein, fat, and fiber, seaweed also contains enzyme, nucleic acid, amino acid, vitamin (A, B, C, D, E, and K), macro minerals such as nitrogen, oxygen, calcium and selenium and also micro minerals like iron, magnesium and sodium (Aslamyah et al. 2015). Seaweed has many benefits for humans, environment, and aquaculture so it needs to be studied, especially in South Sulawesi Province (Nursidi et al. 2017).

In the previous study, we have reported that the use of artificial feed containing fermented seaweed as binder and carbohydrate source showed increasing growth, survival, digestibility level, and body chemical composition of milkfish juvenile (Aslamyah et al 2016). In this study, results of glycogen level in liver and muscle, blood glucose level, hepatosomatic index, and gastric evacuation rate of milkfish fed artificial feed

containing fermented seaweed were reported. This study was aimed specifically to determine the best quality feed ingredient for milkfish by using seaweed as carbohydrate source and binder.

## Material and Method

**Research Location.** The research was conducted from April to August 2015 in Fish Breeding Technology Laboratory, Fishery Department, Faculty of Marine and Fishery, Hasanuddin University, Makassar

**Milkfish juvenile.** Experimental fish used was milkfish juvenile at  $5.57 \pm 0.22$  g in weight. The next procedure was in accordance with the procedure conducted by Aslamyiah et al (2016).

**Seaweed.** Seaweeds used in this study were green strain of *Kappaphycus alvarezii*, brown strain of *K. alvarezii*, *Gracilaria gigas*, *Sargassum* sp. and *Caulerpa* sp. obtained from seaweed farmers in Punaga Village, Takalar Regency. Seaweeds were cleaned and dried, and further crushed into flour.

**Fermentation process.** Fermentation process was done by using 3 species of microorganisms with fermentation composition as follows: a). *Bacillus* sp. bacteria of 2 mL/100 g seaweed powder; b). 1.5% of ragi tape (yeast) as the source of *Rhizopus* sp.; c). 1.5% baker's yeast as the source of *Saccharomyces* sp.; d) mix of *Bacillus* sp., *Rhizopus* sp., *Saccharomyces* sp. at ratio of 1 mL:1 g:1 g/100 g seaweed flour, and control treatment resulted from fermentation process without using any bacteria. The best fermentation product was applied as fish feed mix to be used in further treatments.

Fermentation was started by weighing each of 100 g seaweed and further seaweeds were put into plastic with sealing. Every package was added with microorganisms solved in 20 mL sugar cane drop in each treatment by evenly sprayed it using sprayer. The package was tightly closed and incubated for 72 hours. After 72 hours, seaweed flour was steamed in boiled water for 1-2 minutes to inactivate the microorganism activity.

**Blood glucose level.** Observation of blood glucose level on experimental fish was done at the end of study. Milkfish was fasted for 24 hours and further fed to full. Experimental fish was transferred into container of large basin with aeration. Collection of experimental fish blood was started at hour-0 and hour- 1, 2, 4, 5, 6, 8, 10, 12, 14, 16, and 20 post prandial. Sample of experimental fish blood was collected from the gills and caudal vena by using spuit of 1 mL volume. Measurement of blood glucose level was performed through colorimetric analysis using reagent kit of Gluco Dr AGM 2100.

**Hepatosomatic index.** Hepatosomatic index was calculated by comparing the total weight of fish and the weight of liver. At first, fish was weighed for its weight, after that fish was dissected on ice. Dissection was carefully and quickly performed. The liver was weighed. The value of hepatosomatic index was measured based on the equation below:

$$HI = HP/W$$

where: HI = hepatosomatic index;  
HP = hepatosomatic weight (g);  
W = fish weight (g).

**Gastric evacuation rate.** Observation of gastric evacuation rate (GER) was done at the end of study. Furthermore, the measurement method applied has followed the procedure conducted by Lee et al (2000) which has been modified. Milkfish was fasted for 24 hours, and further fed to full. Fish stomach content was obtained after feeding, and later this process was done at interval of one hour. Stomach content collection was stopped when experimental fish stomach was empty. Feed percentage in digestive track was calculated using the formula:

$$\% \text{ GER} = \frac{\text{Feed in stomach}}{\text{Feed eaten}} \times 100$$

**Data analysis.** All data obtained in this study were analyzed through the analysis of variance and further was continued by response test at significance level of 5% using SPSS 12.0 and descriptively, that was by comparing the results obtained between treatments, and also comparing with supporting literature.

### Result and Discussion

**Blood glucose level.** Blood glucose level of milkfish juvenile immediately increased after fish consumed feed (Figure 1). The highest blood glucose level reached its peak at hour-3 and experienced a decrease at hour-4 until it reached the lowest level at hour-16. The highest glucose level was shown by feed contained *G. gigas* seaweed of 138 mg dL<sup>-1</sup>, followed by the green strain of *K. alvarezii* which amounted to 126 mg dL<sup>-1</sup>, brown strain of *K. alvarezii* of 122 mg dL<sup>-1</sup>, *Sargassum* sp. of 118 mg dL<sup>-1</sup>, and the lowest was found in *Caulerpa* sp. of 86.5 mg dL<sup>-1</sup>.

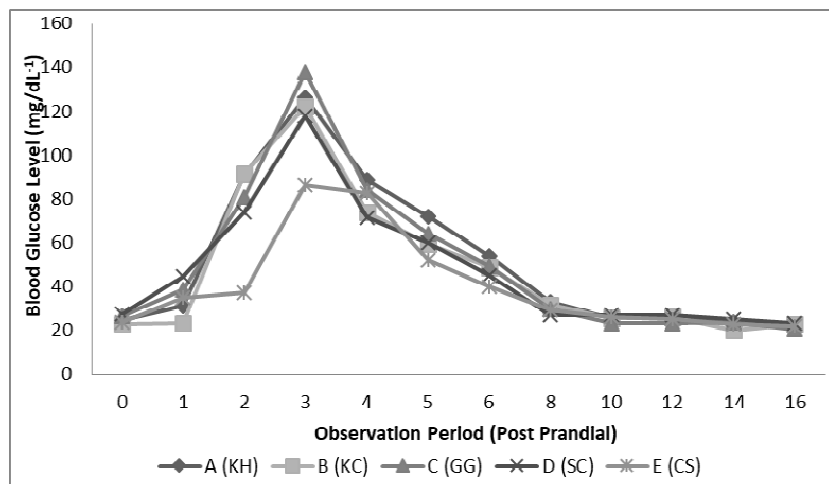


Figure 1. Blood glucose level (mg dL<sup>-1</sup>) of milkfish on each observation period of various fermented seaweed (KH = Green strain of *K. alvarezii*, KC = Brown strain of *K. alvarezii*, GG = *G. gigas*, SC = *Sargassum* sp., and CS = *Caulerpa* sp.)

**Hepatosomatic index.** The results of the measurement of the hepatosomatic index of experimental fish treated with various fermented seaweeds for 60 days of maintenance, at the beginning and the end of study, are presented in Table 1.

Table 1

Hepatosomatic index of milkfish towards various fermented seaweeds

Treatment	Hepatosomatic index
Initial value	1.19±1.19

A (KH)	2.03±0.29
B (KC)	2.02±0.12
C (GG)	2.07±0.15
D (SC)	2.04±0.21
E (CS)	2.05±0.04

KH = Green strain of *K. alvarezii*, KC = Brown strain of *K. alvarezii*, GG = *G. gigas*, SC = *Sargassum* sp., and CS = *Caulerpa* sp.

The measurement result indicated that the highest hepatosomatic index was shown by the feed contained *G. gigas* even though the result of variance analysis revealed that the finding was not significantly different ( $P>0.05$ ) towards milkfish hepatosomatic at the end of maintenance.

**Gastric evacuation rate.** Gastric evacuation rate of experimental fish showed different time periods on each treatment. The fastest gastric emptying was found milkfish given feed contained *Caulerpa* sp. that was at hour-5 post prandial, while gastric evacuation rate in milkfish treated feed contained green strain of *K. alvarezii* strain, brown strain of *K. alvarezii*, *G. gigas*, and *Sargassum* sp. occurred at hour-6 (Table 2).

Table 2

Gastric evacuation rate (%) of milkfish on each observation period of various fermented seaweeds

Hour post prandial (hour)	Gastric evacuation rate (%)				
	A (KH)	B (KC)	C (GG)	D (SC)	E (CS)
0	0	0	0	0	0
1	94.38±0.78	93.94±1.41	93.17±2.41	96.28±1.64	92.05±2.72
2	72.57±8.35	74.36±1.33	79.41±1.92	78.74±0.75	66.44±3.17
3	51.86±1.73	57.57±9.88	55.74±6.39	61.38±7.47	46.94±1.78
4	31.3±7.62	28.54±4.56	38.10±1.3	28.8±2.79	36.50±9.72
5	19.97±3.18	20.63±4.11	27.49±0.8	14.43±3.16	16.44±2.3
6	13.74±1.52	10.81±6.34	14.31±3.91	10.65±1.26	0
7	0	0	0	0	0
8	0	0	0	0	0
9	0	0	0	0	0

KAH = Green strain of *K. alvarezii*, KAC = Brown strain of *K. alvarezii*, GG = *G. gigas*, SC = *Sargassum* sp., and CS = *Caulerpa* sp.

**Discussion.** The use of fermented seaweed as feed ingredient has been widely reported (Zaki et al 1994; Norambuena et al 2015; Ilias et al 2015; Aslamyah et al 2017). The addition of fermented seaweed in feed for milkfish juveniles as the source of carbohydrate showed an increase in fish blood glucose level which reached its peak at hour-3 postprandial for all types of seaweeds. Nutrient intake is a factor that affects the glucose response (Porchas et al 2009). Feed containing different fat and protein will result in different blood glucose levels as well (Cheng et al 2006). The highest peak was seen at the use of *G. gigas* seaweed of 138 mg dL<sup>-1</sup> and the lowest was found in *Caulerpa* sp. of 86.5 mg dL<sup>-1</sup>. These values indicated that the use of *G. gigas* seaweed was able to supply adequate glucose which has a main role in animal bioenergy that will be converted into chemical energy (ATP) released in the form of mechanical energy (Lucas 1996).

The role of seaweed in improving nutrient absorption (Nafiy et al 2015) and metabolism process (Mustafa et al 1995) was also seen in the increasing hepatosomatic index of milkfish. Hepatosomatic index becomes an indicator of energy status in liver (Hismayasari et al 2015) and is important in estimating nutritional value in feed (Ighwela et al 2014). The highest value of hepatosomatic index was found in the use of *G. gigas*, while the lowest was obtained by the green strain of *K. alvarezii* despite overall difference in the value of hepatosomatic index in all types of seaweed did not show a significant difference ( $p > 0.05$ ). It reflected the role of seaweed in increasing hepatosomatic index in milkfish larvae. Result obtained was in line with the finding of study conducted by

Mustafa et al (1995) which found an increase in hepatosomatic index through the use of *Porphyra* sp. in red sea bream (*Pagrus major*).

Gastric evacuation rate showed stomach emptying at hour-7 in all types of seaweeds, except for in *Caulerpa* sp. namely at hour-6. Feed contained *G. gigas* indicated the most feed consumed at hour-6 which amounted to 14.31±3.91, while the least was found in *Caulerpa* sp. This finding showed that feed containing *G. gigas* was longer digested in stomach. It was due to the reason that *G. gigas* feed contained more carbohydrate and other nutrient component compared to other types of seaweed by considering the value of blood glucose level and hepatosomatic index which placed *G. gigas* to reach the highest value. Hepatosomatic index also increased along with the increasing intake of feed contained carbohydrate in *Oreochromis niloticus* (Ighwela et al 2014) and *Cyprinus carpio communis* (Ahmad et al 2012).

**Conclusions.** Seaweed *G. Gigas* can be used as a source of carbohydrates through fermentation. Based on blood glucose level, hepatosomatic index, and gastric evacuation rate showed the highest values in this seaweed species compared to others. Results of this study showed that the use of *G. gigas* seaweed fermented using mix of microorganisms was the best feed ingredient which was able to fulfill nutrient requirement for the growth of milkfish larvae.

**Acknowledgements.** The authors would like to thank the Directorate General of Higher Education for funding this study through the National Priority Research of Masterplan for Acceleration and Expansion of Indonesia Economic Development (Penelitian Prioritas Nasional Masterplan Percepatan dan Perluasan Pembangunan Ekonomi Indonesia 2011-2025, PENPRINAS MP3EI 2011-2025), Fiscal year 2015.

## References

- Ahmad M, Qureshi T. A, Singh A. B., 2012. Effect of dietary protein, lipid and carbohydrate contents on the viscera composition and organ indices of cyprinus carpio communis fingerlings. African Journal of Biotechnology 11(33):8361-8366
- Aslamyah S, Karim M. Y, Badraeni, Tahya A. M., 2016. Seaweed as a source of carbohydrate in the feed of milk fish (*Chanos chanos* forsskal). International journal of Pharmtech Research 9 (11): 64-67
- Aslamyah S, Karim M. Y, Badraeni., 2015. Final Report: Diversification of fermented seaweed as a source of carbohydrates and binders in cheaper artificial feed and environmentally friendly to support the intensification of milkfish aquaculture in South Sulawesi. PENPRINAS MP3EI 2011-2025 – Hasanuddin University, Makassar (In Indonesia)
- Aslamyah S, Karim M. Y, Badraeni., 2017. Fermentation of seaweed flour with various fermentors to improve the quality of fish feed ingredient. Journal of Indonesian aquaculture 16(1): 8-14
- Cheng A. C, Chen C. Y, Liou C. H, Chang C. F., 2006. Effect of dietary protein and lipids on blood parameters and superoxide anion production in the grouper *Epinephelus coioides* (serranidae: Epinephelinae). Zoological studies 45: 492-502.
- De Silva S. S, Hasan M. R., 2007. Feeds and Fertilizers: the key to long term sustainability of Asian aquaculture. In M. R. Hasan, T. Hecht, S.S. De Silva and A.G.J. Tacon, eds. Study and analysis of feeds and fertilizers for sustainable aquaculture development, pp.19-47. FAO Fisheries Technical Paper No. 497. Rome, FAO. 510pp.
- Hismayasari I. B, Marhendra A. P. W, Rahayu S, Saidin, supriyadi D. S., 2015. Gonadosomatic index (GSI), Hepatosomatic index (HIS) and proportion of oocytes stadia as an indicator of rainbow fish *Melanotaenia boesemani* spawning season. International Journal of Fisheries and Aquatic Studies 2(5): 359-362.
- Ighwela K. A, Ahmad A. B, Munafi A. B. A. 2014., The selection of viscerosomatic and hepatosomatic indices for the measurement analysis of *oreochromis niloticus*

Commented [indra2]: edit all the references according to the journal format

- condition fed with varying dietary maltose level. [International Journal of Fauna and Biological Studies 1 \(3\): 18-20.](#)
- Ilias N. N, Jamal P, Jaswir I, Sulaiman S, Zainuddin Z, Azmi A. S., 2015. Potentiality of selected seaweed for the production of nutritious fish feed using solid state fermentation. *Journal of Engineering Science and Technology*. Special issue: 30-40
- Lee S, Hwang U, Cho S. H., 2000. Effects of feeding frequency and dietary moisture content on growth, body composition and gastric evacuation of juvenile Korean rockfish (*Sebastes schlegelii*). *Aquaculture* 187: 399-409.
- Lucas A. 1996. Bioenergetic of aquatic animals. [Taylor & Francis, 169p](#)
- Meyer S. P, Zein-Eldin Z. P., 1972. Binders and Pellet Stability in Development of Crustacean Diets. Reprinted from Proc. 3<sup>rd</sup> Ann. Work-shop-World Maricult. Soc., St. Petterburg, Florida. Jan. 26-28, 1972. 351-364.
- Mustafa M. G, Wakamatsu S, Takeda T, Umino T., 1995. Effect of algae meal as feed additive on growth, feed efficiency, and body composition in red sea bream. *Fisheries Science* 61(1):25-28.
- Natify W, Droussi M, Berday N, Araba A, Benabid M., 2015. Effect of the sea weed *Ulva lactuca* as a feed additive on growth performance, feed utilization and body composition of Nile tilapia. *International Journal of Agronomy and Agricultural Research* 7(3):85-92.
- Norambuena F, Hermon K, Skrzypczyk V, Emery J. A, Sharon Y, Beard A, Turchini G. M., 2015. Algae in fish feed: performance and fatty acid metabolism in juvenile Atlantic salmon. [Plos one 10\(4\): e0124042.](#)
- Nursidi, Ali S. A., Anshary H., Tahya A. M., 2017 Environmental parameters and specific growth of *Kappaphycus alvarezii* in Saugi Island, South Sulawesi Province, Indonesia. *AAFL Bioflux* 10(4):698-702.
- Porchas M. M, Cordova L. R. M, Enriquez R. R., 2009. Cortisol and Glucose: Reliable indicators of fish stress?. *Pan-American Journal of Aquatic Sciences* 4(2): 158-178.
- Zaki M. A, Nour A. M, El-din A. E. T., 1994. The use of seaweed meal in feeding common carp (*Cyprinus carpio* L). [Asian-Aust. Journal of Animal Science 7\(2\): 183-189.](#)

Received: 22 October 2017. Accepted: 16 January 2018. Published online: ... January 2018.

Authors:

Siti Aslamyah, Study Program of Aquaculture, Faculty of Marine Science and Fishery, Hasanuddin University, Jl.

Perintis Kemerdekaan KM. 10, Makassar, South Sulawesi, Indonesia, 90245, e-mail:

hasni\_yulianti@yahoo.com; sitiaslamyah1@gmail.com

Muhammad Yusri Karim, Study Program of Aquaculture, Faculty of Marine Science and Fishery, Hasanuddin

University, Jl. Perintis Kemerdekaan KM. 10, Makassar, South Sulawesi, Indonesia, 90245, e-mail:

yusri\_karim@yahoo.com

Badraeni, Study Program of Aquaculture, Faculty of Marine Science and Fishery, Hasanuddin University, Jl.

Perintis Kemerdekaan KM. 10, Makassar, South Sulawesi, Indonesia, 90245, e-mail: reniarfan@yahoo.com

Akbar Marzuki Tahya, Tadulako University, Jl. Bumi Tadulako Tondo, Palu, Central Sulawesi, Indonesia, 94118,

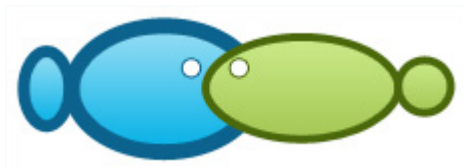
e-mail: amtahya@gmail.com

This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution and reproduction in any medium, provided the original author and source are credited.

How to cite this article:

Aslamyah S., Karim M. Y., Badraeni, Tahya A. M., 2018 [Effect of fermented seaweed addition on blood glucose level, hepatosomatic index, and gastric evacuation rate of milkfish, \*Chanos chanos\* Forsskal larvae.](#) *AAFL Bioflux* 11(1):...-...

**Commented [ipbsmart3]:** our author has moved affiliates since 2017, so right now the right affiliates are in line with that written, ie TADULAKO UNIVERSITY



# Effect of fermented seaweed addition on blood glucose level, hepatosomatic index, and gastric evacuation rate of milkfish, *Chanos chanos* larvae

<sup>1</sup>Siti Aslamyah, <sup>1</sup>M. Yusri Karim, <sup>1</sup>Badraeni, <sup>2</sup>Akbar M. Tahya

<sup>1</sup>Study Program of Aquaculture, Faculty of Marine Science and Fisheries, Hasanuddin University, Makassar, Indonesia; <sup>2</sup>Study Program of Aquaculture, Faculty of Animal Husbandry and Fishery, Tadulako University, Palu, Indonesia. Corresponding author: S. Aslamyah, sitiaslamyah1@gmail.com

**Abstract.** Seaweed is a fishery product which can be used as the source of carbohydrate and binder in fish feed composition. However, excessive use of seaweed results in high crude fiber. Fermentation is an effort that can be done. The aim of this study was to evaluate a variety of seaweeds fermented using microorganism towards glucose level, hepatosomatic index and gastric evacuation rate to see the impact of seaweed use on milkfish larvae. The five types of seaweed used were green strain of *Kappaphycus alvarezii*, brown strain of *K. alvarezii*, *Gracilaria gigas*, *Sargassum* sp. and *Caulerpa* sp. The measurement result of blood glucose level, hepatosomatic index, and gastric evacuation rate consistently showed the highest value on the use of seaweed *G. gigas*.

**Key Words:** fermentation, microorganism, seaweed, feed ingredient, milkfish larvae.

**Introduction.** Milkfish (*Chanos chanos*) is one of the superior brackish water commodities in Indonesia. Many pond fish farmers cultivate this species in traditional system which only relies on live food available in the pond. However, increasing population and increase in demand which are not balanced by the availability of fish farming area makes intensive fish farming system becoming an option. Intensification of milkfish farming business at high stocking density completely depends on artificial food in the form of pellet. This condition causes the feed to be one of production factors that spends the highest cost, reaching approximately 60% of total production cost (De Silva & Hasan 2007).

Several studies (Aslamyah et al. 2016; 2017) have been conducted in an effort to suppress the feed cost without reducing the quality of the feed itself. Fish feed quality, in addition to be determined by nutritional content, is also determined by physical quality, particularly the stability in the water. One of the ingredients that determine the quality is the binder. Additional material used as binder highly determines the stability of feed in the water (Meyer & Zein-Eldin 1972).

One of fishery products containing carbohydrate as well as has a function as binder is seaweed. In general, seaweed consists of water (27.8%), protein (5.4%), carbohydrate (33.3%), fat (8.6%), crude fiber (3%) and ash (22.25%). Besides carbohydrate, protein, fat, and fiber, seaweed also contains enzyme, nucleic acid, amino acid, vitamin (A, B, C, D, E, and K), macro minerals such as nitrogen, oxygen, calcium and selenium and also micro minerals like iron, magnesium and sodium (Aslamyah et al. 2015). Seaweed has many benefits for humans, environment, and aquaculture so it needs to be studied, especially in South Sulawesi Province (Nursidi et al. 2017).

In the previous study, we have reported that the use of artificial feed containing fermented seaweed as binder and carbohydrate source showed increasing growth, survival, digestibility level, and body chemical composition of milkfish juvenile (Aslamyah et al 2016). In this study, results of glycogen level in liver and muscle, blood glucose level, hepatosomatic index, and gastric evacuation rate of milkfish fed artificial feed

containing fermented seaweed were reported. This study was aimed specifically to determine the best quality feed ingredient for milkfish by using seaweed as carbohydrate source and binder.

## Material and Method

**Research Location.** The research was conducted from April to August 2015 in Fish Breeding Technology Laboratory, Fishery Department, Faculty of Marine and Fishery, Hasanuddin University, Makassar

**Milkfish juvenile.** Experimental fish used was milkfish juvenile at  $5.57 \pm 0.22$  g in weight. The next procedure was in accordance with the procedure conducted by Aslamyiah et al (2016).

**Seaweed.** Seaweeds used in this study were green strain of *Kappaphycus alvarezii*, brown strain of *K. alvarezii*, *Gracilaria gigas*, *Sargassum* sp. and *Caulerpa* sp. obtained from seaweed farmers in Punaga Village, Takalar Regency. Seaweeds were cleaned and dried, and further crushed into flour.

**Fermentation process.** Fermentation process was done by using 3 species of microorganisms with fermentation composition as follows: a). *Bacillus* sp. bacteria of 2 mL/100 g seaweed powder; b). 1.5% of ragi tape (yeast) as the source of *Rhizopus* sp.; c). 1.5% baker's yeast as the source of *Saccharomyces* sp.; d) mix of *Bacillus* sp., *Rhizopus* sp., *Saccharomyces* sp. at ratio of 1 mL:1 g:1 g/100 g seaweed flour, and control treatment resulted from fermentation process without using any bacteria. The best fermentation product was applied as fish feed mix to be used in further treatments.

Fermentation was started by weighing each of 100 g seaweed and further seaweeds were put into plastic with sealing. Every package was added with microorganisms solved in 20 mL sugar cane drop in each treatment by evenly sprayed it using sprayer. The package was tightly closed and incubated for 72 hours. After 72 hours, seaweed flour was steamed in boiled water for 1-2 minutes to inactivate the microorganism activity.

**Blood glucose level.** Observation of blood glucose level on experimental fish was done at the end of study. Milkfish was fasted for 24 hours and further fed to full. Experimental fish was transferred into container of large basin with aeration. Collection of experimental fish blood was started at hour-0 and hour- 1, 2, 4, 5, 6, 8, 10, 12, 14, 16, and 20 post prandial. Sample of experimental fish blood was collected from the gills and caudal vena by using sput of 1 mL volume. Measurement of blood glucose level was performed through colorimetric analysis using reagent kit of Gluco Dr AGM 2100.

**Hepatosomatic index.** Hepatosomatic index was calculated by comparing the total weight of fish and the weight of liver. At first, fish was weighed for its weight, after that fish was dissected on ice. Dissection was carefully and quickly performed. The liver was weighed. The value of hepatosomatic index was measured based on the equation below:

$$HI = HP/W$$

where: HI = hepatosomatic index;

HP = hepatosomatic weight (g);

W = fish weight (g).

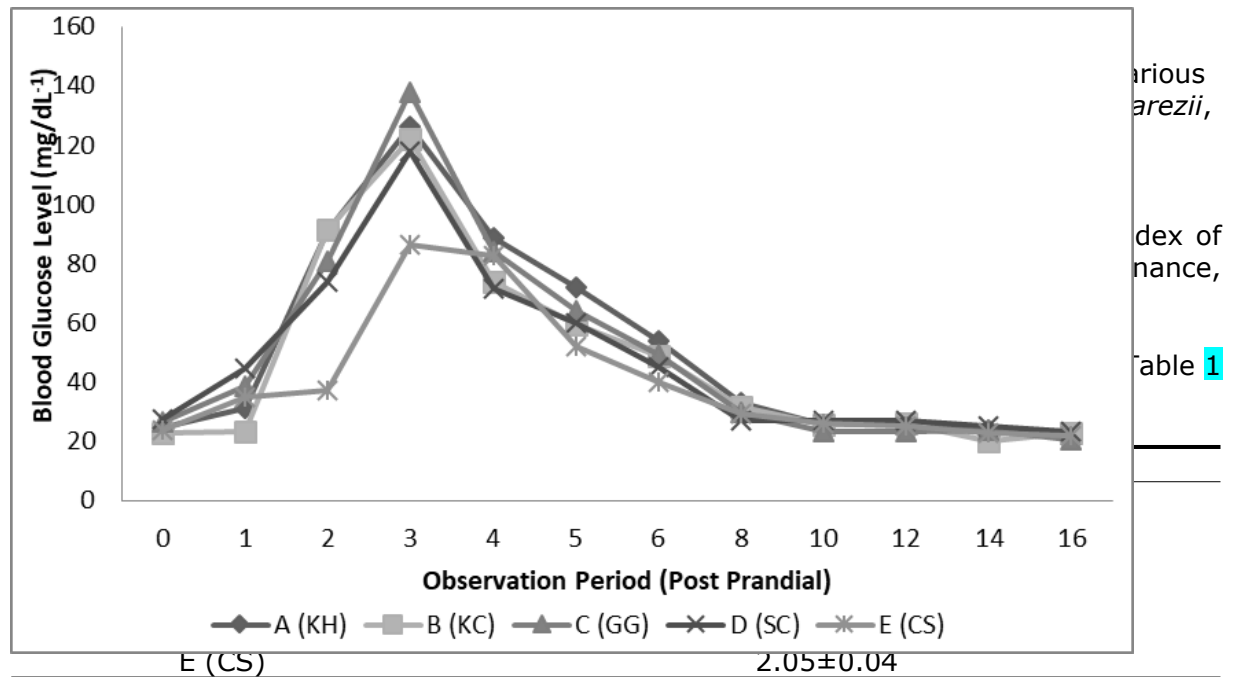
**Gastric evacuation rate.** Observation of gastric evacuation rate (GER) was done at the end of study. Furthermore, the measurement method applied has followed the procedure conducted by Lee et al (2000) which has been modified. Milkfish was fasted for 24 hours, and further fed to full. Fish stomach content was obtained after feeding, and later this process was done at interval of one hour. Stomach content collection was stopped when experimental fish stomach was empty. Feed percentage in digestive track was calculated using the formula:

$$\% \text{ GER} = \frac{\text{Feed in stomach}}{\text{Feed eaten}} \times 100$$

**Data analysis.** All data obtained in this study were analyzed through the analysis of variance and further was continued by response test at significance level of 5% using SPSS 12.0 and descriptively, that was by comparing the results obtained between treatments, and also comparing with supporting literature.

## Result and Discussion

**Blood glucose level.** Blood glucose level of milkfish juvenile immediately increased after fish consumed feed (Figure 1). The highest blood glucose level reached its peak at hour-3 and experienced a decrease at hour-4 until it reached the lowest level at hour-16. The highest glucose level was shown by feed contained *G. gigas* seaweed of 138 mg dL<sup>-1</sup>, followed by the green strain of *K. alvarezii* which amounted to 126 mg dL<sup>-1</sup>, brown strain of *K. alvarezii* of 122 mg dL<sup>-1</sup>, *Sargassum* sp. of 118 mg dL<sup>-1</sup>, and the lowest was found in *Caulerpa* sp. of 86.5 mg dL<sup>-1</sup>.



KH = Green strain of *K. alvarezii*, KC = Brown strain of *K. alvarezii*, GG = *G. gigas*, SC = *Sargassum* sp., and CS = *Caulerpa* sp.

The measurement result indicated that the highest hepatosomatic index was shown by the feed contained *G. gigas* even though the result of variance analysis revealed that the finding was not significantly different ( $P > 0.05$ ) towards milkfish hepatosomatic at the end of maintenance.

**Gastric evacuation rate.** Gastric evacuation rate of experimental fish showed different time periods on each treatment. The fastest gastric emptying was found milkfish given feed contained *Caulerpa* sp. that was at hour-5 post prandial, while gastric evacuation rate in milkfish treated feed contained green strain of *K. alvarezii* strain, brown strain of *K. alvarezii*, *G. gigas*, and *Sargassum* sp. occurred at hour-6 (Table 2).

Table 2

Gastric evacuation rate (%) of milkfish on each observation period of various fermented seaweeds

Hour post prandial (hour)	Gastric evacuation rate (%)				
	A (KH)	B (KC)	C (GG)	D (SC)	E (CS)
0	0	0	0	0	0
1	94.38±0.78	93.94±1.41	93.17±2.41	96.28±1.64	92.05±2.72
2	72.57±8.35	74.36±1.33	79.41±1.92	78.74±0.75	66.44±3.17
3	51.86±1.73	57.57±9.88	55.74±6.39	61.38±7.47	46.94±1.78
4	31.3±7.62	28.54±4.56	38.10±1.3	28.8±2.79	36.50±9.72
5	19.97±3.18	20.63±4.11	27.49±0.8	14.43±3.16	16.44±2.3
6	13.74±1.52	10.81±6.34	14.31±3.91	10.65±1.26	0
7	0	0	0	0	0
8	0	0	0	0	0
9	0	0	0	0	0

KAH = Green strain of *K. alvarezii*, KAC = Brown strain of *K. alvarezii*, GG = *G. gigas*, SC = *Sargassum* sp., and CS = *Caulerpa* sp.

**Discussion.** The use of fermented seaweed as feed ingredient has been widely reported (Zaki et al 1994; Norambuena et al 2015; Ilias et al 2015; Aslamyah et al 2017). The addition of fermented seaweed in feed for milkfish juveniles as the source of carbohydrate showed an increase in fish blood glucose level which reached its peak at hour-3 postprandial for all types of seaweeds. Nutrient intake is a factor that affects the glucose response (Porchas et al 2009). Feed containing different fat and protein will result in different blood glucose levels as well (Cheng et al 2006). The highest peak was seen at the use of *G. gigas* seaweed of 138 mg dL<sup>-1</sup> and the lowest was found in *Caulerpa* sp. of 86.5 mg dL<sup>-1</sup>. These values indicated that the use of *G. gigas* seaweed was able to supply adequate glucose which has a main role in animal bioenergy that will be converted into chemical energy (ATP) released in the form of mechanical energy (Lucas 1996).

The role of seaweed in improving nutrient absorption (Nativity et al 2015) and metabolism process (Mustafa et al 1995) was also seen in the increasing hepatosomatic index of milkfish. Hepatosomatic index becomes an indicator of energy status in liver (Hismayasari et al 2015) and is important in estimating nutritional value in feed (Ighwela et al 2014). The highest value of hepatosomatic index was found in the use of *G. gigas*, while the lowest was obtained by the green strain of *K. alvarezii* despite overall difference in the value of hepatosomatic index in all types of seaweed did not show a significant difference ( $p > 0.05$ ). It reflected the role of seaweed in increasing hepatosomatic index in milkfish larvae. Result obtained was in line with the finding of study conducted by Mustafa et al (1995) which found an increase in hepatosomatic index through the use of *Porphyra* sp. in red sea bream (*Pagrus major*).

Gastric evacuation rate showed stomach emptying at hour-7 in all types of seaweeds, except for in *Caulerpa* sp. namely at hour-6. Feed contained *G. gigas* indicated the most feed consumed at hour-6 which amounted to 14.31±3.91, while the least was found in *Caulerpa* sp. This finding showed that feed containing *G. gigas* was longer digested in stomach. It was due to the reason that *G. gigas* feed contained more carbohydrate and other nutrient component compared to other types of seaweed by considering the value of blood glucose level and hepatosomatic index which placed *G. gigas* to reach the highest value. Hepatosomatic index also increased along with the increasing intake of feed contained carbohydrate in *Oreochromis niloticus* (Ighwela et al 2014) and *Cyprinus carpio communis* (Ahmad et al 2012).

**Conclusions.** Seaweed *G. Gigas* can be used as a source of carbohydrates through fermentation. Based on blood glucose level, hepatosomatic index, and gastric evacuation rate showed the highest values in this seaweed species compared to others. Results of this study showed that the use of *G. gigas* seaweed fermented using mix of microorganisms was the best feed ingredient which was able to fulfill nutrient requirement for the growth of milkfish larvae.

**Acknowledgements.** The authors would like to thank the Directorate General of Higher Education for funding this study through the National Priority Research of Masterplan for Acceleration and Expansion of Indonesia Economic Development (Penelitian Prioritas Nasional Masterplan Percepatan dan Perluasan Pembangunan Ekonomi Indonesia 2011-2025, PENPRINAS MP3EI 2011-2025), Fiscal year 2015.

## References

- Ahmad M, Qureshi T. A, Singh A. B., 2012. Effect of dietary protein, lipid and carbohydrate contents on the viscera composition and organ indices of cyprinus carpio communis fingerlings. *African Journal of Biotechnology* 11(33):8361-8366
- Aslamyah S, Karim M. Y, Badraeni, Tahya A. M., 2016. Seaweed as a source of carbohydrate in the feed of milk fish (*Chanos chanos* forsskal). *International journal of Pharmtech Research* 9 (11): 64-67
- Aslamyah S, Karim M. Y, Badraeni., 2015. Final Report: Diversification of fermented seaweed as a source of carbohydrates and binders in cheaper artificial feed and environmentally friendly to support the intensification of milkfish aquaculture in South Sulawesi. PENPRINAS MP3EI 2011-2025 – Hasanuddin University, Makassar (In Indonesia)
- Aslamyah S, Karim M. Y, Badraeni., 2017. Fermentation of seaweed flour with various fermentors to improve the quality of fish feed ingredient. *Journal of Indonesian aquaculture* 16(1): 8-14
- Cheng A. C, Chen C. Y, Liou C. H, Chang C. F., 2006. Effect of dietary protein and lipids on blood parameters and superoxide anion production in the grouper *Epinephelus coioides* (serranidae: Epinephelinae). *Zoological studies* 45: 492-502.
- De Silva S. S, Hasan M. R., 2007. Feeds and Fertilizers: the key to long term sustainability of Asian aquaculture. In M. R. Hasan, T. Hecht, S.S. De Silva and A.G.J. Tacon, eds. *Study and analysis of feeds and fertilizers for sustainable aquaculture development*, pp.19-47. FAO Fisheries Technical Paper No. 497. Rome, FAO. 510pp.
- Hismayasari I. B, Marhendra A. P. W, Rahayu S, Saidin, supriyadi D. S., 2015. Gonadosomatic index (GSI), Hepatosomatic index (HIS) and proportion of oocytes stadia as an indicator of rainbow fish *Melanotaenia boesemani* spawning season. *International Journal of Fisheries and Aquatic Studies* 2(5): 359-362.
- Ighwela K. A, Ahmad A. B, Munafi A. B. A. 2014., The selection of viscerosomatic and hepatosomatic indices for the measurement analysis of *oreochromis niloticus* condition fed with varying dietary maltose level. *International Journal of Fauna and Biological Studies* 1 (3): 18-20.
- Ilias N. N, Jamal P, Jaswir I, Sulaiman S, Zainuddin Z, Azmi A. S., 2015. Potentiality of selected seaweed for the production of nutritious fish feed using solid state fermentation. *Journal of Engineering Science and Technology. Special issue*: 30-40
- Lee S, Hwang U, Cho S. H., 2000. Effects of feeding frequency and dietary moisture content on growth, body composition and gastric evacuation of juvenile Korean rockfish (*Sebastes schlegeli*). *Aquaculture* 187: 399-409.
- Lucas A. 1996. *Bioenergetic of aquatic animals*. Taylor & Francis, 169p
- Meyer S. P, Zein-Eldin Z. P., 1972. Binders and Pellet Stability in Development of Crustacean Diets. Reprinted from Proc. 3<sup>rd</sup> Ann. Work-shop-World Maricult. Soc., St. Petterburg, Florida. Jan. 26–28, 1972. 351–364.
- Mustafa M. G, Wakamatsu S, Takeda T, Umino T., 1995. Effect of algae meal as feed additive on growth, feed efficiency, and body composition in red sea bream. *Fisheries Science* 61(1):25-28.
- Natify W, Droussi M, Berday N, Araba A, Benabid M., 2015. Effect of the sea weed *Ulva lactuca* as a feed additive on growth performance, feed utilization and body composition of Nile tilapia. *International Journal of Agronomy and Agricultural Research* 7(3):85-92.

- Norambuena F, Hermon K, Skrzypczyk V, Emery J. A, Sharon Y, Beard A, Turchini G. M., 2015. Algae in fish feed: performance and fatty acid metabolism in juvenile atlantic salmon. Plos one 10(4): e0124042.
- Nursidi, Ali S. A., Anshary H., Tahya A. M., 2017 Environmental parameters and specific growth of *Kappaphycus alvarezii* in Saugi Island, South Sulawesi Province, Indonesia. AACL Bioflux 10(4):698-702.
- Porchas M. M, Cordova L. R. M, Enriquez R. R., 2009. Cortisol and Glucose: Reliable indicators of fish stress?. Pan-American Journal of Aquatic Sciences 4(2): 158-178.
- Zaki M. A, Nour A. M, El-din A. E. T., 1994. The use of seaweed meal in feeding common crap (*Cyprinus carpio* L). Asian-Aust. Journal of Animal Science 7(2): 183-189.

Received: 22 October 2017. Accepted: 16 January 2018. Published online: ... January 2018.

Authors:

Siti Aslamyah, Study Program of Aquaculture, Faculty of Marine Science and Fishery, Hasanuddin University, Jl. Perintis Kemerdekaan KM. 10, Makassar, South Sulawesi, Indonesia, 90245, e-mail:

hasni\_yulianti@yahoo.com; sitiaslamyah1@gmail.com

Muhammad Yusri Karim, Study Program of Aquaculture, Faculty of Marine Science and Fishery, Hasanuddin University, Jl. Perintis Kemerdekaan KM. 10, Makassar, South Sulawesi, Indonesia, 90245, e-mail:

yusri\_karim@yahoo.com

Badraeni, Study Program of Aquaculture, Faculty of Marine Science and Fishery, Hasanuddin University, Jl.

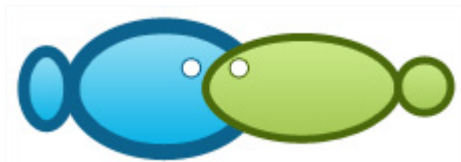
Perintis Kemerdekaan KM. 10, Makassar, South Sulawesi, Indonesia, 90245, e-mail: reniarfan@yahoo.com

Akbar Marzuki Tahya, Tadulako University, Jl. Bumi Tadulako Tondo, Palu, Central Sulawesi, Indonesia, 94118, e-mail: amtahya@gmail.com

This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution and reproduction in any medium, provided the original author and source are credited.

How to cite this article:

Aslamyah S., Karim M. Y., Badraeni, Tahya A. M., 2018 **Effect of fermented seaweed addition on blood glucose level, hepatosomatic index, and gastric evacuation rate of milkfish, *Chanos chanos* Forsskal larvae.** AACL Bioflux 11(1):...-...



# Effect of fermented seaweed addition on blood glucose level, hepatosomatic index, and gastric evacuation rate of milkfish, *Chanos chanos* Forsskal larvae

<sup>1</sup>Siti Aslamyah, <sup>1</sup>M. Yusri Karim, <sup>1</sup>Badraeni, <sup>2</sup>Akbar M. Tahya

<sup>1</sup>Study Program of Aquaculture, Faculty of Marine Science and Fisheries, Hasanuddin University, Makassar, Indonesia; <sup>2</sup>Balik Diwa Marine Technology University, Makassar, Indonesia. Corresponding author: **S.** Aslamyah, [sitiaslamyah1@gmail.com](mailto:sitiaslamyah1@gmail.com)

**Abstract.** Seaweed is a fishery product which can be used as the source of carbohydrate and binder in fish feed composition. However, excessive use of seaweed results in high crude fiber. The effort that is able to conduct is fermentation. The aim of this study was to evaluate a variety of seaweeds fermented using microorganism towards glucose level, hepatosomatic index and gastric evacuation rate to see the impact of seaweed use on fish. The five types of seaweed used were green strain of *Kappaphycus alvarezii*, brown strain of *K. alvarezii*, *Gracilaria gigas*, *Sargassum* sp. and *Caulerpa* sp. The measurement result of blood glucose level, hepatosomatic index, and gastric evacuation rate consistently showed the highest value on the use of seaweed *G. gigas*.

**Key Words:** fermentation, microorganism, seaweed, feed ingredient, milkfish larvae.

**Introduction.** Milkfish (*Chanos chanos*) is one of the superior brackish water commodities in Indonesia. Many pond fish farmers cultivate this species in traditional system which only relies on live food available in the pond. However, increasing population and increase in demand which are not balanced by the availability of fish farming area makes intensive fish farming system becoming an option. Intensification of milkfish farming business at high stocking density completely depends on artificial food in the form of pellet. This condition causes the feed to be one of production factors that spends the highest cost, reaching approximately 60% of total production cost.

Several studies have been conducted in an effort to suppress the feed cost without reducing the quality of the feed itself. Fish feed quality, in addition to be determined by nutritional content, is also determined by physical quality, particularly the stability in the water. One of the ingredients that determine the quality is the binder. Additional material used as binder highly determines the stability of feed in the water (Meyer & Zein-Eldin 1972).

One of fishery products containing carbohydrate as well as has a function as binder is seaweed. In general, seaweed consists of water (27.8%), protein (5.4%), carbohydrate (33.3%), fat (8.6%), crude fiber (3%) and ash (22.25%). Besides carbohydrate, protein, fat, and fiber, seaweed also contains enzyme, nucleic acid, amino acid, vitamin (A, B, C, D, E, and K), macro minerals such as nitrogen, oxygen, calcium and selenium and also micro minerals like iron, magnesium and sodium.

In the previous study, we have reported that the use of artificial feed containing fermented seaweed as binder and carbohydrate source showed increasing growth, survival, digestibility level, and body chemical composition of milkfish juvenile (Aslamyah et al 2016). In this study, results of glycogen level in liver and muscle, blood glucose level, hepatosomatic index, and gastric evacuation rate of milkfish fed artificial feed containing fermented seaweed were reported. This study was aimed specifically to

determine the best quality feed ingredient for milkfish by using seaweed as carbohydrate source and binder.

## Material and Method

**Milkfish juvenile.** Experimental fish used was milkfish juvenile at  $5.57 \pm 0.22$  g in weight. The next procedure was in accordance with the procedure conducted by Aslamyiah et al (2016).

**Seaweed.** Seaweeds used in this study were green strain of *Kappaphycus alvarezii*, brown strain of *K. alvarezii*, *Gracilaria gigas*, *Sargassum* sp. and *Caulerpa* sp. obtained from seaweed farmers in Punaga Village, Takalar Regency. Seaweeds were cleaned and dried, and further crushed into flour.

**Fermentation process.** Fermentation process was done by using 3 species of microorganisms with fermentation composition as follows: a). *Bacillus* sp. bacteria of 2 mL/100 g seaweed powder; b). 1.5% of ragi tape (yeast) as the source of *Rhizopus* sp.; c). 1.5% baker's yeast as the source of *Saccharomyces* sp.; d) mix of *Bacillus* sp., *Rhizopus* sp., *Saccharomyces* sp. at ratio of 1 mL:1 g:1 g/100 g seaweed flour, and control treatment resulted from fermentation process without using any bacteria. The best fermentation product was applied as fish feed mix to be used in further treatments.

Fermentation was started by weighing each of 100 g seaweed and further seaweeds were put into plastic with sealing. Every package was added with microorganisms solved in 20 mL sugar cane drop in each treatment by evenly sprayed it using sprayer. The package was tightly closed and incubated for 72 hours. After 72 hours, seaweed flour was steamed in boiled water for 1-2 minutes to inactivate the microorganism activity.

**Blood glucose level.** Observation of blood glucose level on experimental fish was done at the end of study. Milkfish was fasted for 24 hours and further fed to full. Experimental fish was transferred into container of large basin with aeration. Collection of experimental fish blood was started at hour-0 and hour- 1, 2, 4, 5, 6, 8, 10, 12, 14, 16, and 20 post prandial. Sample of experimental fish blood was collected from the gills and caudal vena by using sput of 1 mL volume. Measurement of blood glucose level was performed through colorimetric analysis using reagent kit.

**Hepatosomatic index.** Hepatosomatic index was calculated by comparing the total weight of fish and the weight of liver. At first, fish was weighed for its weight, after that fish was dissected on ice. Dissection was carefully and quickly performed. The liver was weighed. The value of hepatosomatic index was measured based on the equation below:

$$IH = HP/W$$

where: IH = hepatosomatic index;

HP = hepatosomatic weight (g);

W = fish weight (g).

**Gastric evacuation rate.** Observation of gastric evacuation rate was done at the end of study. Furthermore, the measurement method applied has followed the procedure conducted by Lee et al (2000) which has been modified. Milkfish was fasted for 24 hours, and further fed to full. Fish stomach content was obtained after feeding, and later this process was done at interval of one hour. Stomach content collection was stopped when experimental fish stomach was empty. Feed percentage in digestive track was calculated using the formula:

$$\% \text{ LPL} = \frac{\text{Feed in stomach}}{\text{Feed eaten}} \times 100$$

**Data analysis.** All data obtained in this study were analyzed through the analysis of variance and further was continued by response test at significance level of 5% using SPSS 12.0 and descriptively, that was by comparing the results obtained between treatments, and also comparing with supporting literature.

## Result and Discussion

**Blood glucose level.** Blood glucose level of milkfish juvenile immediately increased after fish consumed feed (Figure 1). The highest blood glucose level reached its peak at hour-3 and experienced a decrease at hour-4 until it reached the lowest level at hour-16. The highest glucose level was shown by feed contained *G. gigas* seaweed of 138 mg dL<sup>-1</sup>, followed by the green strain of *K. alvarezii* which amounted to 126 mg dL<sup>-1</sup>, brown strain of *K. alvarezii* of 122 mg dL<sup>-1</sup>, *Sargassum* sp. of 118 mg dL<sup>-1</sup>, and the lowest was found in *Caulerpa* sp. of 86.5 mg dL<sup>-1</sup>.

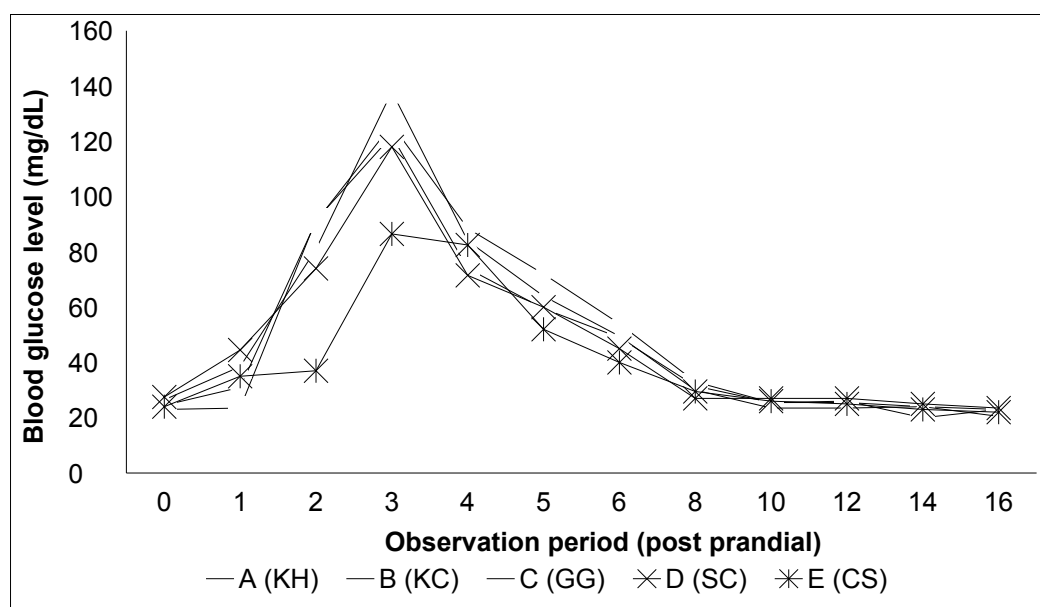


Figure 1. Blood glucose level (mg dL<sup>-1</sup>) of milkfish on each observation period of various fermented seaweed.

**Hepatosomatic index.** The results of the measurement of the hepatosomatic index of experimental fish treated with various fermented seaweeds for 60 days of maintenance, at the beginning and the end of study, are presented in Table 3.

Table 3

Hepatosomatic index of milkfish towards various fermented seaweeds

Treatment	Hepatosomatic index
Initial value	1.19±1.19
A (KAH)	2.03±0.29
B (KAC)	2.02±0.12
C (GG)	2.07±0.15
D (DP)	2.04±0.21
E (CP)	2.05±0.04

KAH = Green strain of *K. alvarezii*, KAC = Brown strain of *K. alvarezii*, GG = *G. gigas*, SS = *Sargassum* sp., and CS = *Caulerpa* sp.

The measurement result indicated that the highest hepatosomatic index was shown by the feed contained *G. gigas* even though the result of variance analysis revealed that the finding was not significantly different ( $P > 0.05$ ) towards milkfish hepatosomatic at the end of maintenance.

**Gastric evacuation rate.** Gastric evacuation rate of experimental fish showed different time periods on each treatment. The fastest gastric emptying was found milkfish given feed contained *Caulerpa* sp. that was at hour-5 post prandial, while gastric evacuation rate in milkfish treated feed contained green strain of *K. alvarezii* strain, brown strain of *K. alvarezii*, *G. gigas*, and *Sargassum* sp. occurred at hour-6 (Table 4).

Table 4

Gastric evacuation rate (%) of milkfish on each observation period of various fermented seaweeds

Hour post prandial (hour)	Gastric evacuation rate (%)				
	A (KH)	B (KC)	C (GG)	D (DP)	E (CP)
0	0	0	0	0	0
1	94.38±0.78	93.94±1.41	93.17±2.41	96.28±1.64	92.05±2.72
2	72.57±8.35	74.36±1.33	79.41±1.92	78.74±0.75	66.44±3.17
3	51.86±1.73	57.57±9.88	55.74±6.39	61.38±7.47	46.94±1.78
4	31.3±7.62	28.54±4.56	38.10±1.3	28.8±2.79	36.50±9.72
5	19.97±3.18	20.63±4.11	27.49±0.8	14.43±3.16	16.44±2.3
6	13.74±1.52	10.81±6.34	14.31±3.91	10.65±1.26	0
7	0	0	0	0	0
8	0	0	0	0	0
9	0	0	0	0	0

KAH = Green strain of *K. alvarezii*, KAC = Brown strain of *K. alvarezii*, GG = *G. gigas*, SS = *Sargassum* sp., and CS = *Caulerpa* sp.

**Discussion.** The use of fermented seaweed as feed ingredient has been widely reported (Zaki et al 1994; Norambuena et al 2015; Ilias et al 2015; Aslamyah et al 2017). The addition of fermented seaweed in feed for milkfish juveniles as the source of carbohydrate showed an increase in fish blood glucose level which reached its peak at hour-3 postprandial for all types of seaweeds. Nutrient intake is a factor that affects the glucose response (Porchas et al 2009). Feed containing different fat and protein will result in different blood glucose levels as well (Cheng et al 2006). The highest peak was seen at the use of *G. gigas* seaweed of 138 mg dL<sup>-1</sup> and the lowest was found in *Caulerpa* sp. of 86.5 mg dL<sup>-1</sup>. These values indicated that the use of *G. gigas* seaweed was able to supply adequate glucose which has a main role in animal bioenergy that will be converted into chemical energy (ATP) released in the form of mechanical energy (Lucas 1996).

The role of seaweed in improving nutrient absorption (Nativity et al 2015) and metabolism process (Mustafa et al 1995) was also seen in the increasing hepatosomatic index of milkfish. Hepatosomatic index becomes an indicator of energy status in liver (Hismayasari et al 2015) and is important in estimating nutritional value in feed (Ighwela et al 2014). The highest value of hepatosomatic index was found in the use of *G. gigas*, while the lowest was obtained by the green strain of *K. alvarezii* despite overall difference in the value of hepatosomatic index in all types of seaweed did not show a significant difference ( $p > 0.05$ ). It reflected the role of seaweed in increasing hepatosomatic index in milkfish larvae. Result obtained was in line with the finding of study conducted by Mustafa et al (1995) which found an increase in hepatosomatic index through the use of *Porphyra* sp. in red sea bream.

Gastric evacuation rate showed stomach emptying at hour-7 in all types of seaweeds, except for in *Caulerpa* sp. namely at hour-6. Feed contained *G. gigas* indicated the most feed consumed at hour-6 which amounted to 14.31±3.91, while the least was found in *Caulerpa* sp. This finding showed that feed containing *G. gigas* was longer digested in stomach. It was due to the reason that *G. gigas* feed contained more carbohydrate and other nutrient component compared to other types of seaweed by considering the value of blood glucose level and hepatosomatic index which placed *G. gigas* to reach the highest value. Hepatosomatic index also increased along with the increasing intake of feed contained carbohydrate in *Oreochromis niloticus* (Ighwela et al 2014) and *Cyprinus carpio communis* (Ahmad et al 2012).

**Conclusions.** Results of this study showed that the use of *G. gigas* seaweed fermented using mix of microorganisms was the best feed ingredient which was able to fulfill nutrient requirement for the growth of milkfish larvae.

**Acknowledgements.** The authors would like to thank the Directorate General of Higher Education for funding this study through the National Priority Research of Masterplan for Acceleration and Expansion of Indonesia Economic Development (Penelitian Prioritas Nasional Masterplan Percepatan dan Perluasan Pembangunan Ekonomi Indonesia 2011-2025, PENPRINAS MP3EI 2011-2025), Fiscal year 2015.

## References

- Ahmad M, Qureshi TA, Singh AB. 2012. Effect of dietary protein, lipid and carbohydrate contents on the viscera composition and organ indices of cyprinus carpio communis fingerlings. *African journal of biotechnology*. 11(33):8361-8366
- Aslamyah S, Karim Y, Badraeni, Tahya AM. 2016. Seaweed as a source of carbohydrate in the feed of milk fish (*Chanos chanos* forsskal). *International journal of farmtech research*. 9 (11): 64-67
- Aslamyah S, Karim Y, Badraeni. 2017. Fermentation of seaweed flour with various fermentors to improve the quality of fish feed ingredient. *Journal of Indonesian aquaculture* . 16(1): 8-14
- Cheng A.C, Chen C.Y, Liou C.H and Chang C.F, 2006. Effect of dietary protein and lipids on blood parameters and superoxide anion production in the grouper *epinephelus coioides* (serranidae: Epinephelinae). *zoological studies*. 45: 492-502.
- Hismayasari I.B, Marhendra APW, Rahayu S, Saidin, supriyadi DS. 2015. Gonadosomatic index (GSI), Hepatosomatic index (HIS) and proportion of oocytes stadia as an indicator of rainbow fish *Melanotaenia boesemani* spawning season. *International journal of fisheries and aquatic studies*. 2(5): 359-362.
- Ighwela KA, Ahmad AB, Munafi ABA. 2014. He selection of viscerosomatic and hepatosomatic indices for the measurement analysis of *oreochromis niloticus* condition fed with varying dietary maltose level.
- Ilias NN, Jamal P, Jaswir I, Sulaiman S, Zainuddin Z, Azmi AS. 2015. Potentiality of selected seaweed for the production of nutritious fish feed using solid state fermentation. *Journal of engineering science and technology*. Special issue: 30-40
- Lucas A. 1996. Physical concepts of bioenergetic
- Meyer SP, Zein-Eldin ZP. 1972. Binders and Pellet Stability in Development of Crustacean Diets. Reprinted from Proc. 3<sup>rd</sup> Ann. Work-shop-World Maricult. Soc., St. Petterburg, Florida. Jan. 26-28, 1972. Hal. 351-364.
- Mustafa MG, Wakamatsu S, Takeda T, Umino T. 1995. Effect of algae meal as feed additive on growth, feed efficiency, and body composition in reared sea bream. *Fisheries science*. 61(1):25-28.
- Natify W, Droussi M, Berday N, Araba A, Benabid M. 2015. Effect of the sea weed *Ulva lactuca* as a feed additive on growth performance, feed utilization and body composition of Nile tilapia. *International journal of agronomy and agricultural research*, 7(3):85-92.
- Norambuena F, Hermon K, Skrzypczyk V, Emery JA, Sharon Y, Beard A, Turchini GM. 2015. Algae in fish feed: performance and fatty acid metabolism in juvenile Atlantic salmon. *Plos one*.
- Porchas MM, Cordova LRM, Enriquez RR. 2009. Cortisol and Glucose: Reliable indicators of fish stress?. *Pan-American Journal of Aquatic Sciences*. 4(2): 158-178.
- Zaki MA, Nour AM, El-din AET. 1994. The use of seaweed meal in feeding common carp (*Cyprinus carpio* L)

Received: 22 October 2017. Accepted: 16 January 2018. Published online: ... January 2018.

Authors:

Siti Aslamyah, Study Program of Aquaculture, Faculty of Marine Science and Fishery, Hasanuddin University, Jl. Perintis Kemerdekaan KM. 10, Makassar, South Sulawesi, Indonesia, 90245, e-mail:

hasni\_yulianti@yahoo.com; sitiaslamyah1@gmail.com

Muhammad Yusri Karim, Study Program of Aquaculture, Faculty of Marine Science and Fishery, Hasanuddin University, Jl. Perintis Kemerdekaan KM. 10, Makassar, South Sulawesi, Indonesia, 90245, e-mail:

yusri\_karim@yahoo.com

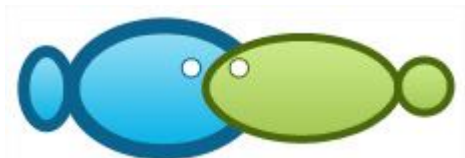
Badraeni, Study Program of Aquaculture, Faculty of Marine Science and Fishery, Hasanuddin University, Jl. Perintis Kemerdekaan KM. 10, Makassar, South Sulawesi, Indonesia, 90245, e-mail: reniarfan@yahoo.com

Akbar Marzuki Tahya, Balik Diwa Marine Technology University, Jl. Perintis Kemerdekaan KM 8 No. VIII, Makassar, South Sulawesi, Indonesia, 90245, e-mail: amtahya@gmail.com

This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution and reproduction in any medium, provided the original author and source are credited.

How to cite this article:

Aslamyah S., Karim M. Y., Badraeni, Tahya A. M., 2018 [Effect of fermented seaweed addition on blood glucose level, hepatosomatic index, and gastric evacuation rate of milkfish, \*Chanos chanos\* Forsskal larvae](#). *AAFL Bioflux* 11(1):...-...



# Effect of fermented seaweed addition on blood glucose level, hepatosomatic index, and gastric evacuation rate of milkfish, *Chanos chanos* larvae

<sup>1</sup>Siti Aslamyah, <sup>1</sup>M. Yusri Karim, <sup>1</sup>Badraeni, <sup>2</sup>Akbar M. Tahya

<sup>1</sup> Study Program of Aquaculture, Faculty of Marine Science and Fisheries, Hasanuddin University, Makassar, Indonesia; <sup>2</sup> Study Program of Aquaculture, Faculty of Animal Husbandry and Fishery, Tadulako University, Palu, Indonesia. Corresponding author: S. Aslamyah, [sitiaslamyah1@gmail.com](mailto:sitiaslamyah1@gmail.com)

**Abstract.** Seaweed is a fishery product which can be used as the source of carbohydrate and binder in fish feed composition. However, excessive use of seaweed results in high crude fiber. This disadvantage could be avoided by the fermentation of the seaweeds. The aim of this study was to evaluate a variety of seaweeds fermented using microorganism towards glucose level, hepatosomatic index and gastric evacuation rate to see the impact of seaweed use on milkfish (*Chanos chanos*) larvae. The five types of seaweed used were green strain of *Kappaphycus alvarezii*, brown strain of *K. alvarezii*, *Gracilaria gigas*, *Sargassum* sp. and *Caulerpa* sp. The measurement result of blood glucose level, hepatosomatic index, and gastric evacuation rate consistently showed the highest value on the use of seaweed *G. gigas*.

**Key Words:** fermentation, microorganism, seaweed, feed ingredient, milkfish larvae.

**Introduction.** Milkfish (*Chanos chanos*) is one of the superior brackish water commodities in Indonesia. Many pond fish farmers cultivate this species in traditional system which only relies on live food available in the pond. However, increasing population and increase in demand which are not balanced by the availability of fish farming area makes intensive fish farming system becoming an option. Intensification of milkfish farming business at high stocking density completely depends on artificial food in the form of pellet. This condition causes the feed to be one of production factors that spends the highest cost, reaching approximately 60% of total production cost (De Silva & Hasan 2007).

Several studies (Aslamyah et al 2016, 2017) have been conducted in an effort to suppress the feed cost without reducing the quality of the feed itself. Fish feed quality, in addition to be determined by nutritional content, is also determined by physical quality, particularly the stability in the water. One of the ingredients that determine the quality is the binder. Additional material used as binder highly determines the stability of feed in the water (Meyer & Zein-Eldin 1972).

One of fishery products containing carbohydrate as well as has a function as binder is seaweed. In general, seaweed consists of water (27.8%), protein (5.4%), carbohydrate (33.3%), fat (8.6%), crude fiber (3%) and ash (22.25%). Besides carbohydrate, protein, fat, and fiber, seaweed also contains enzyme, nucleic acid, amino acid, vitamin (A, B, C, D, E, and K), macro minerals such as nitrogen, oxygen, calcium and selenium and also micro minerals like iron, magnesium and sodium (Aslamyah et al 2015). Seaweed has many benefits for humans, environment, and aquaculture so it needs to be studied, especially in South Sulawesi Province (Nursidi et al 2017).

In the previous study, we have reported that the use of artificial feed containing fermented seaweed as binder and carbohydrate source showed increasing growth, survival, digestibility level, and body chemical composition of milkfish juvenile (Aslamyah et al 2016). In this study, results of glycogen level in liver and muscle, blood glucose level, hepatosomatic index, and gastric evacuation rate of milkfish fed artificial feed

containing fermented seaweed were reported. This study was aimed specifically to determine the best quality feed ingredient for milkfish by using seaweed as carbohydrate source and binder.

## Material and Method

**Research location.** The research was conducted from April to August 2015 in Fish Breeding Technology Laboratory, Fishery Department, Faculty of Marine and Fishery, Hasanuddin University, Makassar, Indonesia.

**Milkfish juvenile.** Experimental fish used was milkfish juvenile at  $5.57 \pm 0.22$  g in weight. The next procedure was in accordance with the procedure conducted by Aslamyiah et al (2016).

**Seaweed.** Seaweeds used in this study were green strain of *Kappaphycus alvarezii*, brown strain of *K. alvarezii*, *Gracilaria gigas*, *Sargassum* sp. and *Caulerpa* sp. obtained from seaweed farmers in Punaga Village, Takalar Regency. Seaweeds were cleaned and dried, and further crushed into flour.

**Fermentation process.** Fermentation process was done by using 3 species of microorganisms with fermentation composition as follows: a). *Bacillus* sp. bacteria of 2 mL/100 g seaweed powder; b). 1.5% of ragi tape (yeast) as the source of *Rhizopus* sp.; c). 1.5% baker's yeast as the source of *Saccharomyces* sp.; d) mix of *Bacillus* sp., *Rhizopus* sp., *Saccharomyces* sp. at ratio of 1 mL:1 g:1 g/100 g seaweed flour, and control treatment resulted from fermentation process without using any bacteria. The best fermentation product was applied as fish feed mix to be used in further treatments.

Fermentation was started by weighing each of 100 g seaweed and further seaweeds were put into plastic with sealing. Every package was added with microorganisms solved in 20 mL sugar cane drop in each treatment by evenly sprayed it using sprayer. The package was tightly closed and incubated for 72 hours. After 72 hours, seaweed flour was steamed in boiled water for 1-2 minutes to inactivate the microorganism activity.

**Blood glucose level.** Observation of blood glucose level on experimental fish was done at the end of study. Milkfish was fasted for 24 hours and further fed to full. Experimental fish was transferred into container of large basin with aeration. Collection of experimental fish blood was started at hour-0 and hour- 1, 2, 4, 5, 6, 8, 10, 12, 14, 16, and 20 post prandial. Sample of experimental fish blood was collected from the gills and caudal vena by using spuit of 1 mL volume. Measurement of blood glucose level was performed through colorimetric analysis using reagent kit of Gluco Dr AGM 2100.

**Hepatosomatic index.** Hepatosomatic index was calculated by comparing the total weight of fish and the weight of liver. At first, fish was weighed for its weight, after that fish was dissected on ice. Dissection was carefully and quickly performed. The liver was weighed. The value of hepatosomatic index was measured based on the equation below:

$$HI = HP/W$$

where: IH = hepatosomatic index;

HP = hepatosomatic weight (g);

W = fish weight (g).

**Gastric evacuation rate.** Observation of gastric evacuation rate (GER) was done at the end of study. Furthermore, the measurement method applied has followed the procedure conducted by Lee et al (2000) which has been modified. Milkfish was fasted for 24 hours, and further fed to full. Fish stomach content was obtained after feeding, and later this process was done at interval of one hour. Stomach content collection was stopped when experimental fish stomach was empty. Feed percentage in digestive track was calculated using the formula:

$$\% \text{ GER} = \frac{\text{Feed in stomach}}{\text{Feed eaten}} \times 100$$

**Data analysis.** All data obtained in this study were analyzed through the analysis of variance and further was continued by response test at significance level of 5% using SPSS 12.0 and descriptively, that was by comparing the results obtained between treatments, and also comparing with supporting literature.

## Result and Discussion

**Blood glucose level.** Blood glucose level of milkfish juvenile immediately increased after fish consumed feed (Figure 1). The highest blood glucose level reached its peak at hour-3 and experienced a decrease at hour-4 until it reached the lowest level at hour-16. The highest glucose level was shown by feed contained *G. gigas* seaweed of 138 mg dL<sup>-1</sup>, followed by the green strain of *K. alvarezii* which amounted to 126 mg dL<sup>-1</sup>, brown strain of *K. alvarezii* of 122 mg dL<sup>-1</sup>, *Sargassum* sp. of 118 mg dL<sup>-1</sup>, and the lowest was found in *Caulerpa* sp. of 86.5 mg dL<sup>-1</sup>.

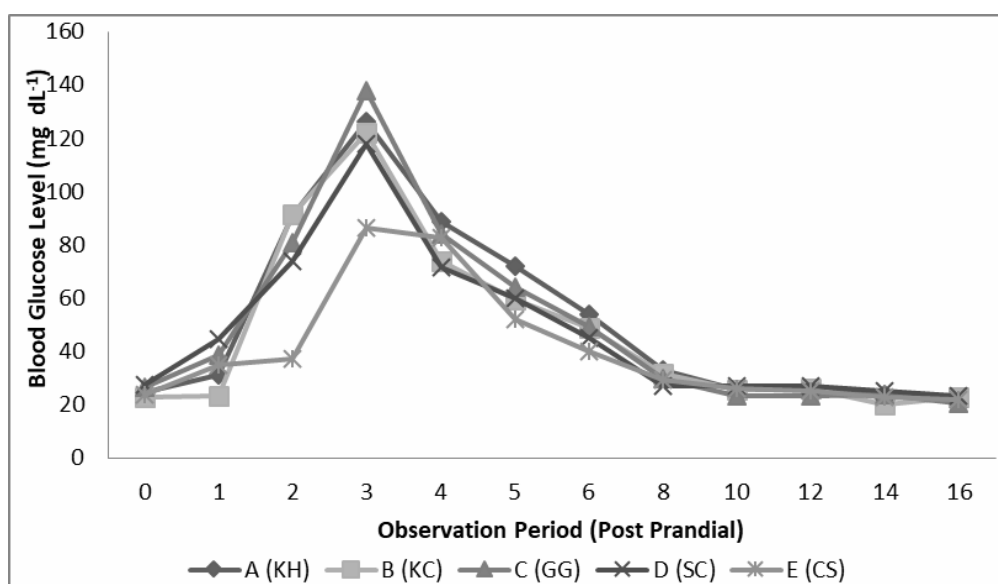


Figure 1. Blood glucose level (mg dL<sup>-1</sup>) of milkfish on each observation period of various fermented seaweed (KH = green strain of *K. alvarezii*, KC = brown strain of *K. alvarezii*, GG = *G. gigas*, SC = *Sargassum* sp., and CS = *Caulerpa* sp.).

**Hepatosomatic index.** The results of the measurement of the hepatosomatic index of experimental fish treated with various fermented seaweeds for 60 days of maintenance, at the beginning and the end of study, are presented in Table 1.

Table 1

Hepatosomatic index of milkfish towards various fermented seaweeds

Treatment	Hepatosomatic index
Initial value	1.19±1.19
A (KH)	2.03±0.29
B (KC)	2.02±0.12
C (GG)	2.07±0.15
D (SC)	2.04±0.21
E (CS)	2.05±0.04

KH = green strain of *K. alvarezii*, KC = brown strain of *K. alvarezii*, GG = *G. gigas*, SC = *Sargassum* sp., and CS = *Caulerpa* sp.

The measurement result indicated that the highest hepatosomatic index was shown by the feed contained *G. gigas* even though the result of variance analysis revealed that the finding was not significantly different ( $p > 0.05$ ) towards milkfish hepatosomatic at the end of maintenance.

**Gastric evacuation rate.** Gastric evacuation rate of experimental fish showed different time periods on each treatment. The fastest gastric emptying was found milkfish given feed contained *Caulerpa* sp. that was at hour-5 post prandial, while gastric evacuation rate in milkfish treated feed contained green strain of *K. alvarezii* strain, brown strain of *K. alvarezii*, *G. gigas*, and *Sargassum* sp. occurred at hour-6 (Table 2).

Table 2  
Gastric evacuation rate (%) of milkfish on each observation period of various fermented seaweeds

Hour post prandial (hour)	Gastric evacuation rate (%)				
	A (KH)	B (KC)	C (GG)	D (DP)	E (CP)
0	0	0	0	0	0
1	94.38±0.78	93.94±1.41	93.17±2.41	96.28±1.64	92.05±2.72
2	72.57±8.35	74.36±1.33	79.41±1.92	78.74±0.75	66.44±3.17
3	51.86±1.73	57.57±9.88	55.74±6.39	61.38±7.47	46.94±1.78
4	31.3±7.62	28.54±4.56	38.10±1.3	28.8±2.79	36.50±9.72
5	19.97±3.18	20.63±4.11	27.49±0.8	14.43±3.16	16.44±2.3
6	13.74±1.52	10.81±6.34	14.31±3.91	10.65±1.26	0
7	0	0	0	0	0
8	0	0	0	0	0
9	0	0	0	0	0

KH = green strain of *K. alvarezii*, KC = brown strain of *K. alvarezii*, GG = *G. gigas*, SC = *Sargassum* sp., and CS = *Caulerpa* sp.

**Discussion.** The use of fermented seaweed as feed ingredient has been widely reported (Zaki et al 1994; Norambuena et al 2015; Ilias et al 2015; Aslamyah et al 2017). The addition of fermented seaweed in feed for milkfish juveniles as the source of carbohydrate showed an increase in fish blood glucose level which reached its peak at hour-3 postprandial for all types of seaweeds. Nutrient intake is a factor that affects the glucose response (Martinez-Porchas et al 2009). Feed containing different fat and protein will result in different blood glucose levels as well (Cheng et al 2006). The highest peak was seen at the use of *G. gigas* seaweed of 138 mg dL<sup>-1</sup> and the lowest was found in *Caulerpa* sp. of 86.5 mg dL<sup>-1</sup>. These values indicated that the use of *G. gigas* seaweed was able to supply adequate glucose which has a main role in animal bioenergy that will be converted into chemical energy (ATP) released in the form of mechanical energy (Lucas 1996).

The role of seaweed in improving nutrient absorption (Nafify et al 2015) and metabolism process (Mustafa et al 1995) was also seen in the increasing hepatosomatic index of milkfish. Hepatosomatic index becomes an indicator of energy status in liver (Hismayasari et al 2015) and is important in estimating nutritional value in feed (Ighwela et al 2014). The highest value of hepatosomatic index was found in the use of *G. gigas*, while the lowest was obtained by the green strain of *K. alvarezii* despite overall difference in the value of hepatosomatic index in all types of seaweed did not show a significant difference ( $p > 0.05$ ). It reflected the role of seaweed in increasing hepatosomatic index in milkfish larvae. Result obtained was in line with the finding of study conducted by Mustafa et al (1995) which found an increase in hepatosomatic index through the use of *Porphyra* sp. in red sea bream (*Pagrus major*).

Gastric evacuation rate showed stomach emptying at hour-7 in all types of seaweeds, except for in *Caulerpa* sp. namely at hour-6. Feed contained *G. gigas* indicated the most feed consumed at hour-6 which amounted to 14.31±3.91, while the least was found in *Caulerpa* sp. This finding showed that feed containing *G. gigas* was longer digested in stomach. It was due to the reason that *G. gigas* feed contained more

carbohydrate and other nutrient component compared to other types of seaweed by considering the value of blood glucose level and hepatosomatic index which placed *G. gigas* to reach the highest value. Hepatosomatic index also increased along with the increasing intake of feed contained carbohydrate in *Oreochromis niloticus* (Ighwela et al 2014) and *Cyprinus carpio communis* (Ahmad et al 2012).

**Conclusions.** Seaweed *G. gigas* can be used as a source of carbohydrates through fermentation. Based on blood glucose level, hepatosomatic index, and gastric evacuation rate, this seaweed showed the highest values compared to the other species. Results of this study showed that the use of *G. gigas* seaweed fermented using mix of microorganisms was the best feed ingredient which was able to fulfill nutrient requirement for the growth of milkfish larvae.

**Acknowledgements.** The authors would like to thank the Directorate General of Higher Education for funding this study through the National Priority Research of Masterplan for Acceleration and Expansion of Indonesia Economic Development (Penelitian Prioritas Nasional Masterplan Percepatan dan Perluasan Pembangunan Ekonomi Indonesia 2011-2025, PENPRINAS MP3EI 2011-2025), Fiscal year 2015.

## References

- Ahmad M., Qureshi T. A., Singh A. B., 2012 Effect of dietary protein, lipid and carbohydrate contents on the viscera composition and organ indices of *Cyprinus carpio communis* fingerlings. African Journal of Biotechnology 11(33):8361-8366.
- Aslamyah S., Karim M. Y., Badraeni, 2015 [Final Report: Diversification of fermented seaweed as a source of carbohydrates and binders in cheaper artificial feed and environmentally friendly to support the intensification of milkfish aquaculture in South Sulawesi]. PENPRINAS MP3EI 2011-2025 – Hasanuddin University, Makassar. [in Indonesian]
- Aslamyah S., Karim Y., Badraeni, Tahya A. M., 2016 Seaweed as a source of carbohydrates in the feed of milk fish (*Chanos chanos* Forsskal). International Journal of PharmTech Research 9(11):64-67.
- Aslamyah S., Karim M. Y., Badraeni, 2017 Fermentation of seaweed flour with various fermentors to improve the quality of fish feed ingredients. Jurnal Akuakultur Indonesia 16(1):8-14.
- Cheng A. C., Chen C. Y., Liou C. H., Chang C. F., 2006 Effects of dietary protein and lipids on blood parameters and superoxide anion production in the grouper, *Epinephelus coioides* (Serranidae: Epinephelinae). Zoological Studies 45:492-502.
- De Silva S. S., Hasan M. R., 2007 Feeds and fertilizers: the key to long term sustainability of Asian aquaculture. In: Study and analysis of feeds and fertilizers for sustainable aquaculture development. Hasan M. R., Hecht T., De Silva S. S., Tacon A. G. J. (eds), FAO Fisheries Technical Paper No. 497, FAO, Rome, pp. 19-47.
- Hismayasari I. B., Marhendra A. P. W., Rahayu S., Saidin, Supriyadi D. S., 2015 Gonadosomatic index (GSI), hepatosomatic index (HIS) and proportion of oocytes stadia as an indicator of rainbow fish *Melanotaenia boesemani* spawning season. International Journal of Fisheries and Aquatic Studies 2(5):359-362.
- Ighwela K. A., Ahmad A. B., Abol-Munafi A. B., 2014 The selection of viscerosomatic and hepatosomatic indices for the measurement and analysis of *Oreochromis niloticus* condition fed with varying dietary maltose level. International Journal of Fauna and Biological Studies 1(3):18-20.
- Ilias N. N., Jamal P., Jaswir I., Sulaiman S., Zainuddin Z., Azmi A. S., 2015 Potentiality of selected seaweed for the production of nutritious fish feed using solid state fermentation. Journal of Engineering Science and Technology. Special issue on SOMCHE 2014 & RSCE 2014 Conference, January (2015), pp. 30-40.
- Lee S. M., Hwang U. G., Cho S. H., 2000 Effects of feeding frequency and dietary moisture content on growth, body composition and gastric evacuation of juvenile Korean rockfish (*Sebastes schlegelii*). Aquaculture 187:399-409.

- Lucas A., 1996 Bioenergetics of aquatic animals. Taylor & Francis, 169 pp.
- Martinez-Porchas M., Martinez-Cordova L. R., Ramos-Enriquez R., 2009 Cortisol and glucose: reliable indicators of fish stress? Pan-American Journal of Aquatic Sciences 4(2): 158-178.
- Meyer S. P., Zein-Eldin Z. P., 1972 Binders and pellet stability in development of crustacean diets. Journal of the World Aquaculture Society 3:351–364.
- Mustafa G., Wakamatsu S., Takeda T., Umino T., Nakagawa H., 1995 Effect of algae meal as feed additive on growth, feed efficiency, and body composition in reared sea bream. Fisheries Science 61(1):25-28.
- Natify W., Droussi M., Berday N., Araba A., Benabid M., 2015 Effect of the sea weed *Ulva lactuca* as a feed additive on growth performance, feed utilization and body composition of Nile tilapia (*Oreochromis niloticus* L.). International Journal of Agronomy and Agricultural Research 7(3):85-92.
- Norambuena F., Hermon K., Skrzypczyk V., Emery J. A., Sharon Y., Beard A., Turchini G. M., 2015 Algae in fish feed: performances and fatty acid metabolism in juvenile Atlantic salmon. PLoS ONE 10(4):e0124042.
- Nursidi, Ali S. A., Anshary H., Tahya A. M., 2017 Environmental parameters and specific growth of *Kappaphycus alvarezii* in Saugi Island, South Sulawesi Province, Indonesia. AACL Bioflux 10(4):698-702.
- Zaki M. A., Nour A. M., Omar E., El-Din A. E. T., 1994 The use of seaweed meal in feeding common carp (*Cyprinus carpio* L.). AJAS 7(2):183-189.

Received: 22 October 2017. Accepted: 16 January 2018. Published online: 25 February 2018.

Authors:

Siti Aslamyah, Study Program of Aquaculture, Faculty of Marine Science and Fishery, Hasanuddin University, Jl. Perintis Kemerdekaan KM. 10, Makassar, South Sulawesi, Indonesia, 90245, e-mail: hasni\_yulianti@yahoo.com; sitiaslamyah1@gmail.com

Muhammad Yusri Karim, Study Program of Aquaculture, Faculty of Marine Science and Fishery, Hasanuddin University, Jl. Perintis Kemerdekaan KM. 10, Makassar, South Sulawesi, Indonesia, 90245, e-mail: yusri\_karim@yahoo.com

Badraeni, Study Program of Aquaculture, Faculty of Marine Science and Fishery, Hasanuddin University, Jl. Perintis Kemerdekaan KM. 10, Makassar, South Sulawesi, Indonesia, 90245, e-mail: reniarfan@yahoo.com

Akbar Marzuki Tahya, Study Program of Aquaculture, Faculty of Animal Husbandry and Fishery, Tadulako University, Jl. Bumi Tadulako Tondo, Palu, Central Sulawesi, Indonesia, 94118, e-mail: amtahya@gmail.com

This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution and reproduction in any medium, provided the original author and source are credited.

How to cite this article:

Aslamyah S., Karim M. Y., Badraeni, Tahya A. M., 2018 Effect of fermented seaweed addition on blood glucose level, hepatosomatic index, and gastric evacuation rate of milkfish, *Chanos chanos* larvae. AACL Bioflux 11(1):226-231.