PJN
ISSN 1680-5194

# PAKISTAN JOURNAL OF NUTRITION

ANSInet
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorpjn@gmail.com

OPEN ACCESS Pakistan Journal of Nutrition

ISSN 1680-5194
DOI: 10.3923/pjn.2017.550.556

# Research Article
# Reproductive Performance of Asian Catfish (*Hemibagrus wyckii*, Bleeker, 1858)-Preliminary Study

[1]Netti Aryani, [1]Indra Suharman, [2]Ainul Mardiah and [3]Hafrijal Syandri

[1]Department of Aquaculture, Faculty of Fisheries and Marine Science, Riau University, Pekanbaru, Indonesia
[2]Department of Aquaculture, Faculty of Marine and Fisheries Science, Nahdlatul Ulama University of West Sumatera, Padang, Indonesia
[3]Department of Aquaculture, Faculty of Fisheries and Marine Science, Bung Hatta University, Padang, Indonesia

## Abstract

**Background and Objective:** Feed level is an important factor that affects oocyte maturation of female *Hemibagrus wyckii* broodstock. The aim of the study was to investigate the effect of different feed levels (700, 1,400 and 2,100 g *lokan* meat per day) on the reproductive performance of female broodfish (initial weight: 2.800±296 g and initial length: 353.2±55.5 mm). **Materials and Methods:** Four experimental and three replicate ponds were used to evaluate the reproductive performance of female broodfish. Broodfish fed formulated feed was used as a control. Five female broodfish were cultured in each pond. Female broodfish were fed *lokan* meat once a day at 17.00 pm during 120 days of the experiments. **Results:** The nutritional content of *lokan* meat (wet base) were 7.08% crude protein, 0.82% crude lipid, 2.44% carbohydrate, 0.29% crude ash and 89.37% moisture content. Feed levels significantly ($p<0.05$) affected final weight, oocyte maturation, egg size, percentage of ovulation, number of egg per spawn, percentage of egg weight and embryo survival. **Conclusion:** Feed with 2,100 g *lokan* meat per day provided the best result for reproductive performance of female *Hemibagrus wyckii* broodfish.

Key words: Asian catfish, endangered species, cultured stock, lokan meat, reproduction performance

Received: April 04, 2017 Accepted: June 01, 2017 Published: June 15, 2017

Citation: Netti Aryani, Indra Suharman, Ainul Mardiah and Hafrijal Syandri, 2017. Reproductive performance of Asian catfish (*Hemibagrus wyckii*, bleeker, 1858)-preliminary study. Pak. J. Nutr., 16: 550-556.

Corresponding Author: Hafrijal Syandri, Department of Aquaculture, Faculty of Fisheries and Marine Science, Bung Hatta University, Padang, Indonesia



Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

## INTRODUCTION

*Hemibagrus wyckii*, Bagridae (local name is geso), is a carnivorous freshwater finfish native to Indonesia[1-3]. This species is found in the Riau Province and lives in the Kampar Kiri river[4], Koto Panjang reservoir[5] and Kampar Kanan river[3,6]. Each broodstock can reach a weight of approximately 3,296 g[7]. Due to the high demand and price in the market (13.33 USD kg $BW^{-1}$), the natural stocks of this species have been overexploited[3,6]. *Hemibagrus wyckii* has been categorized as "least concern" by the International Union Conservation Nature (IUCN) which lists threatened taxa. However, according to Aryani *et al.*[7], *Hemibagrus wyckii* in the Kampar Kanan River was categorized as "vulnerable to endangered" due to environmental degradation and overexploitation. Aryani *et al.*[8] reported that *Hemibagrus wyckii* has a low fecundity with a value of 3,058±144 eggs kg $BW^{-1}$. However, other studies have found that *Hemibagrus nemurus* has a higher fecundity of 35,950±963 eggs kg $BW^{-1}$ [9].

Due to the decreasing population of *Hemibagrus wyckii*, it is necessary to culture this species as a source food fish base. Therefore, this species needs to be domesticated. According to Chong *et al.*[10] and Kanyilmaz,[11] commercial and formulated feed information is needed for successful domestication. Fresh feed from freshwater seashell (*Pilsbryoconcha exilis*; Unionidae), local name "*lokan,*" may be used as feed for *Hemibagrus wyckii* broodfish, since it has been used by local fisherman as a bait to capture *Hemibagrus wyckii* in the Kampar Kanan River. *Lokan* live in the Sungai Paku reservoir in the Kampar Regency in Indonesia. The meat from *lokan* is not utilized as a source of food for local people. *Lokan* is easy to find, has high protein and is valuable for oocyte maturation of broodfish. Understanding nutritional requirements for broodstock are important since it supports biological mechanisms, including oocyte maturation[12,13].

Formulated feed for oocyte maturation of broodstock has been evaluated in several species, including *Xiphophorus helleri*[10], *Cherax quadricarinatus*[14], *Ictalurus punctatus*[15], *Rhamdia quelen*[12], *Hemibagrus nemurus*[16], *Osphronemus gourami*[17], *Salmo kettelati*[11] and *Channa marulius*[13]. Although formulated feed has been successfully used to induce oocyte maturation of broodfish, is remains costly. In addition, there is no research regarding *lokan* meat for oocyte maturation of freshwater species and the use of *lokan* meat as fresh feed for oocyte maturation of *Hemibagrus wyckii* broodfish has not yet been evaluated. The aim of this study was to evaluate the effect of fresh *lokan* meat on oocyte maturation in *Hemibagrus wyckii* broodfish. The results of this study may increase the number of candidate species available for aquaculture.

## MATERIALS AND METHODS

**Broodstock and ponds system:** *Hemibagrus wyckii* were collected from upstream areas of the Kampar Kanan River in the Kouk village (0°19' 23.44"N and 100°56' 40.05"E), Air Tiris village (0°21' 24.77"N and 101°06' 04.90"E) and Tarantang village (0°21' 05.32"N and 101°18' 43.96"E). The samples were collected from February-September 2015. The broodfish were caught by local fishermen using traditional fishing gears, local name "*lukah"* (trap nets) and fishing pole using *lokan* as bait. The 80 broodfish were collected from all sites. The samples were transferred by truck to the Research Centre, Faculty of Fisheries and Marine Science, Riau University (Indonesia), Sungai Paku Kampar Regency.

Brood Asian catfish were treated with a prophylactic formalin bath (100 mg $L^{-1}$) for 1 h in order to remove external parasites and were acclimatized in a pond (6×6×3 m) for four months prior to the experiments. One unit of pond area was (6×6×3 m), which was used to culture 20 male broodfish. The broodfish were fed *lokan* meat during acclimatization. In a separate pond, broodfish were fed commercial feed as a control. Four experimental and three replicate ponds were used to evaluate reproductive performance. Five females were selected and stocked in each pond (4×4×3 m).

Prior to stocking, females were weighed and the length was measured. The average initial weight and length of the female broodfish were 2.800±296 g and 353.2±55.5mm, respectively. At the beginning of the experiment, all female broodfish had an oocyte nucleus positioned in stage I with germinal vesicles in the central position. The broodfish were fed *lokan* meat once a day at 17:00 h due to their nocturnal behavior during 120 days of the experiments. The depth of water in each pond was 2.0 m. The inlet of the pond arrived from Sungai Paku reservoirs at a rate of 0.2 $m^3$ per sec. The temperature of the pond water ranged from 26-28°C, pH ranged from 6.5-6.8, alkalinity ranged from 42.97-57.33 mg $L^{-1}$ and hardness ranged from 104.83-110.51 mg $L^{-1}$.

**Feed of broodstock:** *Lokan* was collected from local fisherman in the Sungai Paku reservoir and kept in a (2×2×2 m) area of the pond. Shells of *lokan* were removed and the *lokan* meat was placed in a cold box. The *lokan* meat was collected everyday and put on a plastic basin for 6 h. The meat was then weighed and divided into groups of 700 , 1,400 and 2,100 g for each pond of broodfish per day.

Table 1: The amino acid profile, mineral content and gross energy of *lokan* meat (Mean±SD)

| Amino Acids (mg $kg^{-1}$) | Results |
|---|---|
| Arginine | 0.866±0.0032 |
| Histidine | 2.249±0.0083 |
| I-leucine | 1.527±0.0031 |
| Leucine | 1.822±0.0025 |
| Lysine | 0.777±0.0015 |
| Methionine | 1.799±0.0020 |
| Phenylalanine | 3.030±0.0020 |
| Threonine | 3.454±0.0015 |
| Valine | 1.904±0.0030 |
| Tryptophan | 0.0 |
| ΣEAA | 17.435±0.0030 |
| Alanine | 1.903±0.0031 |
| Aspartic acid | 0.074±0.0020 |
| Cystine | 1.455±0.0032 |
| Glutamic acid | 1.247±0.0010 |
| Glycine | 6.045±0.0025 |
| Serine | 3.822±0.0014 |
| Proline | 1.612±0.0011 |
| Tyrosine | 0.0 |
| ΣNEAA | 16.16±0.0021 |
| ΣAA | 33.596±0.00051 |
| Mineral (mg 100 g) | |
| Na | 153.28±0.6570 |
| Ca | 1306.08±2.9810 |
| P | 3040.38±8.5274 |
| K | 167.52±0.3362 |
| Mg | 6.73±0.1400 |
| Fe | 18908.27±15.5193 |
| Mn | 6442.96±1.9186 |
| Zn | 357.67±1.2006 |
| GE (kJ $g^{-1}$) | 29.44±0.4801 |

Analysis of the proximate composition was based on the method described by the Association of Official Analytical Chemists (AOAC)[18]. According to the analysis of the proximate composition (% wet weight base) of the *lokan* meat, moisture was 89.37%, crude protein was 7.08%, fat was 0.82%, crude ash was 0.29% and carbohydrate was 2.44%. The moisture content was analyzed by drying the samples in a hot air oven at 105°C. Crude protein was estimated by the Kjeldahl method. Fat content was estimated by the soxhlet extraction method with petroleum ether. Ash content was determined from the residue remaining after incineration of the samples at 550°C in a muffle furnace. Dietary gross energy was calculated using the conversion factors of 23.7 kJ g for protein, 39.5 kJ g for lipid and 17.2 kJ g for carbohydrate[19].

For amino acid analysis, the methods of Cohen[20] were used. Duplicate samples were hydrolyzed with 6 N hydrochloric acid for 24 h at 110°C. Amino acid analysis was determined using a High Performance Liquid Chromatography (HPLC) system, which consisted of a Waters 1525 Binary HPLC Pump, 717 Plus autosampler (Water®) and Water 2475 Multi λ Fluorescence Detector optics (wavelength: 250 nm for excitation and 395 nm for emission). Mineral compositions (sodium, calcium, phosphorous, potassium, magnesium, iron, manganese and zinc) was analyzed using microwave digestion and an atomic absorption spectrophotometer (Varian SAA 110) air acetylene flame[18]. The amino acids profile, mineral content and gross energy (GE) of *lokan* meat (% dry weight base) are presented in (Table 1).

Every month, five female broodfish were removed from each pond. The broodfish were captured with a gillnet forming a net bag with the appropriate mesh size and anesthetized with MS-222 (Sigma-Aldrich St Louis, MO; 40 mg $L^{-1}$)[21]. Oocyte maturation was assessed in each individual. The fish were returned to their pond after evaluation and no mortality occurred. Fish were fasted 48 h prior to the evaluation.

**Assessing oocyte maturation and spawning:** All fish were individually marked using floy tags and weighed. Oocytes sampled *in vivo* were taken from females using the method described by Syandri[22] and were placed in Serra's solution (6:3:1:70% ethanol, 40% formaldehyde and 99.5% acetic acid) for clarification of the cytoplasm. After 5 min, the position of the oocyte nucleus was determined using a four-stage scale by Krejszeff *et al.*[23] as follows.

**Stage 1:** Germinal vesicle in the central position
**Stage 2:** Early migration of the germinal vesicle (less than half of radius)
**Stage 3:** Late migration of the germinal vesicle (more than half of radius)
**Stage 4:** Germinal vesicle in the periphery or germinal vesicle breakdown (GVBD)

Each group of female broodfish had different oocyte maturation. After 120 days of the experiment, different numbers of fish in each pond demonstrated successful oocyte maturation. Each group of female broodfish received two injections of GnRH analogs with a dopamine antagonist (Ovaprim) applied intraperitoneally under the left pectoral n. The first injection was 0.2 mL kg $BW^{-1}$ and the second was 0.6 mL kg $BW^{-1}$ (total 0.8 mL kg $BW^{-1}$) at 12 h intervals.[24] Egg size (50 eggs in each group) was measured using an Olympus.

E-510 digital camera mounted on a binocular microscope Olympus BX51. Ripe gamete donors were anesthetized with MS-222 (40 mg $L^{-1}$).[21] At 24±4, 23±4 and 23±2 h after injection, eggs were stripped into a plastic vessel. Eggs were fertilized using the "dry method" as described[25]. Males were stimulated with a half dose of the same hormonal preparations used to stimulate the females. Sperm was collected using plastic syringes. Spermatozoa motility was not

estimated. One egg sample (75 eggs each) from each female was mixed with 0.3 mL of pooled milt sample. Eggs samples were incubated in a small aquarium [water temperature: 29±1°C; level of Dissolved Oxygen (DO 6.32±0.05 mg $L^{-1}$)]. During the eyed-egg stage (7-day-old embryos), the survival of embryos was recorded. Statistical differences between groups were analyzed using one-way analysis of variance (ANOVA) followed by Tukey tests ($p<0.05$) for significant differences.

## RESULTS AND DISCUSSION

In the present study, female broodfish fed *lokan* meat had successful oocyte maturation. The percentage of oocyte maturation increased with increasing levels of feed weight with values of 46.67±11.54, 73.33±11.54 and 93.33±11.34%, after receiving 700, 1,400 and 2,100 g of food, respectively (Table 2). The highest amount of *lokan* meat (2,100 g) fed to the female broodfish resulted in the highest nutrition. During the domestication process in a new habitat, changes in behavior, physiology and morphology may occur,[11,23,26,] including the food habits of fish[10,27,28]. Nutrition has a significant effect on fecundity and fish maturation[12]. According to Sink *et al.*,[15] the Channel catfish (*Ictalurus punctatus*) can exhibit increased spawning and individual egg weight when fed a single animal protein source compared to a plant source.

The feed levels also had a significant effect on egg size (2.79±0.02, 2.82±0.01 and 2.85±0.01 mm, respectively; ($p<0.05$). Different egg sizes of *Channa marulius* broodstock have also been observed with different crude protein levels in the diet[13]. According to Chambers *et al.*[29] the egg size, yolk

Table 2: Reproduction performance of female *Hemibagrus wyckii* broodfish (Mean±SD)

| Parameters | Domesticated fish |
|---|---|
| **Group 1 (Control)** | 157 g formulated feed/day |
| Final weight (g) | 2.850±160[a] |
| Oocyte maturation (%)* | 0 |
| Eggs size (mm) | - |
| Ovulation (%)** | - |
| Latency time (h) | - |
| Fecundity (number of eggs per *spawn*) | - |
| Percentage of eggs weight (%)*** | - |
| Embryo survival (%) | - |
| **Group 2** | Feed level 700 g of *lokan* meat |
| Final weight (g) | 2.900.60±73.47[a] |
| Oocyte maturation (%)* | 46.67±11.54[a] |
| Eggs size (mm) | 2.79±0.01[a] |
| Ovulation (%)** | 80.89±19.24[a] |
| Latency time (h) | 24±4.0 |
| Fecundity (number of eggs per *spawn*) | 1.523±68[a] |
| Percentage of eggs weight (%)*** | 0.50±0.02[a] |
| Embryo survival (%) | 37.33±4.0[a] |
| **Group 3** | Feed level 1,400 g of *lokan* meat |
| Final weight (g) | 3022.00±64.08[b] |
| Oocyte maturation (%) | 73.33±11.54[b] |
| Eggs size (mm) | 2.82±0.01[b] |
| Ovulation (%) | 80.55±17.34[a] |
| Latin time (h) | 23.0±4.0 |
| Fecundity (number of eggs per *spawn*) | 1704±43[b] |
| Percentage of eggs weight (%)* | 0.54±0.02[b] |
| Embryo survival (%) | 48.44±4.68[b] |
| **Group 4** | Feed level 2,100 g of *lokan* meat |
| Final body weight (g) | 3.166.60±102.62[c] |
| Oocyte maturation (%) | 93.33±11.34[c] |
| Eggs size (mm) | 2.85±0.01[c] |
| Ovulation (%) | 100[c] |
| Latin time (h) | 23.0±2.0 |
| Fecundity (number of eggs per *spawn*) | 1.775±20[c] |
| Percentage of eggs weight (%)* | 0.62±0.02[c] |
| Embryo survival (%) | 55.10±6.84[c] |

There were 5 female broodfish in each pond. The mean values in columns indicated by a letter are significantly different ($p<0.05$), *Number of matured females x 100%/number of female broodfish, **Number of ovulating females x 100%/number of mature female broodfish, *** Weight of eggs x 100%/weight of female broodfish

reserves and hatch age are affected by yolk volume. Although each individual female broodfish was injected with the same dosage of GnRH analogues (Ovaprim) (0.8 mL $BW^{-1}$), differences in the percentage of ovulation were obtained (Table 2), suggesting a possible relationship between egg size and oocyte maturation. However, another study found that there was no relationship between oocyte diameter and female ovulation in the Common tech (*Tinca tinca, Cyprinidae*) species[30]. Furthermore, we found that feed levels had a significant effect ($p<0.05$) on the number of eggs per spawn (Table 2), which may have also affected the quality of the eggs. Egg quality is an important factor for the success of fish spawning[31]. The female broodfish can easily spawn after hormonal injection under controlled conditions. In several studies, *Leuciscus idus*[23,24] and *Platichthys stellatus*[31] were also shown to easily spawn after hormonal treatment and other studies have shown that spawning induction using hormonal injections can synchronize maturation of gametes (sperm or eggs) in different fish species[32,33]. However, in a study by Krist'an *et al*.[34]. showed that the ovulation of pikeperch (*Sander lucioperca* L) was not influenced by HCG and mGRHa hormones.

At a temperature of 28±2°C, the latency time of the female broodfish were 24±4.0, 23±4.0 and 23±2.0 h, respectively. The different latency times were due to the biological quality of the gametes. According to Krejszeff *et al*.,[23] the biological quality of gametes can affect the latency time of ide (*Leuciscus idus*). Moreover, latency time in each fish species is affected by the dosage of the hormone, type of hormone, water temperature and fotoperiod[23,24,31]. The latency time of pikeperch (*Sander lucioperca* L.) was not significantly affected by different dosages of HCG hormones[34]. The percentage of egg weight differed among the treated groups and ranged from 0.50±0.02-0.62±0.02% (Table 2). These values were relatively low because the female broodfish has smaller gonads. Numerous studies have shown that the percentage of egg weights of ide (*Leuciscus idus*) ranges from 14.3±2.1-16.7±2.0%[23], 6.51±2.6-9.21±5.3% for pikeperch (*Sander lucioperca*)[34] and 4.53-10.32% for green catfish (*Hemibagrus nemurus*)[9].

Feed level has a significant effect ($p<0.05$) on embryo survival. The mean embryo survival rates were 37.33±4.0, 48.44±4.68 and 55.10±6.84% in fish fed 700, 1,400 and 2,100 g of lokan meat, respectively (Table 2). Embryo survival differences were positively correlated with the size of the eggs. According to Brooks *et al*.[35] egg size and the composition of the egg may be used as indicators of hatchability and fry quality. Other studies have shown that larger egg size results in better hatching rates[36,37].

In conclusion, 2,100 g of *lokan* meat was sufficient to maintain the broodstock of *Hemibagrus wyckii* in good conditions with the best reproduction performance. Despite positive effects on oocyte maturation, egg size and number of eggs per spawn, the effects on hatching rate and survival embryo remain to be investigated.

## SIGNIFICANCE STATEMENTS

- *Hemibagrus wyckii* was categorized as a "vulnerable to endangered" species, therefore requiring domestication
- *Lokan* meat is a good source of protein for oocyte maturation, especially for carnivorous fish
- *Hemibagrus wyckii* is a carnivorous fish; however, these fish cannot eat commercial feed, so pellets should be provided during the fingerling and juvenile stages

## ACKNOWLEDGEMENTS

This study was supported by the Directorate of Research and Community Service, Ministry of Research Technology and Higher Education, Republic of Indonesia, under the study grant (*Riset Fundamental*) No. 054/SP2H/PL/DRPM/III/2016.

## REFERENCES

1. Kottelat, M., A.J. Whitten, S.N. Kartikasari and S. Wirjoatmodjo, 1993. Freshwater Fishes of Western Indonesia and Sulawesi. Periplus Editions (HK) Ltd., Hong Kong, Pages: 221.
2. Ng, H.H. and M. Kottelat, 2013. Revision of the Asian catfish genus *Hemibagrus* Bleeker, 1862 (Teleostei: Siluriformes: Bagridae). Raffles Bull. Zool., 61: 205-291.
3. Aryani, N., 2015. Native species in Kampar Kanan river, Riau province Indonesia. Int. J. Fish. Aquat. Stud., 2: 213-217.
4. Simanjuntak, C.P.H., M.F. Rahardjo and S. Sukimin, 2006. [Ichthyofauna in floodplain of Kampar Kiri river]. J. Ikhtiologi Indonesia, 6: 99-109, (In Indonesian).
5. Warsa, A., A.S. Nastiti, Krismono and A. Nurfiarini, 2009. Fisheries resources in Koto Panjang reservoir. Bawal, 2: 93-97.
6. Fithra, R.Y. and Y.I. Siregar, 2010. Fishes biodiversity of Kampar River an inventory from Kampar Kanan river. J. Environ. Sci., 2: 139-147.
7. Aryani, N., I. Suharman and S. Hasibuan, 2016. Length-weight relationship and condition factor of the critically endangered fish of Geso, *Hemibagrus wyckii* (Bleeker, 1858) bagridae from Kampar Kanan river, Indonesia. J. Entomol. Zool. Stud., 4: 119-122.

8. Aryani, N., I. Suharman and S. Hasibuan, 2015. Preliminary study on the reproduction of Geso (*Hemibagrus wyckii*, Bagridae) from Kampar Kanan River, Indonesia. Proceedings of the 4th International Seminar on Fisheries Managing, (ISFM'15), Faculty of Fisheries and Marine Science, Riau University, Indonesia.
9. Aryani, N. and I. Suharman, 2014. Effects of 17β-estradiol on the reproduction of green catfish (*Hemibagrus nemurus*, Bagridae). J. Fish. Aquacult., 5: 163-168.
10. Chong, A.S.C., S.D. Ishak, Z. Osman and R. Hashim, 2004. Effect of dietary protein level on the reproductive performance of female swordtails *Xiphophorus helleri* (Poeciliidae). Aquaculture, 234: 381-392.
11. Kanyilmaz, M., 2016. Reproductive performance of a newly described Salmonid fish, Alakir trout (*Salmo kottelati*), a candidate species for aquaculture. Pak. J. Zool., 48: 83-89.
12. Coldebella, I.J., J.R. Neto, C.A. Mallmann, C.A. Veiverberg and G.T. Bergamin *et al*., 2011. The effects of different protein levels in the diet on reproductive indexes of *Rhamdia quelen* females. Aquaculture, 312: 137-144.
13. Hafeez-ur-Rehman, M., F. Abbas, M. Ashraf, N.T. Narejo, K.J. Iqbal, G. Abbas and S. Andleeb, 2017. Effect of different dietary protein levels on egg development and its response to inducing agents during induced spawning of *Channa marulius*. Pak. J. Zool., 49: 337-343.
14. Rodriguez-Gonzalez, H., M. Garcia-Ulloa, A. Hernandez-Llamas and H. Villarreal, 2006. Effect of dietary protein level on spawning and egg quality of redclaw crayfish *Cherax quadricarinatus*. Aquaculture, 257: 412-419.
15. Sink, T.D., R.T. Lochmann, C. Pohlenz, A. Buentello and D. Gatlin, 2010. Effects of dietary protein source and protein-lipid source interaction on channel catfish (*Ictalurus punctatus*) egg biochemical composition, egg production and quality and fry hatching percentage and performance. Aquaculture, 298: 251-259.
16. Aryani, N. and I. Suharman, 2015. Effect of dietary protein level on the reproductive performance of female of green catfish (*Hemibagrus nemurus* Bagridae). J. Aquacult. Res. Dev., Vol. 6. 10.4172/2155-9546.1000377.
17. Masrizal, Z. Udin, M. Zein and U. Bulanin, 2015. Effect of energy, lipid and protein content in broodstock diets on spawning fecundity and eggs quality of giant gourami (*Ospheronemus gouramy* Lac). Pak. J. Nutr., 14: 412-416.
18. AOAC., 2000. Official Methods of Analysis. 17th Edn., Association of Official Analytical Chemistry, Arlington, VA., USA.
19. Brett, J.R. and T.D.D. Groves, 1979. Physiological Energetics. In: Fish Physiology, Hoar, W.S., D.J. Randall and J.R. Brett (Eds.). Vol. 8, Academic Press, New York, pp: 280-351.
20. Cohen, S.A., 2003. Amino Acid Analysis using Pre-Column Derivatization with 6-Aminoquinolyl-N-Hydroxysuccinimidyl Carbamate. In: Protein Sequencing Protocols, Smith B.J. (Ed.). 2nd Edn., Vol. 211, Humana Press Inc., Totowa, NJ., ISBN: 9781592593422, pp: 143-154.
21. Yanto, H., 2009. Utilization of MS-222 and salt solution on the transportation of jelawat (*Leptobarbus hoevenii* Blkr.) fingerling. J. Ilmu-Ilmu Perairan Perikanan Indonesia, 16: 47-54.
22. Syandri, H., 1997. The development of oocytes and testes of Bilih (*Mystacoleucus padangensis* Bleeker) in Singkarak J. Fish. Garing, 2: 1-8.
23. Krejszeff, S., K. Targonska, D. Zarski and D. Kucharczyk, 2009. Domestication affects spawning of the ide (*Leuciscus idus*)-preliminary study. Aquaculture, 295: 145-147.
24. Ciesla, M., R. Jonczyk, D. Gozdowski, J. Sliwinski, J. Rechulicz and W. Andrzejewski, 2014. Changes in ide *Leuciscus idus* (L.) females' reproductive parameters after stimulation with Carp Pituitary Homogenate (CPH) and Ovopel: The effect of domestication? Aquacult. Int., 22: 77-88.
25. Dabrowski, K., A. Ciereszko, L. Ramseyer, D. Culver and P. Kestemont, 1994. Effects of hormonal treatment on induced spermiation and ovulation in the yellow perch (*Perca flavescens*). Aquaculture, 120: 171-180.
26. Marimuthu, K., M.A. Haniffa and M.A. Rahman, 2009. Spawning performance of native threatened spotted snakehead fish, *Channa punctatus* (Actinopterygii: Channidae: Perciformes), induced with ovatide. Acta Ichthyologica Piscatoria, 39: 1-5.
27. Syandri, H., Azrita, Niagara and Junaidi, 2015. Preliminary study on the feeding schedule of laboratory reared of bonylip barb larva, *Osteochilus vittatus* Cyprinidae. J. Aquacult. Res. Dev., Vol. 6. 10.4172/2155-9546.1000368.
28. Aryani, N., A. Mardiah, Azrita and H. Syandri, 2017. Effects of enrichment commercial feed with different fat sources on survival and growth of Bonylip barb (*Osteochilus vittatus* Cyprinidae) fingerlings. J. Fish. Aquat. Sci., 12: 29-35.
29. Chambers, R.C., W.C. Leggett and J.A. Brown, 1989. Egg size, female effects and the correlations between early life history traits of capelin, *Mallotus villosus*: An appraisal at the individual level. Fish. Bull., 87: 515-523.
30. Kujawa, R., D. Kucharczyk, A. Mamcarz, D. Zarski and K. Targonska, 2010. Artificial spawning of common tench *Tinca tinca* (Linnaeus, 1758), obtained from wild and domestic stocks. Aquacult. Int., 19: 513-521.
31. Lim, H.K., 2016. Effect of exogenous hormones on ovulation and gonadal steroid plasma levels in starry flounder, *Platichthys stellatus*. Aquacult. Int., 24: 1061-1071.
32. Bromage, N., J. Jones, C. Randall, M. Thrush and B. Davies *et al*., 1992. Broodstock management, fecundity, egg quality and the timing of egg production in the rainbow trout (*Oncorhynchus mykiss*). Aquaculture, 100: 141-166.
33. Zohar, Y. and C.C. Mylonas, 2001. Endocrine manipulations of spawning in cultured fish: From hormones to genes. Aquaculture, 197: 99-136.

34. Krist'an, J., S.M.H. Alavi, V. Stejskal and T. Policar, 2013. Hormonal induction of ovulation in pikeperch (*Sander lucioperca* L.) using human chorionic gonadotropin (hCG) and mammalian GnRH analogue. Aquacult. Int., 21: 811-818.
35. Brooks, S., C.R. Tyler and J.P. Sumpter, 1997. Egg quality in fish: What makes a good egg? Rev. Fish Biol. Fish., 7: 387-416.
36. Seghal, H.S. and H.S. Toor, 1991. Offspring fitness and fecundity of an Indian major carp, *Labeo rohita* (Ham.), in relation to egg size. Aquaculture, 97: 269-279.
37. Gisbert, E., P. Williot and F. Castello-Orvay, 2000. Influence of egg size on growth and survival of early stages of Siberian sturgeon (*Acipenser baeri*) under small scale hatchery conditions. Aquaculture, 183: 83-94.