



**UNIVERSITI PUTRA MALAYSIA**

**EFFECTS OF *Artemia urmiana* ENRICHMENT IN LARVICULTURE  
OF PERSIAN STURGEON (*Acipenser persicus*)**

**MAHMOUD HAFEZIEH**

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**By**

**MAHMOUD HAFEZIEH**

**Thesis Submitted to the School of Graduate Studies, Universiti Putra  
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Philosophy**

**May 2009**



DEDICATED

WITH APPRECIATION TO:

My dearest parents: Mohammad Taghi Hafezieh  
and Massomeh Salahi

My Wife: Homeira Hossein pour

My Daughter: Massomeh



Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirements for the degree of Doctor of Philosophy

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**May 2009**

**Chairman: Mohd Salleh Kamarudin, PhD**

**Faculty : Agriculture**

The main objective of this study was to improve the Persian Sturgeon, *Acipenser persicus* survival when they released into the Caspian Sea through the enrichment of its larval food, *Artemia urmiana*. A series of experiments was conducted to evaluate effect several enrichment methods on the chemical composition of *A. urmiana nauplii*, larval growth, survival and salinity tolerance of the Persian sturgeon larvae.

In the first series of 3 factorial experiment, the effects of oil sources, oil concentration and enrichment periods on the nutritive value of *A. urmiana* nauplii and growth rate, survival percentage, chemical composition and salinity tolerance of sturgeon larvae fed enriched *Artemia* and unenriched (as control) were evaluated. The results showed Total n-3 highly unsaturated fatty acid contents, DHA/EPA and  $\omega$ 3/ $\omega$ 6 ratios in



*Artemia* nauplii and sturgeon larvae were significantly increased ( $P < 0.05$ ) as HUFA concentration and enrichment period increased. ICES30/4 with 300 ppm concentration during 24h enrichment period was the best combination treatment for improving the overall HUFA contents in *Artemia* ( $10.96 \pm 0.21 \text{ mg g}^{-1} \text{ DW}$ ) and fish larvae ( $5.55 \pm 0.43 \text{ mg g}^{-1} \text{ DW}$ ). *Artemia* enriched with HUFA oil did not affect the growth rate and survival percentage of larvae ( $P > 0.05$ ). When the sturgeon larvae were exposed to salinity test, those fed with HUFA enriched *Artemia* showed tolerance only up to 6 ppt.

In the second series of 3 factorial experiment, the effects of oil sources each with 300 ppm concentration, ascorbyl palmitate levels and enrichment periods on the nutritive value of *A. urmiana* nauplii and growth rate, survival percentage, chemical composition and salinity tolerance of sturgeon larvae fed enriched *Artemia* and unenriched (as control) were evaluated. The results showed vitamin C contents were increased in both *Artemia* and fish larvae significantly ( $P < 0.05$ ). A 300 ppm ICES30/4 plus 20% AP with 24h enrichment period resulted in significantly higher ( $P < 0.05$ ) vitamin C content ( $1063.80 \pm 48.00 \text{ } \mu\text{g/g DW}$ ) in *Artemia* nauplii in than any other combinations. The ICES30/4 supplemented with 10% AP during 24h enrichment period gave the highest vitamin C content in sturgeon larvae ( $175.21 \pm 7.43 \text{ } \mu\text{g/g DW}$ ). The growth rate of enriched sturgeon larvae were not increased significantly compared to control group ( $P > 0.05$ ). Survival rates and chemical compositions were significantly improved ( $P < 0.05$ ) in fish larvae fed *Artemia* enriched HUFA

oil supplemented with AP. The ICES30/4 was the best oil source for improving the chemical composition including fatty acids in the larvae when it was supplemented with vitamin C. Lower levels of vitamin C (less than 30%) and longer enrichment period (24 h) were more effective ( $P < 0.05$ ) in improving the chemical composition of sturgeon fish larvae. When the sturgeon larvae were exposed to salinity test, those fed with HUFA +AP enriched *Artemia* demonstrated high tolerance ( $\geq 90\%$  survival) up to 12 ppt for 120h. Although the enrichment of *Artemia urmiana* with 300 ppm ICES30/4 and 30% vitamin C gave the best salinity tolerance at 12ppt ( $100 \pm 0.00\%$  survival), the enrichment with 300 ppm sturgeon ovary oil and 10% vitamin C was economically affective in increasing the salinity tolerance of Persian sturgeon larvae ( $95 \pm 2.00\%$  survival).



Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia  
sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

**KESAN PENGKAYAAN *Artemia urmiana* DALAM LARVIKULTUR  
IKAN STURGEON FARSI (*Acipenser persicus*)**

Oleh

**MAHMOUD HAFEZIEH**

**Mei 2009**

**Pengerusi: Mohd. Salleh Kamarudin, PhD**

**Fakulti : Pertanian**

Tujuan utaman kajian ini adalah untuk meningkatkan kemandirian ikan sturgeon Farsi apabila ia dilepaskan ke Laut Kaspian melalui pengkayaan makanan larvanya, *Artemia urmiana*. Beberapa siri eksperimen telah dilakukan untuk menilai kesan beberapa kaedah pengkayaan terhadap komposisi kimia naupli *A. urmiana*, pertumbuhan, kemandirian serta ketoleranan larva sturgeon Farsi.

Dalam siri pertama beberapa eksperimen tiga faktor, kesan sumber minyak, kepekatan minyak dan jangkamasa pengkayaan terhadap nilai permakanan naupli *A. urmiana* serta kadar pertumbuhan, peratus kemandirian, komposisi kimia dan ketoleranan larva sturgeon yang diberi samada naupli *Artemia* yang diperkaya atau tidak (kawalan) telah dinilai. Keputusan kajian menunjukkan jumlah kandungan asid lemak tidak tepu n-3, nisbah DHA/EPA dan  $\omega 3/\omega 6$  dalam naupli *A. urmiana* dan larva sturgeon ketara meningkat ( $P < 0.05$ ) apabila



kepekatan asid lemak tak tepu tinggi (HUFA) dan jangkamasa pengkayaan meningkat. ICES30/4 pada kepekatan 300 bpj dan jangkamasa 24 jam pengkayaan merupakan kombinasi rawatan pengkayaan terbaik untuk meningkatkan kandungan HUFA *Artemia* ( $10.96 \pm 0.21 \text{ mg g}^{-1}$  berat badan) dan larva ikan ( $5.55 \pm 0.43 \text{ mg g}^{-1}$  berat badan). Pengkayaan *Artemia* dengan minyak HUFA tidak membaiki ( $P > 0.05$ ) pertumbuhan dan peratus kemandirian larva. Di dalam ujian kemasinan, larva yang memakan *Artemia* yang diperkaya dengan minyak HUFA berupaya hidup sehingga kemasinan 6 bpr.

Dalam siri kedua beberapa experiment tiga faktor, kesan sumber minyak (300 bpj), paras askorbil palmitate (AP) dan jangkamasa pengkayaan terhadap nilai pemakanan nauplii *A. urmiana* serta pertumbuhan, peratus kemandirian, komposisi kimia dan ketoleranan kemasinian larva sturgeon yang memakan *Artemia* yang diperkaya dan tidak diperkaya telah ditentukan. Keputusan kajian menunjukkan kandungan vitamin C ketara meningkat ( $P < 0.05$ ) dalam *Artemia* dan larva ikan. Rawatan 300 bpj ICES30/4 campur 20% AP pada jangkamasa pengkayaan 24 jam memberikan kandungan vitamin C yang ketara lebih tinggi dari kombinasi rawatan yang lain ( $1063.80 \pm 48.00 \text{ } \mu\text{g.g}^{-1}$  berat badan). Dalam eksperimen seterusnya, penggunaan ICES30/4 dan 10% AP selama 24 jam pengkayaan memberikan kandungan vitamin C tertinggi dalam larva sturgeon ( $175.21 \pm 7.43 \text{ } \mu\text{g.g}^{-1}$  berat badan). Pertumbuhan larva sturgeon yang diberi *Artemia* yang diperkaya tidak berbeza ( $P > 0.05$ ) dari kumpulan kawalan. Kemandirian dan komposisi kimia ikan ketara meningkat ( $P < 0.05$ ) di kalangan ikan yang memakan *Artemia* yang diperkaya dengan HUFA dan AP. ICES30/4 adalah sumber minyak yang terbaik untuk meningkatkan komposisi kimia termasuk asid lemak ikan apabila ditambah vitamin C. Paras vitamin C yang rendah (<30%) dan jangkamasa pengkayaan yang lebih panjang (24 jam)



didapati lebih berkesan ( $P < 0.05$ ) dalam meningkatkan komposisi kimia larva sturgeon. Dalam ujian kemiskinan, larva yang memakan *Artemia* yang diperkaya dengan HUFA dan AP menunjukkan ketoleranan yang tinggi ( $>90\%$  kemandirian) sehingga kemiskinan 12 bpr selama 120 jam. Walaupun pengkayaan dengan 300 bpj ICES30/4 dan 30% vitamin C memberikan ketoleranan kemiskinan terbaik pada 12 bpr ( $100 \pm 0.00\%$  kemandirian), pengkayaan dengan 300 bpj minyak ovari sturgeon dan 10% vitamin C adalah lebih berkesan dari aspek ekonomi dalam meningkatkan ketoleranan larva sturgeon Farsi ( $95 \pm 2.00\%$  kemandirian).

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I certify that a Thesis Examination Committee has met on 15<sup>th</sup> May, 2009 to conduct the final examination of Mahmoud Hafezieh on his thesis entitled “Effects of *Artemia urmiana* enrichment In larviculture of Persian sturgeon, *Acipenser persicus*” in accordance with Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia {P.U(A) 106} 15 March 1998. The Committee recommends that the student be awarded the Doctor of Philosophy.

Members of the Thesis Examination Committee were as follow:

**Siti Shapor Siraj, Ph.D**

Professor  
Agriculture faculty  
Universiti Putra Malaysia  
(Chairman)

**Aziz Arshad, Ph.D**

associate Professor  
Agriculture faculty  
Universiti Putra Malaysia  
(Internal Examiner)

**Sharr Azni harmin, Ph.D**

Associate Professor  
Agriculture faculty  
Universiti Putra Malaysia  
(Internal Examiner)

**Donald L. Lovett, Ph.D**

Professor  
Science faculty, Dept. of Biology  
University of New Jersey, USA  
(External Examiner)

---

**BUJANG KIM HUAT, Ph.D.**

Professor and Deputy Dean  
School of Graduate Studies  
Universiti Putra Malaysia  
Date :



This thesis submitted to the Senate of Universiti Putra Malaysia has been accepted as fulfilment of the requirements for the degree of Doctor of Philosophy. The members of the Supervisory Committee are as follows:

**Mohd Salleh Bin Kamarudin, PhD**

Associate Professor  
Faculty of Agriculture  
Universiti Putra Malaysia  
(Chairman)

**Che Roos Bin Saad, PhD**

Associate Professor  
Faculty of Agriculture  
Universiti Putra Malaysia  
(Member)

**Mostafa Kamal Abd Sattar, PhD**

Faculty of Agriculture  
Universiti Putra Malaysia  
(Member)

---

**HASANAH MOHD GHAZALI, PhD**

Professor and Dean  
School of Graduate Studies  
Universiti Putra Malaysia

Date : 9 July 2009



## DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institutions.

MAHMOUD HAFEZIEH

Date :



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