UNIVERSITI PUTRA MALAYSIA

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

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FP 2009 18

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By

MAHMOUD HAFEZIEH

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of 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

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

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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 ω3/ω6 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±0.21 mg g^{-1} DW) and fish larvae (5.55±0.43 mg g^{-1} 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± 48.00 µg/g DW) in Ar*temia* 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±7.43 µg/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 (≥ 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±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±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*. Bebeberapa 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 ω3/ω6 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±0.21 mg g^{-1} berat badan) dan larva ikan (5.55±0.43 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± 48.00 μg.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±7.43 μg.g^{-1} berat badan). Pertumbuhan larva sturgeon yang diberi *Artemia* yang diperkaya tidak berbeda (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 ditambh 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 kemasinan, larva yang memakan *Artemia* yang diperkaya dengan HUFA dan AP menunjukkan ketoleranan yang tinggi (>90% kemandirian) sehingga kemasinan 12 bpr selama 120 jam. Walaupun pengkayaan dengan 300 bpj ICES30/4 dan 30% vitamin C memberikan ketoleranan kemasinan terbaik pada 12 bpr (100±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±2.00% kemandirian).

ACKNOWLEDGMENTS

Praise is to the Almighty ALLAH. Lord of all creations, for his heavenly, luxuriates and blessings over me throughout my life and the period of this study.

I would like to express my heartfelt gratitude and appreciation to my Chief Supervisor, Associate Professor Dr. Mohd Salleh Kamarudin, for his valuable guidance and constructive suggestions throughout the thesis research. I sincerely appreciate the innumerable hours he spent reading the draft and the suggestions in improving the thesis.

I wish to express my deepest thankfulness to my co-supervisors Associate Professor Dr. Che Roos Bin Saad, Dr. Mostafa Kamal Abd Sattar for their valuable suggestion and kind assistance throughout this study.

A very special acknowledgment is given to Dr. Abbas Ali Motallebi the Head of Iranian Fisheries Research Organization (IFRO), his deputies Dr. Mostafa Sharif Rohani and Dr. Aminollam Taghavi for their co-operation during the process of conducting the study.

I would also like to thank Hossein Abdolhay, Mehrdad Rahimi Danesh and head of sturgeon propagation center, Sad- e- Sangar, Rasht for preparing the sturgeon larvae for this project during the two years.

I am grateful to the head and staff of the *Artemia* and Aquatic Animal Research Center, Urmia University for their co-operation.

I wish to express my deepest thanks to my wife, Homeira Hossein pour and my daughter Massomeh for their patience, consistent support and understanding during my study in Malaysia.

Lastly, I would like to thank many others whose name do not appear here, who have helped me during my study period.

I certify that a Thesis Examination Committee has met on 15th 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 Mlaysia {P.U(A) 106} 15 March 1998. The Committee recommends that the student be awarded the Doctor of Philosophy.

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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:

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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.

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MAHMOUD HAFEZIEH

Date :

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