



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**

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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*)

By

MAHMOUD HAFEZIEH

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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 ω 3/ ω 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 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 ($100 \pm 0.00\%$ 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 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 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 :



TABLE OF CONTENTS

ABSTRACT	iii
ABSTRAK	vi
ACKNOWLEDGMENTS	ix
APPROVAL	xi
DECLARATION	xiii
LIST OF TABLES	xvii
LIST OF FIGURES	xxii
LIST OF ABBREVIATION/NOTATIONS	xxvii

CHAPTERS

1- INTRODUCTION	1
1.1 Fatty acid importance in fishes	1
1.2 Vitamin C importance	3
1.3 The Caspian Sea	5
1.4 Stock enhancement of sturgeon fishes in Iran	7
1.5 Statement of the problems	8
1.6 Significance of the study and objectives	9
1.6.1 Research objectives	11
2- LITERATURE REVIEW	12
2.1 Sturgeon fishes	12
2.2 Live food	16
2.2.1 Effects of salinity and temperature on survival and reproduction of <i>Artemia</i> strain	16
2.2.2 Enrichment of live food for aquatic animals	19
2.2.3 Effects of enrichment periods	27
2.2.4 Effects of enrichment concentrations	28
3- GENERAL METHODOLOGY	30
3.1 <i>Artemia</i> cysts hatching	30
3.2 Preparation of HUFA enrichment solution	31
3.3 Preparation of ascorbyl palmitate enrichment solution	31
3.4 Enrichment of <i>Artemia</i> nauplii	31
3.5 Preparation of <i>Acipenser persicus</i> larvae	32
3.6 Feeding of Persian sturgeon larvae	33
3.7 Larval performance	33
3.8 Water quality monitoring	34
3.9 Chemical composition	35
3.9.1 Crude protein	35
3.9.2 Crude lipid	36
3.10 Determination of fatty acid profile	36
3.11 Determination of Vitamin C	37
3.12 Salinity tolerance	38
3.13 Statistical analysis	38



4- EFFECTS OF SALINITY, WATER TEMPERATURE AND pH ON HATCHING EFFICIENCY OF <i>Artemia Urmiana</i> CYSTS	39
4.1 Introduction	39
4.2 Materials and Methods	41
4.2.1 Hatching of <i>Artemia</i> cysts	41
4.2.2 Statistical analysis	41
4.3 Results	41
4.4 Discussion	47
5- THE EFFECTS OF HUFA ENRICHMENT ON PROXIMATE COMPOSITION OF <i>ARTEMIA URMIANA</i>	49
5.1 Introduction	49
5.2 Materials and Methods	50
5.2.1 experimental design	50
5.2.2 Determination of crude protein and lipid	53
5.2.3 determination of fatty acid profile	54
5.2.4 Statistical analysis	54
5.3 Results	54
5.4 Discussion	75
6- THE EFFECTS OF ASCORBYL PALMITATE IN HUFA ENRICHMENT ON THE CHEMICAL COMPOSITION OF <i>Artemia urmiana</i>	79
6.1 Introduction	79
6.2 Materials and Methods	81
6.2.1 Experimental design	81
6.2.2 Vitamin C determination	81
6.2.3 Determination of crude protein, lipid and fatty acid	82
6.2.4 statistical analysis	82
6.3 Results	82
6.4 Discussion	101
7- THE EFFECTS OF HUFA ENRICHED <i>Artemia</i> NAUPLII ON GROWTH, SURVIVAL, CHEMICAL COMPOSITION AND SALINITY TOLERANCE OF <i>Acipenser persicus</i> LARVAE	104
7.1 Introduction	104
7.2 Materials and Methods	107
7.2.1 feeding	108
7.2.2 determination of chemical composition	108
7.2.3 salinity tolerance	109
7.2.4 Statistical analysis	109
7.3 Results	109
7.3.1 Growth, survival and CF	109
7.3.2 Larval chemical composition	113
7.3.3 Salinity tolerance	133
7.4 Discussion	135

8- THE EFFECTS OF AP IN HUFA ENRICHED <i>Artemia urmiana</i> NAUPLII ON PROXIMATE COMPOSITION, VITAMIN C CONTENT, GROWTH, SURVIVAL, AND STRESS RESISTANCE OF <i>Acipenser persicus</i> LARVAE	140
8.1 Introduction	140
8.2 Materials and Methods	142
8.2.1 Experimental design	142
8.2.2 Feeding	142
8.2.3 Larval performance	143
8.2.4 chemical composition	144
8.2.5 Statistical analysis	144
8.3 Results	144
8.3.1 Growth and survival	144
8.3.2 Salinity tolerance	149
8.3.3 Body chemical composition	150
8.4 Discussion	168
9- GENERALDISCUSSION	173
10- CONCLUSION AND RECOMMENDATIONS FOR FUTURE RESEARCH	179
10.1 recommendation for the future study	180
REFERENCES	181
APPENDICES	198
BIODATA OF STUDENT	218
LIST OF PUBLICATION	218



LIST OF TABLES

Table		Page
1.1	Diversity of aquatic species in the Caspian Sea	6
4.1	Hatching efficiency (H.E) of <i>A. urmiana</i> cyst in different salinity (ppt), water temperature (°C), pH and combinations	43
5.1	Abbreviation for combination treatments for different oil and concentration and enrichment periods	52
5.2	The fatty acid composition (mg.g ⁻¹ dry weight) of the enrichment oils. Mean of three replications.	53
5.3	Chemical compositions of <i>Artemia</i> nauplii unenriched and enriched with ICES30/4 combination treatments. Values are the averages of three replications ±sd	55
5.4	Chemical compositions of <i>Artemia</i> nauplii enriched with Cod liver oil combination treatments. Values are the averages of three replications ±SD	56
5.5	Chemical compositions of <i>Artemia</i> nauplii enriched with Sturgeon ovary oil combination treatments. Values are the averages of three replications ±SD	57
5.6	Chemical compositions of <i>Artemia</i> nauplii enriched with Linseed oil combination treatments. Values are the averages of three replications ±SD	58
5.7	Chemical compositions of <i>Artemia</i> nauplii enriched with the main factors. Values are the averages of three replications ±SD	59
5.8	Probability value ANOVA of Chemical compositions of <i>Artemia</i> nauplii enriched with main factors and combinations	60
6.1	Abbreviation for combination treatments for different oil and concentration and enrichment periods	81
6.2	Chemical compositions of <i>Artemia</i> nauplii unenriched and enriched with ICES30/4 supplemented with three AP levels and enrichment periods. Values are the averages of three	84

	replications \pm sd	
6.3	Chemical compositions of <i>Artemia</i> nauplii enriched with sturgeon ovary oil with three AP levels at two enrichment periods. Values are the averages of three replications \pm SD	85
6.4	Chemical compositions of <i>Artemia</i> nauplii enriched with the main factors Values are the averages of three replications (SD)	86
6.5	Probability values of chemical compositions of <i>Artemia</i> nauplii enriched with the main and combination treatments	87
7.1	Growth parameters, survival, FCR and CF for different treatments of sturgeon fish after the 20 th day experiment. Values are the averages of three replications \pm sd.	111
7.2	Chemical compositions of Persian sturgeon larvae fed <i>Artemia</i> unenriched (Control) and enriched with ICES30/4, effects of oil concentrations and enrichment periods. Values are the averages of three replications \pm SD	114
7.3	Chemical compositions of Persian sturgeon larvae fed <i>Artemia</i> enriched with Cod live oil with different concentrations and enrichment periods. Values are the averages of three replications \pm SD	115
7.4	Chemical compositions of Persian sturgeon larvae fed <i>Artemia</i> enriched with Sturgeon ovary oil with various concentrations and enrichment periods. Values are the averages of three replications \pm SD	116
7.5	Chemical compositions of Persian sturgeon larvae fed <i>Artemia</i> enriched with Linseed oil, effects of oil concentrations and enrichment periods. Values are the averages of three replications \pm SD	117
7.6	Chemical compositions of Persian sturgeon larvae fed <i>Artemia</i> enriched with the main factors. Values are the averages of three replications \pm SD	118
7.7	Probability value of chemical composition of Persian sturgeon larvae enriched with the main and combination treatments	119
7.8	Salinity tolerance at 6 ppt. Values is the averages	134

7.9	of three replications \pm sd Salinity tolerance at 12 ppt. Values is the averages of three replications \pm sd	135
8.1	Growth parametes, survival, CF, and FCR and salinity tolerance in sturgeon larvae after the 20 th day experiment. Values is the averages of three replications \pm sd	146
8.2	Chemical compositions of Persian sturgeon larvae fed <i>Artemia</i> unenriched and enriched with ICES30/4 with different AP levels (%) during two enrichment periods. Values are the averages of three replications \pm sd	151
8.3	Chemical compositions of Persian sturgeon larvae fed <i>Artemia</i> enriched with Sturgeon oil supplemented with AP levels (%) at 12, 24 h enrichment periods. Values are the averages of three replications \pm sd	152
8.4	Chemical compositions of Persian sturgeon larvae enriched with the main factors. Values are the averages of three replications \pm sd	153
8.5	Probability value of chemical compositions of Persian sturgeon enriched with the main and combination treatments	154
1	Fatty acids (mg g ⁻¹ DW) composition of <i>Artemia</i> nauplii enriched with ICES30/4. Values are the averages of three replications (SD)	Appendix I
2	Fatty acids (mg g ⁻¹ DW) composition of <i>Artemia</i> nauplii enriched with Cod liver oil . Values are the averages of three replications (SD)	Appendix I
3	Fatty acids (mg g ⁻¹ DW) composition of <i>Artemia</i> nauplii enriched with Sturgeon ovary oil. Values are the averages of three replications (SD)	Appendix I
4	Fatty acids (mg g ⁻¹ DW) composition of <i>Artemia</i> nauplii enriched with Linseed oil. Values are the averages of three replications (SD)	Appendix I
5	Fatty acids (mg g ⁻¹ DW) composition of <i>Artemia</i> nauplii enriched with main factors. Values are the averages of three replications (SD)	Appendix I
6	Probability of fatty acid profiles of <i>Artemia</i> nauplii	Appendix I

enriched with main factors and combinations.

7	Fatty acids (mg g ⁻¹ DW) composition of <i>Artemia</i> nauplii enriched with ICES30/4 and AP levels at 12 and 24 h. Values are the averages of three replications (SD)	Appendix I
8	Fatty acids (mg g ⁻¹ DW) composition of <i>Artemia</i> nauplii enriched with Sturgeon ovary oil supplemented with three AP levels during two enrichment periods. Values are the averages of three replications (SD)	Appendix I
9	Fatty acids (mg g ⁻¹ DW) composition of <i>Artemia</i> nauplii enriched with main factors. Values are the averages of three replications (SD)	Appendix I
10	Probability of fatty acid profiles of <i>Artemia</i> nauplii enriched with main factors and combinations	Appendix I
11	Fatty acids (mg g ⁻¹ DW) composition of <i>Artemia</i> nauplii unenriched and enriched with ICES30/4 supplemented with three AP levels during two enrichment periods. Values are the averages of three replications (SD)	Appendix I
12	Fatty acids (mg g ⁻¹ DW) composition of <i>Artemia</i> nauplii enriched with Cod liver oil supplemented with three AP levels during two enrichment periods. Values are the averages of three replications (SD)	Appendix I
13	Fatty acids (mg g ⁻¹ DW) composition of <i>Artemia</i> nauplii enriched with Sturgeon ovary oil supplemented with three AP levels during two enrichment periods. Values are the averages of three replications (SD)	Appendix I
14	Fatty acids (mg g ⁻¹ DW) composition of <i>Artemia</i> nauplii enriched with Linseed oil supplemented with three AP levels during two enrichment periods. Values are the averages of three replications (SD)	Appendix I
15	Fatty acids (mg g ⁻¹ DW) composition of <i>Artemia</i> nauplii enriched with the main factors. Values are the averages of three replications (SD)	Appendix I
16	Probability of fatty acid profiles of <i>Artemia</i> nauplii enriched with main factors and combinations	Appendix I

17	Fatty acids (mg g^{-1} DW) composition of <i>Artemia</i> nauplii unenriched and enriched with ICES30/4 supplemented with three AP levels during two enrichment periods. Values are the averages of three replications (SD)	Appendix i
18	Fatty acids (mg g^{-1} DW) composition of <i>Artemia</i> nauplii enriched with Sturgeon ovary oil supplemented with three AP levels during two enrichment periods. Values are the averages of three replications (SD)	Appendix i
19	Fatty acids (mg g^{-1} DW) composition of <i>Artemia</i> nauplii enriched with the main factors. Values are the averages of three replications (SD)	Appendix i
20	Probability of fatty acid profiles of <i>Artemia</i> nauplii enriched with the main factors and combination treatments	Appendix i

LIST OF FIGURES

Figures		Pages
2.1	Caspian sea sturgeons	13
3.1	A 40 liter tank with gate filter	33
4.1	Hatching Efficiency (HE) of <i>A. urmiana</i> cysts in different physical conditions. Means within the grouping followed by the same letters are not statistically different ($P>0.05$)	46
5.1	Crude protein in <i>A. urmiana</i> nauplii enriched with different oil and concentrations during two periods. Mean within the grouping followed by the different letters show statistically different ($P<0.05$).	61
5.2	Crude Lipid of <i>A. urmiana</i> nauplii in different enrichment oils media, vary concentration and enrichment periods. Mean within the grouping followed by the different letters show statistically different ($P<0.05$)	62
5.3	Total saturated fatty acids in <i>A. urmiana</i> nauplii enriched with oils in variety concentrations and 12, 24 h enrichment periods. Mean within the grouping followed by the different letters show statistically different ($P<0.05$)	63
5.4	Total monoene in <i>A. urmiana</i> nauplii enriched with different oil and concentrations during two periods. Mean within the grouping followed by the different letters show statistically different ($P<0.05$)	64
5.5	Arachidonic acid of <i>A. urmiana</i> nauplii enriched with oils in different concentration and 12, 24 h enrichment periods. Mean within the grouping followed by the different letters show statistically different ($P<0.05$)	65
5.6	Eicosapentaenoic acid in <i>A. urmiana</i> nauplii enriched with main factors (oils, concentrations and enrichment period) and combinations. Mean within the grouping followed by the different letters show statistically different ($P<0.05$)	66

5.7	Docosahexaenoic acid (22:5n-3) content of <i>A. urmiana</i> nauplii enriched with different oils and concentration at 12, 24 h enrichment periods. Mean within the grouping followed by the different letters show statistically different (P<0.05)	67
5.8	DHA/EPA ratio of <i>A. urmiana</i> nauplii enriched with oils in variety levels and 12, 24 h enrichment periods. Mean within the grouping followed by the different letters show statistically different (P<0.05)	68
5.9	ω -3/ ω -6 ratio of <i>A. urmiana</i> nauplii enriched with oils in variety levels and 12, 24 h enrichment periods. Mean within the grouping followed by the different letters show statistically different (P<0.05)	69
6.1	Vitamin C contents of <i>A. urmiana</i> nauplii enriched HUFA supplemented with AP levels at 12, 24 h enrichment periods. Mean within the grouping followed by the different letters show significantly different (P<0.05)	88
6.2	Protein contents of <i>A. urmiana</i> nauplii enriched with AP levels in HUFA oil during two enrichment periods. Mean within the grouping followed by the different letters show significantly different (P<0.05)	89
6.3	Lipid contents of <i>A. urmiana</i> nauplii enriched with HUFA oils and AP levels at 12, 24 h enrichment periods. Mean within the grouping followed by the different letters show significantly different (P<0.05)	90
6.4	Total saturated fatty acids contents of <i>A. urmiana</i> nauplii enriched HUFA supplemented with AP levels at 12, 24 h enrichment periods. Mean within the grouping followed by the different letters show significantly different (P<0.05)	91
6.5	Total monoenes contents of <i>A. urmiana</i> nauplii enriched with AP levels in HUFA oils at 12, 24 h enrichment periods. Mean within the grouping followed by the different letters show significantly different (P<0.05)	92

6.6	Arachidonic acid contents of <i>A. urmiana</i> nauplii enriched HUFA supplemented with AP levels at 12, 24 h enrichment periods. Mean within the grouping followed by the different letters show significantly different (P<0.05)	93
6.7	EPA contents of <i>A. urmiana</i> nauplii enriched HUFA supplemented with AP levels during two enrichment periods. Mean within the grouping followed by the different letters show significantly different (P<0.05)	94
6.8	DHA contents of <i>A. urmiana</i> nauplii enriched with HUFA oils and AP levels at 12, 24 h enrichment periods. Mean within the grouping followed by the different letters show significantly different (P<0.05)	95
6.9	DHA/EPA ratio of <i>A. urmiana</i> nauplii enriched HUFA supplemented with AP levels during two enrichment periods. Mean within the grouping followed by the different letters show significantly different (P<0.05)	96
6.10	ω -3/ ω -6 ratio of <i>A. urmiana</i> nauplii enriched with AP levels in HUFA oils at 12, 24 h enrichment periods. Mean within the grouping followed by the different letters show significantly different (P<0.05)	97
7.1	Crude protein of <i>A. persicus</i> larvae fed <i>Artemia</i> enriched with oils and different concentrations in enrichment periods (12 and 24h). Mean within the grouping followed by the different letters show significantly different (P<0.05).	120
7.2	Crude lipid of <i>A. persicus</i> larvae in different enrichment HUFA oils and concentrations during two enrichment periods (12 and 24h). Mean within the grouping followed by the different letters show significantly different (P<0.05)	121
7.3	Total saturated fatty acid of <i>A. persicus</i> larvae in different enrichment oils and concentrations in two enrichment periods. Mean within the grouping followed by the different letters show significantly different (P<0.05)	122
7.4	Total monoene fatty acid of <i>A. persicus</i> larvae fed <i>Artemia</i> enriched with different HUFA oils, various concentrations during two enrichment periods.	123