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Cage Culture in Iraq, Current Status & Potential: A Review

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Abstract: The present investigation aimed at discussing the present status of cage culture in Iraq and its future potential. Iraqi water resources can provide the basic requirements for successful fish culture in cages. Environmental conditions may maintain sustainable growth rate for 10 months at least. This has encouraged the investors and fish culturists to adopt such technique and make use of its advantages. Development of cage culture in Iraq has been reviewed from the early seventies till now. Fish production from cage culture was analyzed focusing upon recent developments in terms of fish consumption criteria and the per capita in Iraq. The floating cages culture system is considered now as the main culture system, because environmental conditions are suitable for cage culture more than the earthen ponds and recirculating systems. Cage culture industry relies on row materials that are locally available. They includes, frames, bridges, passage ways, nets, floating materials, feeders and wave breakers. Most of the cage units are locally manufactured from steel or wooden frame in square or rectangular shapes. Some circular and octahedral units are used in Kurdistan and Mosul. Researches on cage culture continued to optimize parameters such as stocking density, feeding and stocking sizes, stocking density of fish in the cages was fixed at 60-70 fish per m^3 or 1500-2000 fish per cage of 1.5 x 4 x 4m using fish of 100 g in weight. Problems facing cage culture in Iraq are summarized by high prices of feeds, viral infection and other fish diseases, deterioration of water quality, the policy of importing fish from neighboring countries and lack of skills among farmers. Solutions for the above problems and recommendations for future development are discussed at the end of the article.

Keywords: Carp fish, Culturists problems, Feed, Floating cages.

Overview

Fish cages is considered as one of the culture systems that can be constructed in any available unpolluted water body with suitable water flow. It does not compete with other agriculture activities which need land to be established (Arab Organization for Agricultural Development, 2013). These type of culture is characterized by rapid growth and high productivity of healthy and disease-free fishes, if farmers follow the standard procedures. In addition, it is a good production method in areas which are difficult to use fish farming methods (Mwebaza-Ndawula *et al.*, 2013). They have also special characters superior to other fish culture systems. In cage culture fish can be stoked

with high densities and would be monitored and harvested much easily. Moreover cage culture need no water replacing or aeration techniques. Fish production would be enhanced by practicing such activity to reduce pressure on local fisheries resources and recovery of fish stocks.

Iraqi water resources can provide the basic requirements for successful fish culture in cages in certain suitable places. Environmental conditions may maintain sustainable growth rate for the 10 months during the whole year; this has encouraged the investors and fish culturists to adopt such technique and make use of its advantages. Fish culture in cages has started in Habbaniya Lake early in the eighties, but was not successful for many reasons (Al-Daham, 1990). Common carp *Cyprinus carpio*, bunni *Barbus sharpeyi* (=*Mesopotamichthys sharpeyi*) and gattan *Barbus xanthopterus* (= *Luciobarbus xanthopterus*) fingerlings were cultivated in Razzaza and Tharthar Lakes in cages to monitor their growth rate before releasing into the lakes (IFI, 1982). Saleh & Suliman (1988) tried cage culture for common carp in the drainage canals. Salman *et al.* (1997) used cage culture for common carp in the Northern part of the main drainage canal. According to Taher (2014), fish culture in cages has started on commercial scale in Iraqi water by the year 2009 especially in the middle and western provinces of Iraq after giving farmers legal permissions to establish floating cages projects with governmental loans.

Current Status

Fish culture in cages has been expanded since 2017 when tens of thousands of cages projects have been established in many Iraqi provinces especially Babylon, Wasit, Qadisyah, Northern Baghdad, Salahuldeen and Anbar (AFP, 2020). This was encouraged by low construction cost and high financial profits. The result was a huge mass of closely constructed cage units along the upper and lower reaches of rivers and streams. The mass production of these projects caused a correspondent reduction in wholesale and retailed prices in Iraqi fish markets beside the increased amounts of imported fish.

Before establishing fish cages, the production of fish in Iraq from an area of 4914 thousand square meter fish farms in 2007 reached 14,286 Ton (Ali & Jaek, 2008). The numbers of cage projects in Iraq are shown in table (1) as recorded by the Ministry of Agriculture (2012). Al-Salem (2013) recorded higher number of cages in Babylon Province approaching 84 project with 844 cages. These projects and others in many parts of Iraq have been established without legal permission.

Salman & Saleh (2021) stated that there were no actual record of the amount of fish produced by the cages industry in Iraq. At the end of 2018, the Ministry of Agriculture announced the autarky of fish production and prevent the import of fish from neighboring countries. If the population of Iraq approaching 40 million with an annual consumption of 7 kg per capita, autarky means reaching 280 thousand ton yearly. In another announcement, the Ministry allowed exporting fish to Jorden and Gulf States. Both parameters indicate the superiority of fish production which is estimated to be more than 350 thousand ton most of it came from cage culture according to the Iraqi Fish Producers Society (Salman & Saleh, 2021).

Accordingly prices of fish in Iraqi fish markets decreased from 6000 ID in 2007 to 3500 ID in 2017 for one kg. Furthermore, and as a proof of such outstanding production, a

complementary production of feed stuffs was monitored and found to reach 900 thousand ton most of it was used for cage culture. In addition to that high protein feed stuffs were imported from other countries (about 40 thousand ton) to satisfy the increased needs of cage culture industry for more feed for the cage-cultured fish (Salman & Saleh, 2021). However, feed conversion ratio (FCR) values (< 2.5) are used as an indicator to evaluate the biological and economic efficiency of feed stuffs. Al-Salem (2013) summarized the production and economic analysis for those projects as seen in tables (2 & 3).

Table (1): Number of cage culture projects in Iraqi Provinces with their total volume (Ministry of Agriculture, 2012).

Province	Volume m3	No. of Cages	Permissions
Basrah	6452	293	130
	16890	625	24
Wasit	10992	338	20
Babylon	11040	338	11
Dhiqar	1118	45	10
Qadisya	5750	195	8
Anbar	2900	105	5
Najaf	1028	21	2
Muthana	512	8	2
Salahuldin	522	6	2
Karbala	600	25	1
Mosul	12	1	1
Total	**57816**	**2000**	**216**

Table (2): Production analysis of cage culture project (Al-Salem, 2013)

Parameters	Average	Range
Initial wt. (g)	124.3	50.0 – 250.0
Rearing period (days)	154	90 - 290
Production (kg)/cage	1701	450 - 4500
Production Kg/m3	51.5	12.1 - 97.6
Food conversion ratio	2.68	1.50 - 6.11
Relative growth (%)	788	250 - 1775
Specific growth(%g/day)	0.655	0.250 - 1.220
Daily increment (g/day)	6.6	2.0 - 11.0
Mortality %	7.67	0.50 – 25.00

Table (3): Economic analysis of the revenue (million ID) for floating cages of various sizes (Al-Salem, 2013).

Groups	>200 m3	120–200 m3	< 120 m3
Parameters	43.	33.7	19.6
T. Capital	74.1	49.9	24.8
T. Revenue	30.2	16.2	5.1
Financial flow	1.69	1.48	1.26
ID profit	0.69	0.48	0.26

Basic structure of cage culture

Cage culture industry relies upon row materials that are locally available. They includes, frames, bridges, passage ways, nets, floating materials, feeders and wave breakers. Most of the cage units are locally manufactured from steel or wooden frame in square or rectangular shapes with the dimensions of: 3x3x2, 2x3x4, 2x4x4, 2x3x6 and 2x4x6 m (Plate 1). Some circular and

octahedral units are imported from Turkey and used in Kurdistan and Mosul.

Two kinds of nets are usually used, the external sets for protection and are made of steel BRC covered with plastic. The internal net which accommodate fish are med of nylon of 1 inch diameter. It should be flexible to allow cleaning, sampling, treating and harvesting. Floating materials are also used in the form of barrels or polystyrene. Feeding is performed by mechanical feeders or demand feeders (Plate 1). Protection from severe water current is important and done by several types of wave breakers.

Plate (1): Structure of locally-made cages with demand feeders.

Research

Research on cage culture in Iraq is rare. Few papers have been published in recent years on some experimental trials. These include the work of Saleh & Salman (1988) regarding the use of drainage water for rearing common carp. Salman *et al.* (1997) studied the acclimation of common carp and Gattan to drainage waters by using floating cages. Al-Jader & Al-Sulevany (2012) tested the impact of various protein levels in carp ration on growth and feed conversion in wooden cages in Northern Iraq (Duhok). Salman (2013) discussed the use of locally made fish rearing cages in the Iraqi marshes in a case study. Taher *et al.* (2013) studied the effects of stocking density for common carp cultivated in floating cages on mortality ratio of Spring Viraemia of Carp and use of some chemotherapeutic control. Stocking density of fish in the cages was studied by Al-Janabi (2014) and fixed at 60-70 fish per m3 or 1500-2000 fish per cage of 1.5 x 4 x 4m. Stocking density of fish in the cages was studied also by Taher (2014) and fixed at 75 fish per m3. Abdul-Hakim (2005) studied the effect of artificial illumination on the growth of common carp in cages. Al-Shemmary (2015) studied the effect of initial weight and ration quality on the productive performance of common carp reared in floating cages. Abbas *et. al.* (2016) studied the effect of stocking density and partitioning of rearing period on growth, feed utilization and production of common carp raised in floating cages **.**

Al-Jubouri, *et. al.* (2017) studied clinical diagnosis of some diseases and parasites infected common carp cultivated in floating cages at Babylon Province. Al-Dubakel *et. al.* (2018) studied the relationship between weight and mortality ratio of common carp cultivated in floating cages during acute

increasing of temperature in Shatt Al-Arab. Albahadly (2019) studied the effects of floating and sinking pellets on production of common carp and also studied the effect of grading on common carp cultivated in floating cages. Taher (2020a) studied economic evaluation of four imported floating feeds used for cultivation of common carp in floating cages in Basrah Province, Iraq. Taher (2020b) studied the use of dry fish and dry bread as diet for common carp cultivated in floating cages. Few economic studies concerning feasibility of cage culture projects compared with earthen ponds production such as Al-Salem (2013) on technical and economic evaluation of cage culture projects in Babylon Province.

Viral infections

In October 2018 huge rate of mortality was recorded among fish of the cage projects of Northern Babylon down Al-Musayab Electrical Station but not above (Plate 2). The first diagnosis was symptoms of gill rots. Hundred percent mortality was recorded along the 12 km river course with a total loss of nearly 20 thousand tons (AFP, 2020). After critical check, fins and gills rot disease was excluded and the possibility of chemical pollution from the electric power station or other source was expected. Samples from tissues of dead fish was sent to foreign laboratories in Jordan, Italy and UK by private sector and FAO team indicated the viral infection by Koi herpesvirus KHV (Ababneem, 2018; Jerregino, 2018).

Plate (2): Viral infection of common carp which caused huge mortality in cages.

Reasons for spread of such infection can be summarized by:

1. Cage projects are not following the standard rules regarding:

a. Cage density along the river.
b. Fish culture density within the cage.
c. Reduced flow of water.
d. Irregularity of fish examination.

2. Throwing of dead fish from cages to the river directly instead of burying them.

The Ministry of Agriculture has not done much via the Directory of Veterinary Medicine regarding the production of viral vaccine or compensating the infected projects. Instead, officials have ordered the unlicensed projects to be removed especially at city centers. Such practice, in addition to leaving

the business by some investors, have reduced the number of cage projects by 40-70% depending on locality and degree of enforcement orders (AFP, 2020).

Fish cage culturists responded to the KHV infection by the following arrangements:

1. Some of them have closed their projects.
2. Others worked partially by reducing number of cages or fish density and lower feeding rates.
3. Rearing fish species which have more resistance to KHV such as grass carp as suggested by AFP (2020), despite its lower growth rate compared with common carp.
4. Other culturists continued their usual activity, adapting the occurrence of KHV.

To compensate for the lost, some of the cage culture projects have been transferred from the centers of the big cities to places outside these centers. For instance in Anbar Province, projects were transferred to Garma and Fallujah along the Euphrates instead of Ramadi City. Despite the catastrophy, fish cages projects have continued producing fish during Covid-19 Crises and compensate for preventing fish import from neighboring countries. The prices of fish continued low (around 3000 ID.kg^{-1}) compared with previous periods.

To reduce the impact of KHV in light of vaccine absence and to continue culture practices, culturists have implemented the following arrangements:

1-Sterilization: In the absence of any vaccine for KHV, the veterinary medicine offices distribute a sterilization materials called Vargon S which was not so effective. Instead, other sterilization materials such as Cobra, Sanidox and Fungcides (CuSO4) are used by culturists. Some veterinary doctors advised them to use Antibiotics.

2-Use of Immune promoting materials through feeding such as Bio Boost, Aqua and Thepax.

3-Leaving spaces of at least 2m between cage lines to allow better circulation aeration and healthy environment.

4-Starting the season from March or May by rearing fish of 300-500 g initial weight and harvesting in September to avoid the infection period during Autumn.

5-Following herd immunity practice by purchasing extra number of fingerlings (20-25 g in weight) to be reared in earthen ponds or cages with deliberate exposure to disease infection at the aim of producing 25% disease-resistant strains for further fattening culture. Some of those can be sold to other farmers. The purchase of such immune-induced strains and use them for cage culture in the upstream areas of Tigris and Euphrates at Salahuldeen and Anbar Provinces may have the risk of spreading the virus infection agents to areas at the downstream areas down south at Baghdad, Babylon and Wasit Provinces.

Unfortunately, mortalities have occurred again at lower degrees in 2019 and 2020 in the same places and with the same effects, despite early precautions. Lack of governmental effort to cooperate with fish culturists and competition of imported fish from foreign countries may cause a real problem to such industry.

Problems facing cage culture of fish

Cage aquaculture activities in Iraq faced many problems:

1-The majority of feed stuffs used are imported with high prices which increase feed and production costs.

2-Low prices of marketable fish which reached some times less than two dollars.

3-Environmental effects accounted for 90% of cage problems, primarily water physio-chemical properties and reduction of water level. Water is becoming more saline and very hot during summer months in the Southern part. This could be seen as stressors influencing fish growth, behavior and immune suppression, leading to disease infection and mortality (Morales *et al*., 2005; Masser, 2008). However, in these areas, the activity of this system is limited, compared with the central and western regions.

4-Aggregation of barnacles (*Amphibalanus* spp.) on cage nets (Plate 3) especially when water became more saline and closed all nets openings leading to low dissolved oxygen in side cages and retardation of fish growth. However, the effect of this factor is limited in the central and western regions.

5-One of the challenges facing cage culture in Iraq is the pandemic spread of Spring Viraemia of Carp (SVC) which cause huge rate of mortalities in many regions of Iraq. Chemotherapeutic agents are mainly applied in fish culture to control and treatment of the diseases. One of them is the salt NaCl, which is defined as antiparasitic, antifungal and antibacterial agents (Roberts, 2001; Plante *et al*., 2002).

6-Cage culture may have an impact on aquatic environment and socio-economic status of local communities due to location inside water bodies (Beveridge & Stewart, 1998; Kim, 2000; Rawson *et al*., 2002). According to Pillay (2004), hazards caused by cage culture include increased precipitation rates and bloom growth of phytoplankton due to organic pollution and enrichment of nutrients. The distribution of pathogens, toxic medicines and chemicals formed additional negative impacts. Changes in the biodiversity of bottom fauna which may affect the balance of the aquatic ecosystem is well expected.

Plate (3): Accumulation of barnacles and Algal materials on cage nets.

Proposed solutions

To improve aquaculture, especially in the southern part of Iraq, all these parameters should be considered to plan an effective management.

Solutions can be summarized as follows:

1-Encouraging the construction of fish cages and other culture systems in the main drainage canals in Iraq in which salinity levels are suitable for common carp.

2-Fry and fingerlings supply should be maintained through establishing new local hatcheries and improve hatchery production techniques to increase fingerlings yields of all carp species (common carp, grass carp *Ctenopharyngodon idella* and silver carp *Hypophthalmichthys molitrix*) in addition to some native species such as bunni and gattan.

3-Advising culturist especially in Iraqi marshes to cultivate grass carp in floating cages depending only on aquatic plants as feeds.

7-Events of fish escape from cages have also been reported to affect wild fish stocks in rivers and streams.

8-The introduction of new fish species that are more tolerable to the present water quality especially euryhaline species such as sobaity seabream (*Sparidentex hasta*) and flathead grey mullet (*Mugil cephalus)* or some commercial shrimp species such as the white-legged shrimp (*Litopenaeus vannamei*).

9-Sustainability and aquatic environment conservation became an important aim of modern cage culture in many parts of the world for the benefit of people living in the area (Grøttum & Beveridge, 2007).

10-There are big chances of success especially with the availability of sufficient amount of very productive water resources and cheap work power (Plate 4), but research for optimizing stocking, feeding and harvesting is essential.

Plate (4): Fish in cages can be harvested more easily by cheap work power.

Future Needs

Future needs for promoting fish production via cage aquaculture practices to cover local consumption and export are:

1-Simplifying permits conditions to establish a fish cage projects within the carrying capacity of the water bodies.

2-Supply of active vaccine for viral disease by veterinary medicine offices.

3-Supply of feed stuffs such as protein concentrates and soybean meal by the State Company for Agricultural Supply with reasonable prices to facilitate manufacturing of fish feeds locally at lower prices. This can be done through collaboration with other animal production activities.

4-Reduction of feed stuffs and medicines prices, which are the main reasons for raising the production cost of cage-cultured fish and hence prices of fish compared with the imported one due to free trade.

Contributions of authors

N.A. Salman.: Revised the Manuscript and linguistic editing.

K.I. Saleh: Wrote the Manuscript, data collection.

M.M. Taher: Wrote the Manuscript, data collection.

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Ethical approval

All ethical guidelines related to Fish and care issued by national and international organizations were implemented in this report.

Conflicts of interest

The authors declare that they have no conflict of interests.

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استزراع الاسماك بالأقفاص في العراق، الوضع الحالي والاحتمالات، دراسة مرجعية

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المستخلص: تهدف الدراسة الى مناقشة الوضع الحالي في العراق لاستزراع الاسماك في الاقفاص والتوقعات المستقبلية. ان مصادر المياه العراقية ممكن ان توفر الاحتياجات الاساسية لغرض نجاح استزراع الاسماك في الاقفاص، إذ ان الظروف البيئية تكون مناسبة لنمو الاسماك لمدة 10 اشهر على الاقل. مثل هذه الظروف شجعت المستثمرين ومربي الاسماك استخدام الاقفاص والاستفادة من ايجابياتها. تم فحص تطور هذا القطاع منذ السبعينيات ولحد الان. انتاج الأسماك في العراق تم التركيز عليه من خلال زيادة حصة الفرد العراقي من الاسماك. يعتبر قطاع استزراع الاسماك في الاقفاص القطاع الرئيس من ضمن انظمة الاستزراع كون الظروف غير مناسبة لطرق الاستزراع بالاحواض الترابية والأنظمة المغلقة. ان صناعة الاقفاص العائمة تعتمد على المواد الاولية المحلية والتي تتضمن الهياكل والجسور والممرات والشباك ومواد الطفوا والمغذيات وكذلك كواسر الامواج، وان معظم وحدات الاقفاص تصنع محليا من الفولاذ او الهياكل الخشبية المربعة او الدائرية الشكل. بعض الوحدات الدائرية او الثمانية الاسطح قد استعملت في كردستان والموصل. ان البحوث مستمرة على الاستزراع بالأقفاص لغرض تحديد بعض المعايير المثالية مثل كثافة الاستزراع والمغذيات وكذلك الحجم الاولي لأسماك الاستزراع، إذ حددت كثافة الاستزراع بحوالي 60–70 سمكة لكل متر مكعب او 1500–2000 سمكة لكل قفص بأبعاد 4 x 4 x 1.5 متر لأسماك الكارب الشائع. ان المشاكل التي تواجه استزراع الاسماك في الاقفاص داخل العراق لخصت بارتفاع اسعار الاعلاف والاصابات الفيروسية وبقية انواع الامراض وتدهور نوعية المياه واجازات استيراد الاسماك من دول الجوار. ان الحلول لهذه المشاكل والتوصيات لغرض التطوير المستقبلي للقطاع قد نوقشت في نهاية هذه الدراسة.

الكلمات المفتاحية: اسماك الكارب، مشاكل مربي الاسماك، الاعلاف، الاقفاص العائمة.