T. R.
VAN YUZUNCU YIL UNIVERSITY
INSTITUTE OF NATURAL AND APPLIED SCIENCES
DEPARTMENT OF FISHERIES ENGINEERING

A COMPARISON STUDY OF NUTRITIONAL AND PRODUCTIVE ASPECTS OF COMMON CARP (*Cyprinus carpio* L.) REARED IN EARTHEN PONDS IN RANYA (NORTH OF IRAQ)

M.Sc. THESIS

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VAN-2018

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ACCEPTANCE a[illegible]VAL PAGE

This thesis entitled "**A Comparison Study of Nutritional and Productive Aspects of Common Carp (*Cyprinus carpio* L.) Reared in Earthen Ponds in Raniya**" presented by Brwa Abdullah RASOOL under supervision of Asst. Prof. Dr. Ş. Şenol PARUĞ in the Faculty of Fisheries has been accepted as a M. Sc. thesis according to Legislations of Graduate Higher Education on 14.05.2018 with unanimity / ~~majority~~ of votes members of jury.

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THESIS STATEMENT

All information presented in the thesis was obtained according to the ethical behaviors and academic rules frame. And also, all kinds of statement and source of information that does not belong to me in this work prepared in accordance with the rules of thesis were cited to the source of information absolutely.

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Brwa Abdullah RASOOL

ABSTRACT

A COMPARISON STUDY OF NUTRITIONAL AND PRODUCTIVE ASPECTS OF COMMON CARP (*Cyprinus carpio* L.) REARED İN EARTHEN PONDS İN RANYA (NORTH OF IRAQ)

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May 2018, 78 pages

The increasing necessity on fish meat at Northern Iraqs' cities particularly in Sulaimaniya and Erbil Governorates due to the increasing population with suitable economic situation especially after 2010; also brought about excessive demand on various types of fish meats obtained from natural growing fishes in lakes. In this region, water temperature values are optimum about 5-6 months during the year for growing of subtropical climate Cyprinids. For this reason, a rapid increasing has seen on earthen ponds establishment.

In this study, it was aimed to determine the productivity aspects of common carp (*Cyprinus carpio* L.) in Ranya Zone (Raparin Administration), with comparing ponds statics of selected six farms in different s. The study was carried out during the five months period (between May and September) between the farming period and the harvesting season. The mean values of moisture ratio (75.937 % to 70.498 %) were not significantly different ($P>0.05$), however fat ratio (13.36 % to 6.33 %), protein ratio (21.79 % to 10.40 %) and ash ratio (2.35 % to 1.01 %) of fish meat samples, which were taken from different fish ponds, were found significantly different ($P<0.05$). The organoleptic tests that were conducted to evaluate the quality of fish's meat, showed significant differences ($P<0.05$) in tenderness (4.8 to 3.0 on 5) and overall acceptability (4.8 to 3.6 on 5), and no significant differences ($P>0.05$) in each of juiciness (4.2 to 3.4 on 5) and flavor (4.6 to 3.6 on 5).

Keywords: Carp, Earthen pond, Meat quality, Organoleptic evaluation, Ranya, Water quality.

ÖZET

RANYA'DAKİ (KUZEY IRAK) TOPRAK HAVUZLARDA YETİŞTİRİLEN PULLU SAZANIN (*Cyprinus carpio* L.) BESİNSEL VE VERİMLİLİK YÖNLERİNİN KARŞILAŞTIRILMASI ÜZERİNE BİR ÇALIŞMA

RASOOL, Brwa Abdullah
Yüksek Lisans Tezi, Su Ürünleri Mühendisliği Anabilim Dalı
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İkinci Danışman: Dr. Öğr. Üsey. Nasreen M. ABDULRAHMAN
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Özellikle 2010'dan sonra ekonomik açıdan iyi duruma sahip nüfus artışına bağlı olarak, Kuzey Irak şehirlerinden bilhassa Süleymaniye ve Erbil Valiliklerinde balık etine olan ihtiyacın artması; göllerde doğal olarak yetişen balıklardan elde edilen çeşitli balık etlerine olan haddinden fazla talebi de beraberinde getirmiştir. Bu bölgede, subtropikal iklim sazangillerinin büyümesi için, su sıcaklık değerleri yılın 5-6 ayı boyunca en uygun seviyelerdedir. Bu nedenle, toprak havuzlarının kurulmasında hızlı bir artış görülmüştür.

Bu çalışmada, Ranya Bölgesi'ndeki (Raparin Yönetimi) pullu sazanın (*Cyprinus carpio* L.) verimlilik yönlerinin, farklı bölgelerde seçilen altı çiftliğin havuz dinamiklerinin karşılaştırılarak belirlenmesi amaçlanmıştır. Çalışma, yetiştiricilik dönemi ile hasat mevsimi arasındaki beş aylık (Mayıs-Eylül arası) dönemde gerçekleştirilmiştir. Farklı balık havuzlarından alınan balık eti örneklerinin ortalama nem oranları (75.937 - 70.498 %) arasında istatistiksel açıdan anlamlı fark bulunmazken ($P>0.05$), yağ oranı (13.36 - 6.33 %), protein oranı (21.79 - 10.40%) ve kül oranı (2.35 - 1.01 %) değerleri anlamlı derecede farklı bulunmuştur ($P<0.05$). Balık etinin kalitesini değerlendirmek için gerçekleştirilen duyusal analizler, yumuşaklıkta (5 üzerinden 4.8-3.0) ve genel kabul edilebilirlikte (5 üzerinden 4.8-3.6) anlamlı farklar olduğunu ($P<0.05$); sululukta (5 üzerinden 4.2-3.4 on 5) ve lezzette (5 üzerinden 4.6 ila 3.6) anlamlı farklar olmadığını ($P>0.05$) göstermiştir.

Anahtar kelimeler: Et kalitesi, Duyusal değerlendirme, Ranya, Sazan, , Su kalitesi, Toprak havuz.

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SYMBOLS AND ABBREVIATIONS

Some symbols and abbreviations used in this study are presented below, along with description.

Symbols	Description
ºC	Centigrade
cm	Centimeter
m^2	Square Meter
m^3	Cubic Meter
mg/l	Milligram / Litter
g	Gram
kg	Kilo Gram
ppm	Part Per Million
µs/cm	Microsiemens / Centimetre
pH	Potential of Hydrogen
NH_3	Ammonia
NO_2	Nitrite
NO_3	Nitrate
Cl^-	Chloride
PO_4	Phosphate
SO4	Sulfate

Abbreviations	
Dn	Donum (2500 m^2)
IW	Inlet Water
PW	Pond Water
$S_{1,2,3,4,5,6}$	Locations
SD	Stocking Density
PL	Pond Length
SW	Surface Well
IL	Illiterate
Se	Secondary School
Pr	Primary School
Di	Diploma Degree
Bc	Bachelor Degree
FAO	Food and Agriculture Organization
AOAC	ssociation of Official Analytical Chemists
GIS	Geographic Information System
GAFP	General Adminstration of Fish Production
MAI	ministry of agriculture Iraq
USAID	United States Agency for International Development
TE	Trading Economics
MAWAR	Ministry of Agriculture and Water Resources
MPN	Ministry of Planning north Iraq

WB	World Bank
ha	Hectare
UN	United Nation
HUFA	Hig Unsaturated Faty Acid
PUFA	Poly Unsasturated Faty Acid
EPA	Eicosapentaenoic Acid
DHA	Docosahexaenoic Acid
EBT	Erochrome Black T
EDTA	Ethylene Diamine Tetra Acetic Acid
DO	Dissolved Oxygen
EC	Electrical conductivity
(TDS)	Total dissolved solid
am	Ante meridiem
pm	Post meridiem

1. INTRODUCTION

Fish is the cheapest and most easily digestible animal protein and was obtained from natural sources from time immemorial for consumption. Due to over exploitation and pollution, the availability of fish in natural waters has declined considerably, forcing scientists to adopt various methods to increase its production. Fish farming in controlled or under artificial conditions has become the easier way of increasing the fish production and its availability for consumption. Farmers can easily take up fish culture in village ponds, tanks or any new water body and can improve their financial position substantially. It also creates gainful employment for skilled and unskilled youths (FAO, 2015).

The technology developed for fish culture in which more than one variety of compatible fishes are cultured simultaneously is the most popular mode of fish culture in the country and is known as Composite Fish Culture. This technology enables to get maximum fish production from a pond or a tank through utilization of available fish food organisms in all the natural niches, supplemented by artificial feeding. Even seasonal ponds can also be utilized for short duration fish culture (FAO, 2015).

Aquaculture has been growing rapidly faster than any other food production sector over the past three decades, and continuing. Considerable social and economic benefits have been provided, documented and felt. It is clear that the bulk of fish required to feed the world in the coming decades will come from aquaculture. It is also time to put "nutrition security" at par with "food security". Aquaculture, an aquatic agricultural system, offers great possibilities for keeping people healthy and hauling them out of poverty. Marked increases in productivity are possible, as are approaches which can help to buffer seasonal swings in dietary diversity and income. Community engagement and nutrition education along with increased productivity and income open new doors for reducing under nutrition (FAO, 2015).

Fisheries play a vital role in the food and nutritional security of people, especially in rural areas (Sugunan, 2002). But the production of inland fish is far less than the demand, and naturally, the cost of the fish is high in this continent. So, there is necessity for augmentation of inland fish production. For optimum production of fish, supplementary diet is required, in addition to natural food present in the aquatic environment. Market available fishmeal is quite expensive and is in short supply (Adewumi et al., 2016). Fish is a micro-nutrient dense food that can play a more important role as a provider of nutrients such as iron, zinc, iodine, calcium and selenium. This is particularly true for small fish traditionally eaten whole (FAO, 2015).

Production increase must occur in a context where resources necessary for food production, such as land and water, are even scarcer in a more crowded world, and thus the sector needs to be far more efficient in utilizing productive resources. Further, in the face of global climate change, the world is required to change the ways to conduct economic activities (WB, 2013).

Fish represents 16 percent of all animal protein consumed globally, and this proportion of the world’s food basket is likely to increase as consumers with rising incomes seek higher value seafood and as aquaculture steps up to meet increasing demand. Matching growing market demand with this private sector interest in reliable and sustainable sourcing presents a major opportunity for developing countries prepared to invest in improved fisheries management and environmentally sustainable aquaculture. By taking up this opportunity, countries can create jobs, help meet global demand, and achieve their own food security aspirations (WB, 2013). Fisheries and aquaculture is a source not just of health but also of wealth. Employment in the sector has grown faster than the world’s population. The sector provides jobs to tens of millions and supports the livelihoods of hundreds of millions. Fish continues to be one of the most-traded food commodities worldwide. It is especially important for developing countries, sometimes worth half the total value of their traded commodities (FAO, 2014a). Fish, wherever it comes from, is a global commodity of key significance due to its potential to improve human health and nutrition, its accessibility by the poor, and the low environmental impact of its production compared to that of other animal source foods. Fish provides long-chain omega 3 fatty acids, Vitamin A, and several critical micronutrients, which help reduce ischemic heart diseases and improve health during the critical 1000-day window of life opportunity (pregnancy/lactation/infancy) (FAO, 2015)**.**

The most important factor in many fish farms is the management of the pond ecosystem and the definition of adequate stocking. Natural feed for fish can be stimulated by fertilization. Mineral fertilizers stimulate the autotrophic-based food chain, whereas organic manures improve both the autotrophic and heterotrophic food chain, thus allowing higher fish crops. Pond stocking must be defined in order to be as close as possible to the bio-technical-economic optimum. When too low, natural productivity is under-exploited and yield is low. When too high, fish growth decreases quickly and use of an expensive artificial feed become necessary. Another way of improving pond productivity consists in breeding several species with complementary feeding regimes (Lazard and Dabbadie, 2009).

Freshwater aquaculture production is mainly based on the culture of short food chain fish (carps, tilapias) and differs basically from marine fish culture based on carnivorous fish (salmon, Japanese amberjack). Freshwater aquaculture is mainly based on extensive and semi-intensive aquaculture production systems where poly-culture, fertilization, and supplementary are the key points. In the last decades, major bio-technical innovations have had a strategic impact on the freshwater aquaculture development: artificial breeding, use of supplementary feeding and artificial feed, genetic improvement, introduction of exotic species to many countries for aquaculture purposes. Despite all the scientific studies carried out in this field, the pond as a culture environment remains a black box where fish feeds at many levels of the food web and fish species interact actively. The progresses in pond fish culture management practices have mainly been obtained by a trial and error process (Lazard and Dabbadie, 2009).

The objective of study was to enumerate the status of aquaculture production in Ranya zone, highlight on problems, development prospects, provide good production and management practices able to boosting aquaculture production.

2. LITERATURE REVIEW

2.1. Importance of Fisheries and Aquaculture

Water is essential to life and is arguably our most precious resources. Water resources made up of various resources like: the water itself, animals and plants in it, and the minerals in it. These are referred to altogether as aquatic resources. These resources over the years have been tapped into in various ways to improve the standard of living of man. And the amount of using the aquatic resources in a country by its people keep increasing due to the population growth and profitable earnings got from them. The exploitation of aquatic resources increase in response to the growing of some developmental activities which include agricultural, industrial, recreational, domestic, fisheries and aquaculture, and navigation developments. All these developmental activities are what a nation can depend on for a sound outcome for her economy (FAO, 2009).

Aquaculture production specifically refers to output from aquaculture activities that are designated for final harvest for consumption or other purposes (e.g. ornamental purposes). Output is reported in weight generally in tones of live weight equivalent for aquatic animals and in wet weight for aquatic plants (Tacon, 2003).

Fisheries and aquaculture have been of great importance to a nation economy in the areas of fish production, raw materials to industries, employments, household and other purposes. Fish production in the recent years has been of importance in strengthening international relationship in terms of trade and other purposes (FAO, 2009) .

Demand for fish is growing as a result of population growth, urbanization, and increasing wealth. Research suggests that aquaculture production should double by 2030 to meet the world's growing demand and needs. If it comes up short, per capita fish supplies, according to the World Bank. The people of Africa and Asia (excluding China) have the lowest consumption of animal-source foods. But they try to make up for this by having the highest proportion of fish in their diet. Africa and Asia also have the highest levels of poverty and malnutrition. These facts clearly indicate the importance of making fish more accessible and affordable to the vulnerable communities in Africa and Asia (FAO, 2015).

Aquaculture is the fastest growing food production industry and the vast majority of aquaculture products are derived from Asia. The quantity of aquaculture products directly consumed is now greater than that resulting from conventional fisheries (Yongphet et al., 2016). Fisheries and aquaculture remain important sources of food, nutrition, income and livelihoods for hundreds of millions of people around the world. World per capita fish supply has outpaced population growth in the past five decades and reached a new record high of 20 kg in 2014 (double the level of the 1960s),due to vigorous growth in aquaculture, and to a slight improvement in the state of certain fish stocks due to improved fisheries management (FAO, 2016).

Fish continues to be one of the most-traded food commodities worldwide with more than half of fish exports by value originating in developing countries .Oceans and inland waters now, and more so in the future, have potential to contribute significantly to food security and adequate nutrition for a global population expected to reach 9.7 billion by 2050 (FAO, 2016). Aquaculture is now fully comparable to capture fisheries when measured by volume of output on global scale. The contribution from aquaculture to the world total fish production of capture and aquaculture in 2012 reached 42.2 percent, up from 25.7 percent in 2000. Asia is the only continent producing more fish (54 percent) than capture fisheries. The share of aquaculture in total fish production also rose in all other continents with Europe staying at 18 percent and others below 15 percent (FAO, 2014b).

A total of 567 “species items” had been registered in global aquaculture statistics database it is estimated that a great diversity of over 600 aquatic species is cultured worldwide. In 2012.84 percent of all people employed in the fisheries and aquaculture sector were in Asia, followed by Africa (more than 10 percent). About 18.9 million were engaged in fish farming (more than 96 percent in Asia). In the period 2010–2012, at least 21 million people were capture fishers operating in inland waters (FAO, 2014a). One important feature of this food-producing sector is that fish is highly traded in international markets. According to the FAO (2012), 38 percent of fish produced in the world was exported in 2010. This implies that there are inherent imbalances in regional supply and regional demand for fish, and international trade through price signals in markets provides a mechanism to resolve such imbalances (WB, 2013).

2.2. Fish Resources in Iraq

Fish have been the major food item in Mesopotamia over the last 5000 years apart from milk and grain. In Mesopotamia one of the sources of early human civilization, fish, crustacean, mollusks and turtles in the Euphrates and Tigris rivers with their tributaries and the coastal waters of the Arabian/Persian gulf were a major food source (Sahrhage, 1999; Tabish, 2004). Many kinds of fish are mentioned in administrative documents from the third millennium B. C. up to the period of the first dynasty in Babylon. A Sumerian text from about 2000 B.C. describes the habits and appearance of many species of fish in some detail (Saggs, 1962). The inhabitants of Babylonia were no less interested in the observation of animals, and fish were as accurately and recognizably depicted on the bas-relief as were contemporary mammals (Jawad, 2006).

Ancient people of Mesopotamia had skillful ways of preparing fish for food that included eating it fresh, salted, smoked, and dried in the sun (Maspero, 1896). Fish was not just considered a food for the poor people, but was also included in the menu for the palace of kings of Mesopotamia (Postgate, 1994). Moreover, it was included among the food that was offered to the gods in temples (Saggs, 1987). Fishermen were actually found in large numbers amongst the temple personnel, being divided into freshwater fishers, sea fishers, and fishers in salt waters. The latter group denotes fishermen operating in the tidal lagoons of the delta of the Tigris and Euphrates Rivers. According to the code of Hammurabi, fishermen were given some rights similar to those given to certain classes of society like priestesses and merchants. Fishing techniques such as spearing, harpooning, angling, and the use of baskets and various other types of nets were already well developed during the time of ancient Mesopotamia (Sahrhage, 1999; Jawad, 2006).

In the 1950s, carp species were introduced for the first time in Iraq, but only for scientific research purposes. The main aim was to acclimatize these species in the Iraqi inland waters and to establish whether they would be suitable for rearing in the Iraqi environment without interference and without a negative impact on endemic species. However, at that time, this experience was not channeled into commercial activities. Significant attention was given to the aquaculture sector, initially with the establishment of hatcheries and the construction of fish farms. The first artificial reproduction was started recently in Iraq, by following up on the experimental phase. However, the reproduction and rearing of local fish species was not carried out sufficiently, due to a lack of knowledge of the biology of the species (FAO, 2017a).

Iraq's inland fishery is based on the Tigris-Euphrates riverine system, its lakes, and seasonal floods (with a flooded area of 15000 to 20000 km^2) and it plays an important role in the country's economy. The Tigris and Euphrates rivers and their branches are the main sources of inland fresh water in Iraq. The inland fresh water bodies cover between 600000 and 700000 ha, made up of natural lakes (39 %); dams and reservoirs (13.3 %), rivers and their branches (3.7 %) and marshes (44 %). The inland fisheries are based in great part on carps *Cyprinus* spp., while the most important Iraqi indigenous fishes are barbs belonging to the genus *Barbus*. The total area under aquaculture production in Iraq is estimated to be 7500 ha. The main species cultured is common carp and to a lesser extent grass and silver carp (Tabish, 2004).

The aquaculture sector developed after 1954, but was not given any importance or particular attention. It was limited by laws, codes and regulations which protected, organized and utilized the existing fishing techniques in inland waters. In 1985, hatcheries, as well as, farms for fish reproduction and rearing were built, but these farms were too small, and not suitable for commercial purposes. In 1989, the General Board for Fish Resource Development was disbanded and became a branch under the Animal Resource Services Company (FAO, 2017a).

In Iraq, fish production relies on inland and marine fisheries. In developing this sector, the aquaculture in Iraq depends on the availability of water, as well as, good soil and adequate sites. The rivers Tigris and Euphrates, including also the country’s tributaries, marshes, dams and reservoirs comprise Iraq’s main water source. Iraq has a limited coastline of approximately 59 km bordering the Gulf with a water surface area of approximately 700 km^2. Despite the availability of water resources, freshwater aquaculture production is limited to pond culture of common carp (*Cyprinus carpio carpio*). There is also a limited culture of grass carp (*Ctenopharyngodon idellus*) and silver carp (*Hypophthalmichthys molitrix*). In 2007, the total production deriving from freshwater and marine aquaculture was estimated to be approximately 16000 tones. (FAO, 2017a; MAI, 2016).

In 2004, the General Board for Fish Resource Development restarted as an independent state institute to assume responsibility as a scientific authority to improve fish production in Iraq, by applying fisheries and aquaculture science methodologies. A number of developmental projects, assisting directly and indirectly the development of aquaculture and the inland fishery industry in Iraq have been carried out, for example, upgrading the central fish hatchery and laboratory at Wasit, rehabilitating fish farming sites in several areas in the country, building a functional hatchery for local fish species production and the building of operational closed recirculating systems and pilot cages (FAO, 2017a). Total fisheries production (metric tons) in Iraq was reported at 52099 in 2015, according to the World Bank collection of development indicators (TE, 2017), (Figure 2.1).

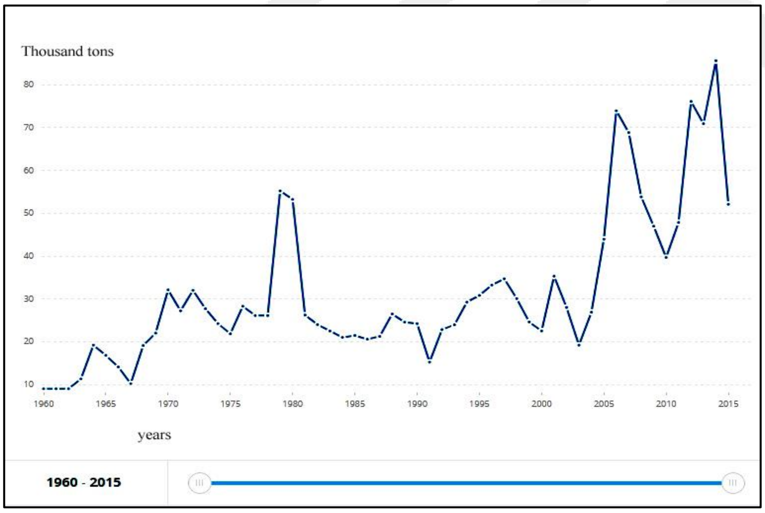

Figure 2.1. Annual total fish production in Iraq (TE, 2017).

Iraq is one of the late countries in the development and exploitation of fish wealth, despite the availability of the components of this important economic wealth, and this side is suffering from neglect and has not been placed within the policy planning for development. The interest in fish in Iraq is due to the increased demand for fish products and to improve their live level (Muhammad, 2014). It has been shown through research that the environmental conditions in Iraq and the availability of water surface has given the possibility of creating a variety of projects for fish farming in Iraq. The availability of warm water and cold water and a salt water and fresh water, encourages the introduction of new varieties of fish of commercial value and economic (Al-Zubadi and Jabr 2014).

Research and studies are currently being carried out in the area of acclimation and artificial reproduction of the native *Barbus* sp. at the Sewera central hatchery. Successful results have previously been achieved from the acclimation of Acanthus

purges lotus at al-Razaza Lake, which is an enclosed salty lake. With the collaboration of various scientific authorities, the General Board for Fish Resource Development is carrying out research and studies on these desirable species in order to reproduce this build up hatchery (FAO, 2014c)

The average per capita consumption of fish meat in the last record of a modest percentage did not exceed 1.8 kg / year (Sahhd et al., 2017; Al-Zwbaidy et al., 2015; Abdul-Magid and Al-uzyi 2010). The per capita share rose to 4 kg / year for 2013 (Al-Rafai, 2016).

Farmers were faced with a multitude of problems including disease, the lack of electricity, poor feed quality, lack of water and several economic hardships, such as high operations costs, low prices and transportation issues. In 2008, USAIDA Agribusiness Program began a partnership with Iraq’s largest and best designed hatcheries to help improve carp fingerling production in Iraq. In order to revive the Iraqi aquaculture industry, they brought improved carp fingerlings from Hungary to Iraq for cross breeding with the native carp species. One of the main benefits was that cross-breeding helped improve the overall health of the fingerlings. Future production of the carp species will be dependent on the cross-breeding program with Hungarian brood stock, which are quickly adapting to the Iraqi waters. They repaired and upgraded the infrastructure of both farms and continues to improve linkages in the fish market value chain., the hatcheries produced approximately 180 million fingerlings in 2011 compared to the 12 million in 2008 from the local non-cross bred variety (USIDA, 2012).

The production of fish in Iraq is facing a number of problems and obstacles that prevent the availability of available resources, which led to the fluctuation of the level of fish production and the decline in average per capita fish compared to the average per capita globally, the lack of good management of water bodies, and the lack of control of fishing the widespread use of illegal means of fishing, lack of effective control to reduce water pollution, and the lack of state support for production inputs such as fodder, fingerlings, medicines, etc. **(**Al-Zwbaidy et al., 2015). There is a variation in the genetic existing characteristics of fish currently (carp fish) introduced into Iraq in a contract 1970s, and there were no serious studies to introduce varieties and a new genotype with high productivity and tolerance of the Iraqi environmental conditions (Sahhd et al., 2016). Inland fisheries ecology is profoundly affected by changes in water availability, which can be affected by precipitation and runoff changes that may occur due to climate change, or by human activities changing either the quantity or quality of water available. These, as well as other factors and in combination with a growing population and increasing demand for fish, can lead to overfishing, and increasingly destructive fishing practices as less fish is available. Appropriate fisheries management, including an ecosystem approach to fisheries and aquaculture, are needed in order to ensure the sustainability of the sector and the livelihoods of those communities living in this basin Euphrates–Tigris (FAO, 2014b).

Water diversion has caused serious environmental damage to large areas of Iraq's wetlands. Thick reed beds teeming with life once covered 8000 square miles (20.480 square kilometers). Less than one-third is left of eastern marshes that reach into Iran. Rice paddies and fishing grounds are gone. And global migrations have been disrupted. The marshes have suffered badly during the political upheavals of the past few decades. According to the UN Environment Program, some 7000 square miles, or a staggering 93 percent, of the Mesopotamian Marshes drained between 1991 and 2000 (Tabish, 2004).

In Iraq, inland capture fisheries represent more than 50 percent of total fisheries production, and combined with inland aquaculture this share increases significantly, mainly tied to the increase in production of common carp (FAO, 2014b).

2.3. Production of Common Carp in Aquaculture

Common carp is one of the most cultured fish species in the world. Carp is thus well-established cultured species with a well-known production cycle. Carp is an omnivorous species, eating plankton and benthos (worms, insects, mollusks) as well as detritus in natural conditions (Adamek, 2004) .The typical carp culture practice is to use artificial shallow earthen ponds in which production is based on plankton and benthos production, supplemented by cereals. The digestive system of carp is better adapted to a diet including more carbohydrates than carnivorous species (Mraz, 2012).

Common carp, the most common cyprinid species, creates an important part of inland fish production (Çetinkaya, 2006). In a temperate climate, carp spawn once a year between May and June (Kottelat, 2007).Common carp is the most commonly transplanted species of fish in the world. This fish is very much favored for cultivation in ponds in Asia, near and far east, alone or in combination with other fishes, because of its excellent growth rate, omnivorous habit, breeding in confined waters (Naeem Khan et al., 2016; FAO, 2018). Global Aquaculture Production for Carp in 1950 were 92616 and 2014 were 4159117 tones as shown in (Figure 2.2).

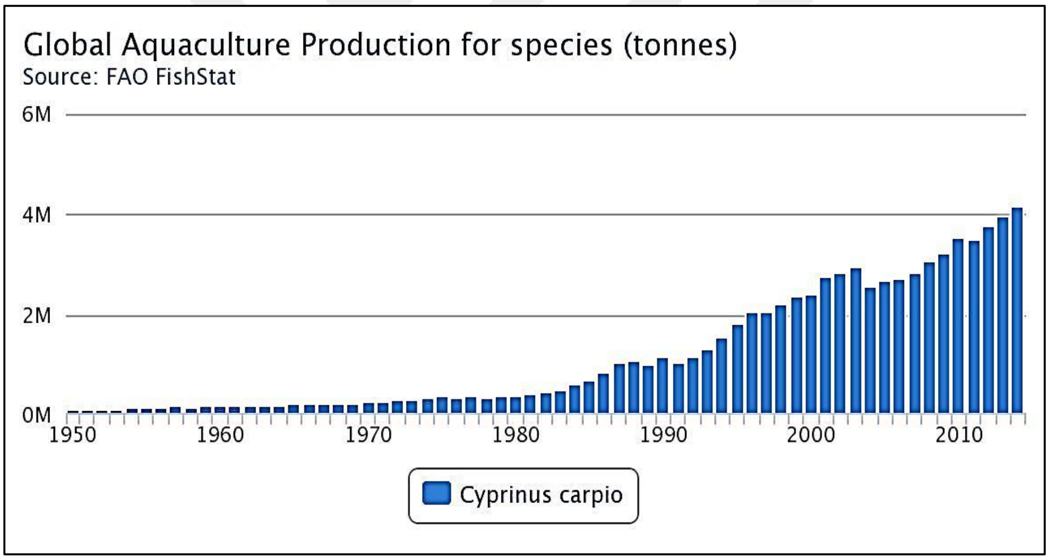

Figure 2.2. Global aquaculture production for carp in 1950-2014 (FAO, 2016).

Common carp has long been observed as a highly persistent and deleterious non-native species worldwide, with restricted impacts branded more recently in several other parts of its introduced range (Vilizz and Tarkan, 2015;Vilizzi et al., 2015). The organization of common carp has therefore become a major issue of concern in efforts to lessen its detrimental effects on freshwater ecosystems (Britton et al., 2011). This is in particularly true for ecosystems already ruined by human activities (Smith, 2009)and those susceptible to the effects of climate change (Britton et al., 2010). Common carp is able to colonize these ecosystems by the virtue of its versatile ecological necessities (Balon, 2004), and eventually the costs of common carp invasion are a decrease in native biodiversity and simultaneous homogenization of the fish fauna (Marr, 2013). Improvement of these impacts results in costly eradication and control measures at any time practicable, as well as economic losses due to deterioration in amenity value (Koehn, 2004). Consequently, common carp has been introduced into many water bodies throughout the world, including Europe, Australia and North America. The broad distribution and successful introductions of common carp are frequent due to its tolerance to changeable environmental conditions (Mills, 1993).

Common carp is tolerated to large variations of quality of ambient conditions. This species is not susceptible to disease and is tolerated to handling. (Ljubojevic et al., 2012).

Carp culture could therefore be an example of long-term sustainable production without relying on a supply of fish oil and fish meal. In addition, carp culture turns nutrients lost to water (especially N and P) into highly valuable nutritious flesh via the natural food chain in carp ponds. The low trophic levels are an especially important source of valuable n-3 HUFA in central parts of continents, where the population has less access to marine fish from capture (Mraz, 2012). Fresh fish and marine products are extremely perishable as compared to other fresh meat commodities. The hygienic quality of fish and marine products declines rapidly due to microbial cross contamination from various sources, ultimately leading to spoilage. Carp farms have proliferated in the last decades and a subsequent oversaturation of the trout market has occurred in some areas (Can, 2011).

Common carp also plays an important role in poly-culture system in seasonal reservoirs and ponds (Chakrabarty, 1982). It is the only exotic carp that is known to breed naturally in lakes, it has high fecundity and hatchability (Nathaniel, 2001), and can grow to a maximum length of 1.5m and a maximum weight of over 37.5kg (Panek, 1987). Today it remains the best choice for utilizing pond resources (FAO, 2011). Carp represent the species of choice due to their high growth rate, significant tolerance to environmental stresses, easy to reproduce and unquestionable market demand (Tiamiyu et al., 2016).

Common carp is now established in 91 out of 120 countries worldwide (Naeem Khan et al., 2016). Common carp is currently classed as susceptible in most of its native areas of distribution owing to a significant loss of genetic variability in domesticated races, breeds and strains mixing with the pure wild form (Khalili, 2010). On the contrary, in other areas of introduction such as Western Europe and the Mediterranean Region, common carp had previously been regarded as naturalized, that is, having well-known self-sustaining populations in the wild, and has been present long enough to have integrated itself within the resident community of organisms (Copp, 2005)

2.4. Aquaculture in North of Iraq

Aquaculture activity in the north region of Iraq started in 1960 with common carp on Dokan and Darbandikhan dam (MAWR, 2017). In 1999 when the Food and Agriculture Organization established two projects for fish; one was in Erbil and the other in Sulaimaniya, and the development of a hatchery for the artificial reproduction of common carp (*C. carpio*), silver carp *(Hypophthalmichthys molitrix)* and grass carp (*Ctenopharyngodon idellus*) (MPN, 2012). The capacity of each hatchery is about 20 million larvae per season, and there are two small feed-mills of a capacity of 4-5 ton per hour. The project has a number of model fish ponds for demonstration and training (MAWR, 2017).

In addition, FAO established six model fish ponds in the Agriculture College in Dohuk Governorate for demonstration and training. FAO has also distributed hand-size fish to farmers with small ponds established for storing water and irrigation. This is the first step to teach farmers in the north region to raise fish, which is a new profession in the region. (MAWR, 2017). Some estimates state that the total quantities of fish production (fisheries and river fishing) reached about 4300 ton. The production, however, was affected by a number of factors, like fishermen’s non-compliance with fishing prohibitions during breeding season, in addition to fodder shortages, and insufficient monitoring. Available statistics indicate that there are 930 fishermen in the region, most of which are fish farms (GAFP, 2017).

Freshwater fish production consists of pond culture of the common carp, as well as the grass carp (*C.idellus*) and the silver carp (*H.molitrix*). There have been no initiatives to provide opportunities for the development of native fish production due to a limited supply of good quality fish seed, a lack of scientific knowledge and because native species are economically worthless to be produced or cultured in ponds. Such species require 4-5 years to reach marketable size (FAO, 2014c; MAWR, 2017).

The species are farmed in northern of Iraq were: *Cyprinus carpio*, *C.idellus*, *H.molitrix*, and Salmon *O.mykiss*. Most fish projects depend on well water and there are both a high establishment cost and a high production cost. The use of well water means that the filling of ponds requires energy which doubles the production cost. Only about 50 % of these projects are successful for many causes. The lack of interest by government authorities in this subject and limited of support for farmers and the high cost of production because of the mountainous nature hinder success. Manpower employed in the fishery and aquaculture pertains to public and private sectors. Those employed in the private sector are mostly fishing in inland water bodies rather than working in aquaculture, but a few are involved in the basic work on the fish farms (FAO, 2014c).

Carp is farmed either independently (monoculture) or together with other fish species (polyculture) in various production systems (earthen ponds, dam lakes, net cages). Regardless of the used production system, methods and technologies, the quality of water in aquaculture facilities is dependent on a number of abiotic (physical and chemical) and biotic factors. Physico-chemical parameters of water are of primary importance in the evaluation of its quality for aquaculture purposes, as water temperature, dissolved oxygen, content of biogenic elements, organic matter load etc. are essential for optimization of the environment in aquaculture farms. All this creates preconditions for production of high-value fish. Its flavor, nutritional qualities become more and more important for consumer preferences in the purchase of fish and retail trade (Pieniak, 2007; Bauer, 2009).

In order to analyze the water quality in carp ponds beside physical and chemical analysis of water phyto and zooplankton organisms can be used as bio-indicators (Dulic et al., 2006; Dulic at el., 2009). Using biological methods of water assessment are a very useful tool since they can reflect overall ecological quality, integrate variations in the environment and indicate biologically available nutrients which chemical analysis cannot measure (Lyngby, 1990; Gold at el., 2003). Within the growing aquaculture industry, it is accepted that good water quality is needed for maintaining viable aquaculture production. Poor water quality can result in low profit, low product quality and potential human health risks. Production is reduced when the water contain contaminants that can impair development, growth, reproduction, or even cause mortality to the cultured species. Some contaminants can accumulate to the point where it threatens human health even in low quantities and cause no obvious adverse effects (Pilminaq, 2008). Fish perform all its physiological activities in the water – breathing, excretion of waste, feeding, maintaining salt balance and reproduction. Thus, water quality is the determining factor on the success or failure of an aquaculture operation. The continued degradation of water resources due to anthropogenic sources necessitates a guideline in selecting sites for aquaculture using water quality as a basis (Pilminaq, 2008).

The efficient and profitable production of fish, crustaceans, and other aquatic organisms in aquaculture depends on a suitable environment in which they can reproduce and grow. Because those organisms live in water, the major environmental concern within the culture system is water quality. Water supplies for aquaculture systems may naturally be of low quality or polluted by human activity, but in most instances, the primary reason for water quality impairment is the culture activity itself. Manures, fertilizers, and feeds applied to ponds to enhance production only can be partially converted to animal biomass. At moderate and high production levels, the inputs of nutrients and organic matter to culture units may exceed the assimilative capacity of the ecosystems (Batran, 2014).

Fish ponds have resulted in increase in nutrients (nitrogen and phosphorus) and organic wastes, through feeding inputs, leading to general deterioration of water quality (Sipauba at el., 2013**;** Santeiro at el., 2013). Water quality is one of the most important limiting factors in fish production where it directly affects feed efficiency, growth rates and overall health status. The most critical water quality parameters in aquaculture production systems are dissolved oxygen, un-ionized ammonia, carbon dioxide, nitrite and nitrate concentration, pH, turbidity and alkalinity levels (Mmochi et al., 2002**;** Tiwari, 2006).

Excretion of nitrogenous compounds by cultured fish and microbial decomposition of organic matter are the main source of ammonium, nitrates, nitrites, phosphates and other inorganic substances (Hall, 1992). High concentrations of carbon dioxide (CO_2), ammonia and other nitrogenous compounds are introduced into the water column after phytoplankton blooms collapse (Mmochi et al., 2002). Most fish kills, disease outbreaks, poor growth, poor feed conversion efficiency and similar management problems are directly related to poor water quality (Barker, 2002).

Manipulations of fish ponds to improve water quality and to enhance fish production require a thorough understanding of the physical, chemical and biological processes taking place to find solutions to increase the fish production (Pereira, 2004). Also, the relationship between the water quality parameters and cultivated fish species is of great importance and basically essential in fish culture (Batran, 2014).

2.4.1.Water physico-chemical factors

Temperature: Water temperature may be the single most important factor affecting the welfare of fish. Fish are cold-blooded organisms and assume approximately the same temperature as their surroundings. The temperature of the water affects the activity, behavior, feeding, growth, and reproduction of all fishes. Metabolic rates in fish double for each -7.7 ºC rise in temperature. Fish are generally categorized into warm water, cool water, and cold water species based on optimal growth temperatures. In their natural environment, fish can easily tolerate the seasonal changes in temperature, e.g. a decrease to 0 °C in winter and increase to 20–30 °C (depending on fish species) with young fry, problems may arise even where the difference in temperature is as low as 1.5–3 °C (FAO, 1993).

Tolerable to pond culture fish is 30-35 ºC (Delince, 1992). the levels of temperature as 28-32 ºC good for tropical major carps <12 ºC – lethal but good for cold water species; and > 35 ºC- lethal to maximum number of fish species (Bhatnagar et al., 2004) and according to (Santhosh and Singh ,2007) suitable water temperature for carp culture is between 24 and 30 ºC (Bhatnagar and Devi, 2013).according FAO the optimum temperature of growing is between 20 and 25 ^{o}C (FAO, 2017b).

Dissolved oxygen (DO): Different fish species have different requirements for the concentration of oxygen dissolved in water, typically reported in units of ppm. Cyprinids are less demanding; they can thrive in water containing 6–8 mg per liter and show signs of suffocation only, when the oxygen concentration falls to 1.5–2.0 mg per liter (FAO, 1993). The oxygen requirements of fish also depend on a number of other factors, including the temperature, pH, and CO_2 level of the water, and the metabolic rate of the fish. The major criteria for the oxygen requirement of fish include temperature, and the average individual weight and the total weight of fish per unit volume of water. Oxygen requirements increase at a higher temperature (e.g. an increase in water temperature from 10 to 20 °C at least doubles the oxygen demand; a higher total weight of fish per unit volume of water can lead to increased activity and thus increased respiration as a result of overcrowding (FAO, 1993).

Oxygen level drops below the required minimum level will cause the fish to become stressed. It is this stress which causes fish death. More than that, fish reduce food intake, leading to a reduction in growth, reproduction is inhibited, and both fertilization success and larval survival are compromised. When the oxygen level is maintained near saturation or even at slightly super saturation at all times it will increase growth rates. As the dissolved oxygen concentration decreases, respiration and feeding activities also decrease. As a result, the growth rate is reduced and the possibility of a disease attack is increased. However, fish is not able to assimilate the food consumed when DO is low (Mallya, 2007).

While the temperature and salinity increases, the solubility of oxygen in the water decreases. It is for this reason that aeration can be used as an option during summer months especially in areas where the aquaculture activity is intense to avoid fish kills. Decomposition of organic materials is the greatest consumer of oxygen in the system. Therefore food wastage and feed quality should be monitored as both significantly affect the levels of dissolved oxygen in the system (Pilminaq, 2008).

pH: The pH is interdependent with other water quality parameters; the pH can also affect fish health. For most freshwater species, a pH range between 6.5- 9.0 are ideal, but most marine animals typically cannot tolerate as wide range pH as freshwater animals, thus the optimum pH is usually between pH 7.5 and 8.5. Below pH 6.5, some species experience slow growth (Pilminaq, 2008). At approximately pH 4.0 or below and pH11 or above, most species die. The pH of pond water increases daily as phytoplankton consume carbon dioxide during photosynthesis (reaching a maximum value near 6 pm), and decreases at night as they release carbon dioxide during respiration (reaching a minimum value near 6 am). Indirectly, changes in pH can also affect aquatic organisms. In fish ponds, the low pH levels can accelerate the release of metals from rocks and sediments. These metals can affect the metabolism of the fish and its ability to take up water through the gills. Moreover, low pH can reduce the amount of dissolved inorganic phosphorous and carbon dioxide available for phytoplankton during photosynthesis (Pilminaq, 2008). The optimal pH range for fish is from 6.5 to 8.5 pH values above 10.8 and below 5.0 may be rapidly fatal to cyprinids. Water pH can also be changed when mineral acids and hydroxides, or other acidic or alkaline substances, are discharged or leach into water courses, ponds or lakes (FAO, 1993).

Electrical conductivity (EC): (EC) is a measure of how well a solution conducts electricity and is correlated with salt content. Conductivity is typically reported in units of (µs/cm) (micro siemens per centimeter). Freshwater fish generally thrive over a wide range of electrical conductivity. Some minimum salt content is desirable to help fish maintain their osmotic balance (Nathan and Thomforde, 2004).

Conductivity of water depends on its ionic concentration (Ca^{2+}, Mg^{2+}, HCO_3^-, CO_3^-, NO_3^- and PO_4^-), temperature and on variations of dissolved solids. Distilled water has a conductivity of about 1 µs/cm and natural waters have conductivity of 20-1500 µs/cm. Conductivity of freshwater varies between 50 to 1500 µs/cm (Boyd, 1979), but in some polluted waters it may reach 10,000 µs/cm and seawater has conductivity around 35.000 µs/cm and above. As fish differ in their ability to maintain osmotic pressure, therefore the optimum conductivity for fish production differs from one species to another, a conductivity range of 3.8 -10µs/cm as extremely poor in chemicals, the desirable range 100-2,000 µs/cm and acceptable range 30-5000 µs/cm for pond fish culture (Bhatnaga and Devi, 2013).

Salinity: Salinity plays an important role in the growth of culture organisms through osmoregulation of body minerals from that of the surrounding water, typically reported in units of ppm. Salinity is defined as the total concentration of electrically charged ions (cations – Ca^{++}, Mg^{++}, K^+, Na^+ ; anions – CO_3^-, HCO_3^-, SO_4^-, Cl^- and other components such as NO_3^-, NH_4^+ and PO_4^-). Salinity is a major driving factor that affects the density and growth of aquatic organism’s population. Fish are sensitive to the salt concentration of their waters and have evolved a system that maintains a constant salt ionic balance in its bloodstream through the movement of salts and water across their gill membranes ,it have given desirable range 2 ppt for common carp (Bhatnaga and Devi, 2013).

Total dissolved solid (TDS): Total Dissolved solids refer to those materials dissolved in the water, such as, bicarbonate, Sulphates, phosphate, nitrate, calcium, magnesium, sodium, organic ions, and other ions, typically reported in units of ppm. These ions are important in sustaining aquatic life. However, high concentrations can result to damage in organism's cell, water turbidity, reduce photosynthetic activity and increase the water temperature (Pilminaq, 2008). Factors affecting the level of dissolved solid in water body are urban and fertilizer run-off, wastewater and septic effluent, soil erosion, decaying plants and animals, and geological features in the area. However, this kind of criteria can be ambiguous. The totality of the contribution of all effluents such us(uneaten feeds, fishes fecal matters, agricultural run-off, etc.) will be difficult to detect using percentage increase since their impact will not be spread out evenly in the water body (Pilminaq, 2008).

Hardness: Is a measure of the calcium and magnesium concentrations in water. Other divalent ions (those with 2+ charges) contribute to total hardness but are usually present in insignificant typically reported in units of ppm. The amount of calcium hardness is important in pond fertilization because higher rates of phosphorus fertilizer are required at higher calcium hardness concentrations. At least 5 mg/l of calcium hardness is needed in fish hatchery water supplies (Nathan and Thomforde, 2004).

Ammonia (NH_3): Ammonia is the initial product of the decomposition of nitrogenous organic wastes and respiration, typically reported in units of ppm. Nitrogenous organic wastes come from uneaten feeds and excretion of fishes. Thus, the concentration of ammonia-N is positively correlated to the amount of food wastage and the stocking density. High concentrations of ammonia causes an increase in pH and ammonia concentration in the blood of the fish which can damage the gills, the red blood cells, affect osmoregulation, reduce the oxygen-carrying capacity of blood and increase the oxygen demand of tissues (Lawson, 1995). Generally NH_4^+ is harmless and can dissipate into the atmosphere easily, however NH_3 can be extremely toxic. Its toxicity was found out to be directly correlated with temperature and pH. Ammonia levels increases as the temperature and pH increases (Pilminaq, 2008). The final product of nitrogen metabolism in carp (as it is in other species) and most of it is excreted via the gills into the water. If the diffusion rate is reduced for some reason or another (high water pH, oxygen deficit, damaged gills etc.), the ammonia level in the blood will steadily rise, causing a condition known as autointoxication, which may lead to toxic gill necrosis in carp (FAO, 1993).

Nitrite (NO_2): Nitrite is an intermediate product of the aerobic nitrification bacterial process, produced by the autotrophic *Nitrosomonas* bacteria combining oxygen and ammonia, typically reported in units of ppm. Nitrite can be termed as an invisible killer of fish because it oxidizes hemoglobin to methemoglobin in the blood, turning the blood and gills brown and hindering respiration also damage for nervous system, liver, spleen and kidneys of the fish (Bhatnaga and Devi, 2013). The toxicity of nitrite is dependent on chemical factors such as the reduction of calcium$^-$, chloride$^-$, bromide$^-$ and bicarbonate ions, and levels of pH, dissolved oxygen and ammonia. One example is the culture of milkfish in freshwater, wherein nitrite is 55 times more toxic than in brackish and marine water (Pilminaq, 2008). The ideal and normal measurement of nitrite is zero in any aquatic system. the desirable range 0-1 mg/l NO_2 and acceptable range less than 4 mg L-1 NO_2,0.02-1.0 ppm is lethal to many fish species, >1.0 ppm is lethal for many warm water fishes and <0.02 ppm is acceptable (Bhatnaga and Devi, 2013).

Nitrate (NO_3): Nitrate is formed through nitrification process, oxidation of NO_2 into NO_3 by the action of aerobic *Nitrobactor* bacteria, typically reported in units of ppm. Nitrate not taken up directly by aquatic plants is denitrified in anaerobic sediments and microzones (Pilminaq, 2008). Nitrate levels in drinking water for humans and livestock are a major concern. Typical levels in surface waters range from 0.005 to 0.5 mg/l nitrate. However, nitrate is relatively nontoxic to fish and is not a health hazard except at exceedingly high levels (above 90 mg/l NO_3-N) (Philomena, 2012).

Chloride: Chloride (Cl^-) together with sodium (Na) forms common salt (sodium chloride), typically reported in units of ppm. Chloride is a common component of most waters and is beneficial to fish in maintaining their osmotic balance. In commercial catfish, carp, tilapia production, chloride (in the form of salt) is often added to waters to obtain a minimum concentration of 60 mg/l. A ratio of chloride to nitrite of 10:1 reduces nitrite poisoning. High chloride levels (above 100 mg/l) are a concern only if the water is also used to irrigate sensitive land-based crops (Nathan and Thomforde, 2004).

Phosphate (PO_4): Among the common sources of phosphorous are wastewater and septic effluents, detergents, fertilizers, soil run-off (as phosphorous bound in the soil will be released), phosphate mining, industrial discharges, and synthetic materials which contain organophosphates, such as insecticides. Aquaculture farms located near these sources can expect to have higher concentrations of phosphates in the water bodies. Total phosphorus associated with suspended matter in unpolluted tropical rivers normally ranges between 620 – 1860 µg/l (Pilminaq, 2008). Phosphate level of 0.06 mg/l is desirable for fish culture, 0.05-0.07 ppm is optimum and productive (Bhatnaga and Devi, 2013).

Sulfate (SO_4): Sulfate is a common compound found in water as a result of the dissolution of minerals from soil and rocks. Typical levels are between 0 and 1,000 mg/l. Fish tolerate a wide range of sulfate concentrations, and levels of sulfate above 500 mg/l are a concern only if the water is used for other purposes, such as watering cattle (Nathan and Thomforde, 2004).

2.5. Fish Production in Earthen Ponds and Their Impacts on Fish Meat Quality

Semi-intensive production was concerned to be one of the least polluting. This fact has been reassessed especially in many countries culturing carp. One of the most significant influences on a fish pond ecosystem in semi-intensive carp production is changing its characteristics by adding low quality supplemental feeding. Therefore, the type of fish feed, its physical and chemical characteristics can considerably change the water quality of a fish pond (DULIC et al., 2010). Fish consumption is steadily increasing world-wide and fish is being promoted as healthy and beneficial for human health. Nutrients in fish and other aquatic organisms that are recognized as characteristic for these foods and that are important for human health are proteins, lipids, especially the n-3 polyunsaturated fatty acids (n-III PUFA), vitamins D and B12, antioxidants such as astaxanthin and some trace elements, like selenium, iodine. Altogether, these compounds make fish consumption an important source of beneficial bioactive compounds in human nutrition. EPA and DHA are therefore misleadingly called marine fatty acids or fish fatty acids. These n-3 HUFA are to a large degree synthesized by microalgae, both in freshwater and saltwater, and transported via the food chain in the systems (Mraz, 2012).

Meat quality of carp are differences mostly caused due to the analysis of fish of different age, breeding systems and food, and because of that there are wide ranges of fat content in carp from 2.3 to 16.8 % (Miroslav, 2011; Ljubojevic et al., 2012) while varying slightly less in case of protein which content is in range from 14 to 20 % (Trbovic, 2009; Cirkovic, 2010).

Common carp fed exclusively with natural food from fish-pond shows a significant level of total n-3 and n-6 fatty acids (Cirkovic, 2010). Supplementary feeding with grains leads to reduced amounts of these essential fatty acids and this is due to the lower proportion of natural food in the diet of the carp which received additional grain (Miroslav, 2011). The energy value of fish meat is directly proportional to fat content. Essential fatty acids affect the fluidity, flexibility, and permeability of membranes. They are precursors of the eicosanoids and are necessary for maintaining the impermeability barrier of the skin. They are also involved in cholesterol transport and metabolism (Steffens, 2005).

The development of fatty tissues associated with growth of carp is stimulated by the use of lipid-enriched or high-energy artificial diets. Fat is accumulated in specific adipose tissues and the analysis of the relative development of these tissues could give valuable information on the over-accumulation of fat and its distribution in the whole body. Accumulation of fat has either positive or negative consequences for sensory evaluation depending on the source and the composition of fat. Different muscle tissues comprising different fiber types are found in cyprinids. These tissues together with adipose tissues compose the edible part of carp and explain most of protein retention (Benoit Fauconneau, 1995).

The common carp is covering its nutrient demands mostly from the pond bottom thus it was hypothesized that its characteristics have a profound effect (directly via its consumption and indirectly through the water) on the carp meat quality (Varga et al., 2010).

However the borrowing habit of common carp makes pond water turbid and muddy which decreases the transparency and light penetration into water, which in turn not only hampers photosynthesis and primary pond productivity but also reduces visibility necessary to search for food. This ultimately negatively effects fish growth and the overall fish production. Slow growth of common carp is also attributed to genetic deterioration due to consistent breeding of existing stocks since decades. On the other hand, common carp fetches a relatively low price on the market when compared with other carps (Khan et al., 2016).

Total protein content in cereals grains is different depending on the plant species ranging between 7 and 15 % (Przybyl, 2004; DULIC et al., 2010). These proteins are poor in essential amino acids for fish and have anti-nutritional agents (chemical compounds naturally occurring in grains which can disturb the regular metabolism in fish). Use of good quality pelleted and especially extruded feed, has proven to be less expensive, can minimize water pollution and spread of diseases owing it to high digestibility, low conversion rate better fish growth, less organic waste per kg of fish produced (DULIC et al., 2010).

Technology of production and composition of planktonic and benthic organisms in fish ponds have been recognized as significant factors affecting carp meat quality and desirable chemical and fatty acid composition. Carp meat quality also production parameters and fish health are positively influenced by a balanced feed mixture. Due to the low content of saturated fatty acids and cholesterol plus high levels of unsaturated fatty acids, common carp meat consumption could be linked with reduced risk of different heart diseases in humans. Also, fish proteins can have many beneficial roles in the preservation of human health (Ljubojevic et al., 2017).

The additional chicken manure alone was effective to stimulate productivity with conductive range of water quality and growth of fish without affecting proximate composition of fish meat. Farmers can get double benefit in introducing the common carp in the pond as it increases the availability of nutrients for phytoplankton which in turn enhances fish production. *Cyprinus carpio* has the ability to survive under various climatic conditions and is found to be most suitable for many fish farming systems (Kaur et al., 2015).

3. MATERIALS AND METHODS

3.1. Materials

3.1.1. Description of studied area Ranya (Raparin Administration)

Ranya is a town located in north of Iraq , 130 kilometers (81 mi) northwest of Sulaimaniya Governorate (36°15'16.26"N, 44°52'59.79"E). Ranya is surrounded by three mountain, the Kewarash at the northern, the Asos at eastern the Hajila at western and Dukan Lake at southern. Ranya with Pshdar Zone (Include Qaladze district with Sangasar, Zharawa, Esewa, Hero ,Halsho Sub-Districts), at its east Bitwen zone (Include Chwarqurna, Hajiawa Sub-Districts) at south western Betwata zone (Include Saruchawa Sub-District with Khoshnawaty valley) at northern west are called Raparin administration, it area cover about 2214 km² and it perimeter 308 Km, it has international boundary with Iran at east of Qaladze district its 55Km far from Ranya central. However Raparin zone has best agriculture land and touristic places it has also many Orchard at mountain and valley, Rivers, lake, dyke, Brooks, watersheds as shown in (Figure 3.1) (Khalid, 2010).

3.1.2. Description of studied fish farms

Survey was took 20 days completely from 26 March to 16 April- 2017 however all ponds had pathway but it was raining season, some ponds were not constructing some of them were empty, or waiting marketing shift, etc. But asking villagers took most time because they were answering carefully.

The first location located at 36°9'2.95"N, 45°7'24.40"E in Khase village in Qaladze district it also near Little Zab use (S.W) as water resource, it's include 5 ponds the first one farming fish of last year 20mx100m the other fourth are 5000m^2 two of them water were mixed with other and last one fish farmed at later, the maximum depth of water were 130cm and 90 cm for shallow.

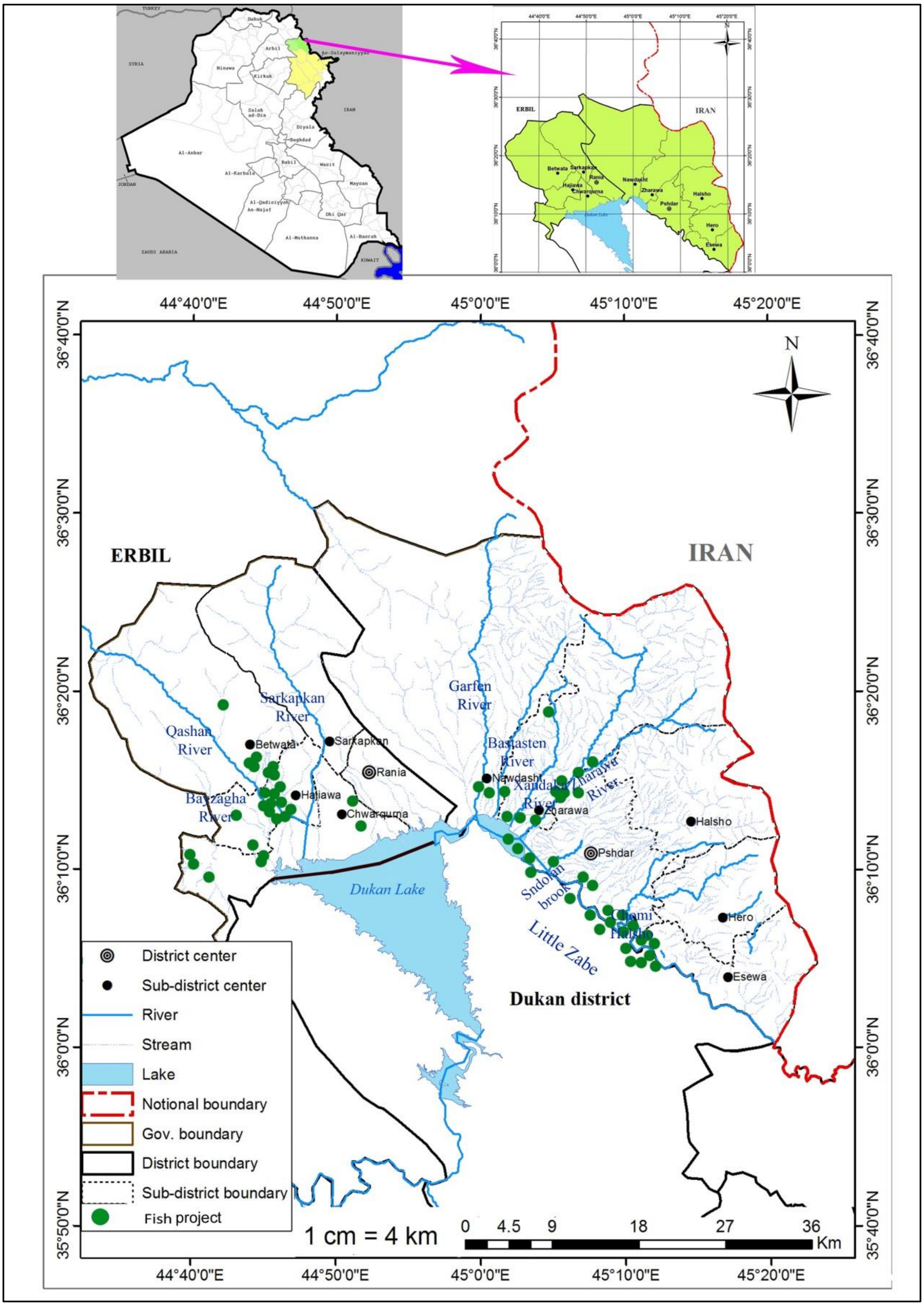

Figure 3.1. Map of study area explaining area, district and sub-district, river, ponds location (GIS, 2017).

Figure 3.2. Satlaite map showing sampling locations.

Totally had 23 feeders and 7 aerators, three of them 3500 fishes half hand size 45-53g were farmed in 5-Mrch-2017, fourth one beside of guard house 2000 fishes farmed at late April, at the north of pond Hill and road was found at both east and west side there are agriculture land and brooks at 500m distance western side other fish farm is found, at southern by 1000m there are quarry and Little Zab.as shown in (Figure 3.2; Figure 3.3 ; Figure 3.4).

The second location located at 36°14'3.20"N, 45° 5'31.43"E in Kawe-Babasan village in Qaladze sub-district, they use brunch from Zharawa River as water resource for pond as shown in (Figure3.2; Figure 3.3), river at nothern coming frome mountain and valley at thouthern by 7km mixing with Little Zab, at all line of river which is suitable for agriculture were planted by many kind of vigitable,

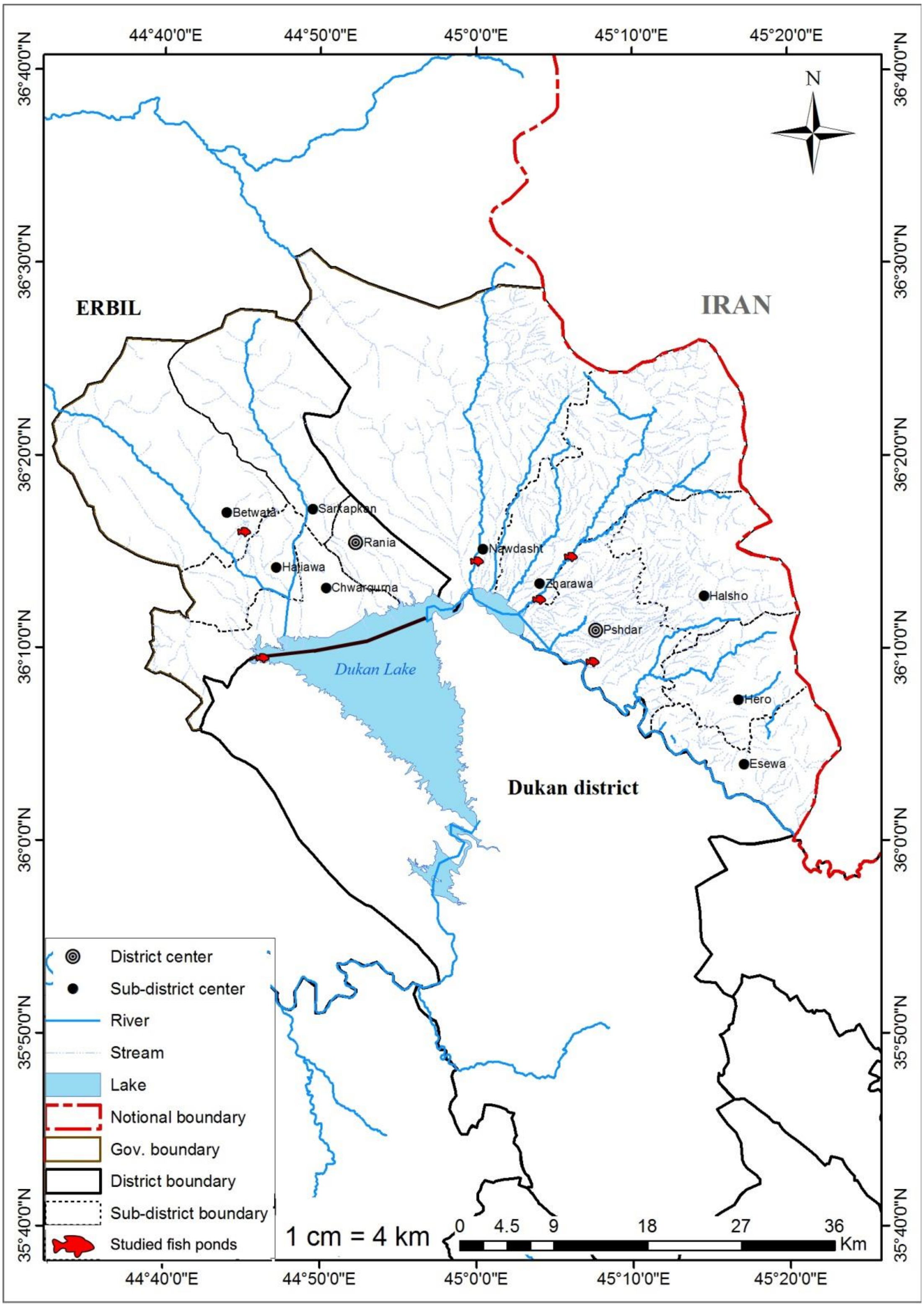

Figure 3.3. The map showing sampling locations in study area (GIS, 2017).

Figure 3.4. Showing fish farm at first location in Qaladze/khase village.

1km at northern of pond a poultry farm was found and in 7 km Rishawan village the villiger was busy with farming and cattle. In both east and west there were sesonal crop is plantting but they were only land all over summer and autumn. However there were many farming ponds around it tow of them at northern have last years product, at estern they were four ponds tow of them were mixed with bigger fish farming pond and mix with , and tow other ponds were dry they farmed later as shown in (Figure 3.5), at sothern by 700m it was Kawey–babasan vilage and at 2.5km it was Zharawa sub-district.

This farm include one pond 2500m^2 maximum depth was 80cm and 40-50cm for shallow, it was farmed 3000 half hand size 60g in 2April 2017, it had 11feeders and 2 aerators as shown in (Figure 3.2; Figure 3.5).

Third location located on Kalsoanan village in Zharawa sub-district at 36°12'29.72"N, 45° 3'28.44"E use stream from Zharawa River and surface will as water resource for pond, its directly at the down of Kalsonan village, at northern by 2km its Zharawa sub-district, 2km at southern its Little Zab as shown in (Figure 3.3;Figure 3.6), it was also located on Zharawa river line in both side sesonal crop was planted, on whole line of Zharawa river was planted by summer vegetables like bean, okra,rice..ect.

Figure 3.5. Showing fish farm at second location in kawy-babasan village.

This farm include three ponds 3600m^2,2700m^2,2400m^2 had 15 feeders and 7 aerators, 6100 half size hand fishes 50g were farmed in 24March-2017, maximum depth of ponds 90cm and 50cm for shallow, the bigest one stocking denisty 3000, 1600, 1500 fishes continusly, the stream was inlet directly it also use surface will water in hot days to decreas teamprature of water other two pond mix farmed with bigger fish and new farm .also some time mix in water pond.

The fourth one located on southern Sangasar sub-district at 36°14'24.19"N, 44°59'52.04"E as shown in (Figure 3.3; Figure 3.7), it use stream from Gafren River and surface will as water resource for ponds. its located on Gafren river line at northern had one poultry farm with small orchard directly, toward northern in 700m were Sangasar and Twasuran Sub-districts, 900m a quarry, at 3km one trout fish farm.

At other side of river by a few meter at northern other fish breeder and seller was found, toward southern on higher place by 700m other poultry farm and lands with planted by summer vegetable, in 3km its Little Zab. This farm include 3 ponds 102m x 45m stocking density 3000, 2500 fish per ponds in 4March 2017, other one has last year fish.

Figure 3.6. Showing fish farm at third location in Kalsonan village.

The biggest one use in stream or surface well directly the both other in directly. Maximum depth of water 100cm and 30cm for shallow. It has 5 aerators with 15 feeders.

Fifth location located on southern Saruchawa village in Betwata sub-district by 2100m at 36°15'58.84"N, 44°45'20.60"E use stream from Saruchawa channel as water resource for pond, in all side there are cultured land by different plants and orchard as shown in (Figure 3.8), by 700m far from north its Saruchawa barrage, at western at other stream side there were many other ponds and cultured land, 1500m far at north and east its Makok mountain. This farm include one pond 5000m^2 stocking density 3200 fishes hand size 65g were farmed in 15 February maximum depth of water 70-100cm and 30cm fore shallow, it has 2 aerators with 5 feeders.

Sixth location located on Darmanaw village in Chwarqurna sub-district at 36° 8'58.52"N, 44°44'51.12"E use spring water as water resource for ponds, were built directly between Baiz Agha river and Darmanaw spring, small orchard land was between pond and spring as shown in Figure (3.9). This farm include three ponds ($33150m^2$) stocking density for each one and 3000 hand size fishes 65g was farmed

Figure 3.7. Showing fish farm at fourth location in Sangasar sub-district.

26April 2017. Maximum depth 180cm and 80cm for shallow. The first one from spring directly but the both other from spring and first pond it has 13 feeders and 4 aerators. At southern side is Darmanaw village directly the villager busy with breeding cattle and sheep, and more its dry land of crop more than that by 2500m its Kosrat mountain.

At eastern are many natural trees were grew on spring stream and river channel. Dukan Lake its far by 1500m, at northern is Qamtaran village the villager also busy with cattle, sheep and poultry. More than that distance is Kanimaran land its cultured by many kinds of summer plant like sunflower, rice, bean, sesame, okra etc. at western by 300 m its Gomaga Natural big pond and more by 1km it was other fish farming. (Figure 3.9) showing method study on six ponds in different position with different water source

Figure 3.8. Showing fish farm at fifth location in Saruchawa sub-district.

Figure 3.9. Showing fish farm at sixth location in Darmanaw village.

3.2. Methods

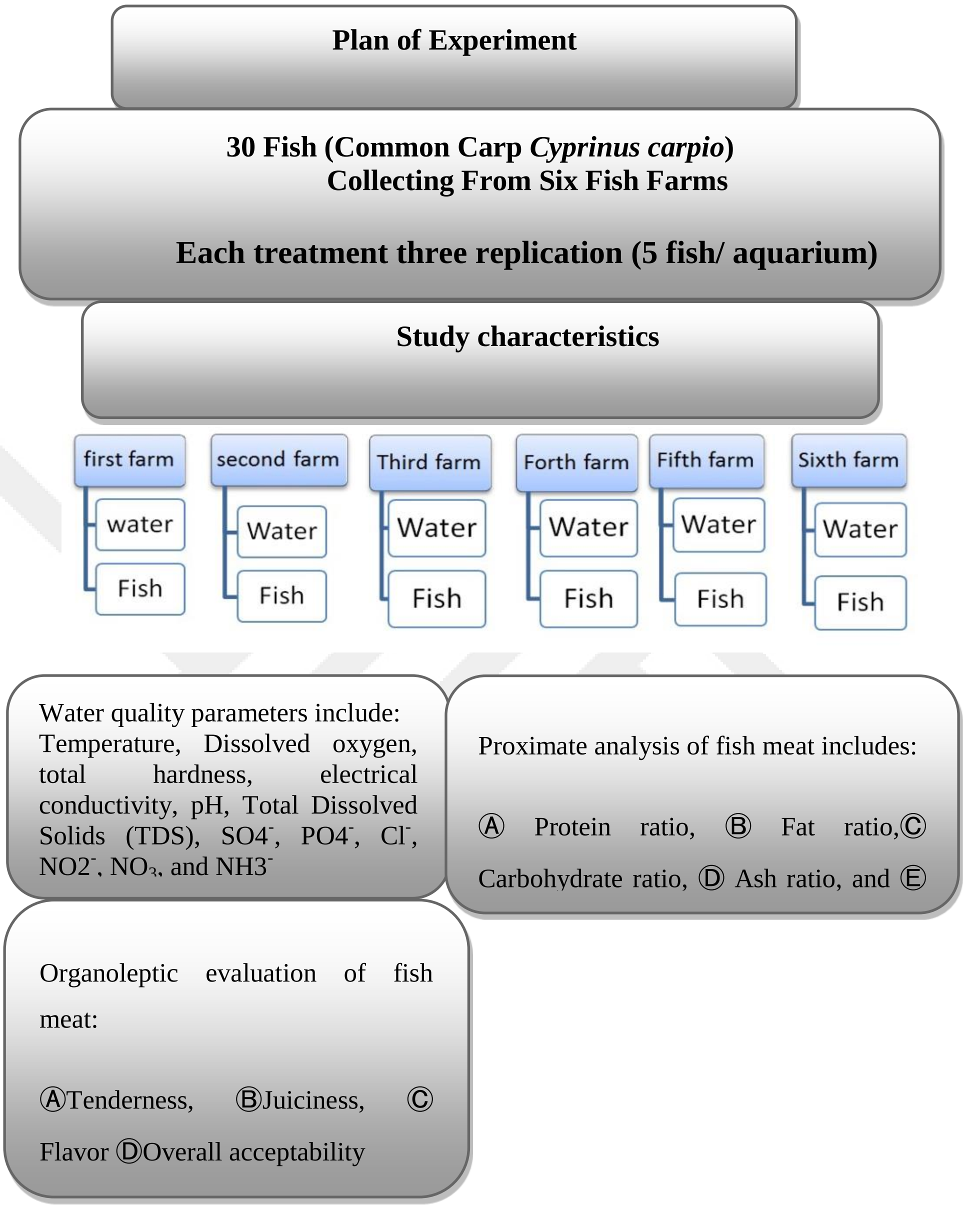

Figure 3.10. Study planning and processing data collection

3.2.1. Studied physio-chemical parameters in pond water

Water samples collection was took at 2pm-6pm in 30-35 cm depth via study period monthly for five months (May to September) in dark bottles kept in EPS box with icepacks.

Water temperature: measured by simple mercury thermometer 0-100ºC on ponds directly.

Dissolved oxygen (DO) measured on ponds directly by Water Quality meter (86031AZ).

pH measured on ponds directly by (Multi 3420SET C) German manufacture and (86031AZ).

Electric conductivity (EC) measured on ponds directly by (Multi 3420SET C) and (86031AZ).

Salinity (Sa) measured on ponds directly by (Multi 3420SET C) and (86031AZ).

Total dissolved solid (TDS) measured on ponds directly by (Multi 3420SET C) German (86031AZ) Taiwan manufacture.

Chloride (Cl) measured by Ion Chromatography System (Dionex, 2005).

Ammonia (NH3) measured by Wanklyn method.

Nitrite (NO2) measured by Ion Chromatography (Dionex, 2005).

Nitrate (NO3) measured by Ion Chromatography system (Dionex, 2005).

Phosphate (PO4) measured by Ion Chromatography System (Dionex, 2005).

Sulphate (SO_4) measured by Ion Chromatography System (Dionex, 2005).

Hardness, took 20ml of sample, add 2ml buffer pH10 (ammonium chloride+ ammonia), add 3 drops of EBT (Erochrome Black T), Titrate with 0.01 EDTA carefully to knowing used volume until color changing from violet to blue.

Hardness equation (ppm) $=\frac{\mathbf{A\ x\ B\ x\ Cx1000}}{\mathbf{volume\ of\ sample}}$ (Equation 3.1)

A= molarity of EDTA (0.01) B= used volume of EDTA

C= molecular weight $CaCO_3$ (100) (Schwarzenbach, 1969).

3.2.2. Fish sampling

The proximate analysis for fish meat were don for six pond position (S) for each pond 5 fishes were took randomly by thrown net. In order to detect the nutritional value of fish meat as chemical composition and organoleptic evaluation should be taken along with the chemical composition of the feed given to the reared fish. All fish samples were used for the chemical analysis of the muscle (Moisture %, crude protein %, ether extract % and ash %) according to (AOAC, 2000) analytical methods.

3.2.3. Proximate analysis of fish meat

3.2.3.1. Moisture ratio

Evaluating of Moisture content was determined by drying samples in oven at 120ºC for 24 hours to steady weight (AOAC, 2000).

3.2.3.2. Fat ratio

The Soxhlet method for determining crude fat content, the solvent extraction step alone takes six hours (AOAC, 2000).

3.2.3.3. Protein ratio

Determination of the crude protein by Kjeldahl method (büchi autokjeldahl unit k-370) (Application Note 2006,Distillation Unit K-355) by calculating the total nitrogen content in the sample after digesting a known weight with concentrated sulfuric acid, distillation with boric acid and hydrochloric acid correction, then multiplying the nitrogen value by (6.25) (AOAC, 2000).

3.2.3.4. Ash ratio

Ash was determined by combustion at 550 ± 25 ºC (AOAC, 2000).

3.3. Organoleptic Evaluation of Fish Meat

Sensory analyses will be performed by a panel of seven experienced assessors. The fish meat fillets specimens are placed in open aluminum boxes and cooked for 15 minutes in an oven pre-heated at 180°C (Appleton and Wisconsin, 1982), (AOAC, 2000) each member of the panel will filled a sensory evaluation table, the will recording evaluation points in table, as shown in (Table 3.1).

Table 3.1. Organoleptic (Sensory) evaluation table for common carp meat reared in different ponds.

Treatments	Tenderness	Juiciness	Flavor	Overall acceptability
T1				
T2				
T3				
T4				
T5				
T6				

5 =extremely like; 4 = like; 3 = neither like nor dislike; 2 = dislike; 1 = extremely dislike

3.4. Statistical Analysis

Analysis of variance is conducted using the general linear models (GLM) procedure of XLSTAT. Pro. 7.5 one way (ANOVA). Fisher's L.S.D test's was used to compare between means of the control and experiment treatments. The model of analysis was as follows:

$$Yij = \mu + Ti + Eij \qquad \text{(Equation 3.2)}$$

μ = The overall mean, *Ti*= The effect of treatment, *Eij*= The random error

3.5. Second Experiment

A survey must be done to evaluate fish production in Iraq, and the survey form will be focus on five sectors as the following:

3.5.1 . General information of the fish projects and farmers

3.5.1.1. Investment costs

Pond number, area of each pond, area of the project, costs, cost of each pond, number and costs of the dykes, number and costs of the feeders, Equity capital in the projects, managements and observer in the projects.

3.5.1.2. Operating costs

The number of employees in the project, monthly wage per worker, duration of work, the number and wage of guards.

3.5.1.3. Fingerlings used

Stocking density, average weight of the fingerlings, cost of the fingerlings, weight gain, and mortality.

3.5.1.4 . Feeding frequency

Daily feeding frequency, type of the feed, amount and cost of the feed, type of feeding, amount and cost of feeding in the season, feeds formula.

3.5.1.5. Treatments and disinfections used during production season

Type, way and cost of each treatments and disinfections used for diseases and fish enemies' control.

3.5.1.6. Revenues and incomes

Mean fish weight at market size, price of one kilo, number/ amount of harvest.

4. RESULTS AND DISCUSSION

4.1. Chemical and Physical Parameters

4.1.1. Water temperature

In five months studied period from May to September different degree were recorded the air temperature were 30, 37, 38, 36, 32ºC respectively, for (IW) maximum water temperature was 32 ºC at July in third pond (S_3) and minimum was 14 ºC at May in s (S_2, S_4), for (PW) maximum temperature was 31 ºC at June for fourth pond (S_4), July for (S_1, S_2, S_4) and minimum was 21 ºC at September in sixth pond (S_6), as shown in (Table 4.1).

Table 4.1. The temperature value range of IW and PW of ponds.

Months	(IW) ºC						(PW) ºC					
	S_1	S_2	S_3	S_4	S_5	S_6	S_1	S_2	S_3	S_4	S_5	S_6
May	17	14	17	14	16	18	26	24	26	25	25	23
June	18	28	28	27	17	20	28	29	29	31	29	26
July	18	30	32	26	18	19	31	31	30	31	27	25
August	18	26.5	21.5	27	21	21	26	27	26	29	28	26.5
September	18	25	23	20	19	20	23	23	23	23	22	21
Average	17.8	24.7	24.3	22.8	18.2	19.6	26.8	26.8	26.8	27.8	26.2	24.3
Minimum	17	14	17	14	16	18	23	23	23	23	22	21
Max	18	30	32	27	21	21	31	31	30	31	29	26.5

According to (FAO, 1993) in their natural environment, fish can easily tolerate the seasonal changes in temperature, e.g. a decrease to 0 °C in winter and increase to 20–30 °C (depending on species). The optimum temperature of growing is between 20 and 25 ^{o}C (FAO, 2017b), Common carp live in the temperature range of 3–35 ^{o}C. The optimum water temperature for growth and propagation is 20–25 ^{o}C (FAO, 2018), according to (Bhatnagar and Devi, 2013) acceptable range for carp is 15-35 ^{o}C and optimum temperature is 20-30 ^{o}C but <12, >35 are lethal. According to Santhosh, (2007) optimum temperature for carp culture 24-30 ^{o}C.

At may however the weather temperature 30 ^oC but IW for S_2,S_4 about 14 ^oC it was refer to both of water sources coming from mountains and coldest area and the snow was starting malting, the highest water temperature 30, 32 ^oC in both (S_2, S_3) at July weather was 38 ^oC around farming area but in some place far from river and cultured land reached 50 ºC the weather directly have effect on water temperature, also the farming seasons were decreasing water amount until after good raining season, other reason in that time most lands were cultured by summer vegetable and using water for irrigation the incoming water was low at day and increase at night, for (PW) the minimum temperature was recorded at September in sixth pond (S_6) because it has maximum from spring near farm 12inch of 20C^o and 22 ^oC for pond in fifth (S_5) it in let water temperature was 19 ^oC. The highest temperature was recorded mostly at Jun and July because of high weather temperature and decreasing water changing in the days shown in (Table 4.1).

4.1.2. Dissolved oxygen (DO)

In (Table 4.2) the maximum value for (IW) was10.42 ppm at May in second pond (S_2) and minimum was 6.12 ppm at Jun in sixth pond (S_6) for (PW) the maximum value was 9.31ppm at May in third pond (S_3) and minimum was 3.81ppm at July in third pond (S_3).

Table 4.2. The DO value range of (IW) and (PW) of ponds.

Months	(IW)DO(mg/l)						(PW)DO(mg/l)					
	S_1	S_2	S_3	S_4	S_5	S_6	S_1	S_2	S_3	S_4	S_5	S_6
May	6.73	10.42	8.68	10.34	9.63	8.43	8.92	8.22	9.31	7.35	6.83	7.59
June	7.82	7.92	7.53	7.82	8.85	6.12	7.42	6.43	6.22	5.12	7.12	5.32
July	7.46	7.32	6.65	6.34	9.45	7.78	3.81	4.68	6.45	4.83	5.23	5.12
August	7.26	7.89	7.45	7.68	7.74	6.34	5.34	6.38	5.11	5.93	5.46	5.12
September	6.93	8.11	7.64	8.68	9.11	7.89	5.15	5.45	6.59	5.79	6.02	5.08
Average	7.24	8.332	7.59	8.172	8.956	7.312	6.128	6.232	6.736	5.804	6.132	5.646
Minimum	6.73	7.32	6.65	6.34	7.74	6.12	3.81	4.68	5.11	4.83	5.23	5.08
Max	7.82	10.42	8.68	10.34	9.63	8.43	8.92	8.22	9.31	7.35	7.12	7.59

According to Santhosh (2007) the major source of DO coming from phytoplankton and plant in photosynthetic activity, and dissolving some amount of oxygen from atmosphere in by simple diffusion, agitation and turbulence on water surface make faster diffusion. However with increasing temperature of water the solubility of oxygen will decreasing, according to (FAO, 1993) Cyprinids are less demanding for DO they can growing in water containing 6–8 ppm and show signs of suffocation when the oxygen concentration falls to 1.5–2.0 ppm, according to (Bhatnagar and Devi, 2013) 3-5 ppm is desirable range <3, >8 make stress. The oxygen requirements of fish depend on a several factors, including the temperature, pH, and CO_2 level of the water, and the metabolic rate of the fish.

The major criteria for the oxygen requirement of fish include temperature, and the average individual weight and the total weight of fish per unit volume of water. in May to September air temperature were 30, 37, 38, 36, 32ºC respectively expect increasing of live weight mass of fish and demanding more oxygen use. in 3 pond s noticed low value, at May first pond (S_1) and (PW) minimum was 3.81 caused to suffocation of 600 fish in 2Kg weight of last year breeding in different pond by electric power off after mid night for 9 hours and stopping aerators, but for the pond took water sample caused to make stress on them with no dead. Also same problem occurred to water pond (S_2, S_4) as shown in (Table 4.2).

4.1.3. pH

In both and as shown in (Table 4.3) there were no big changing in value of pH and causing stress on fish farming. The maximum value for (IW) was 8.443 at Jun in second pond (S_2) and minimum value was 7.115. For (PW) the maximum value was 8.875 in first (S_1) at Jun and minimum value was 7.481.

The optimum pH range for fish is from 6.5 to 8.5 pH values above 10.8 and below 5.0 may be rapidly fatal to cyprinids (FAO, 1993), 6.5 - 9 desirable range <4, >11 make stress (Bhatnagar and Devi, 2013), 6.7-9.5 range for carp culture, and optimum range is 7-8.5 (Santhosh, 2007). High alkaline pH can occur in eutrophic reservoirs (ponds) where the green plants (the blue-green algae, green algae and higher aquatic plants) take up considerable amounts of CO_2 during the day for intensive photosynthetic activity (FAO, 1993).

Table 4.3. The pH value range of (IW) and (PW) of ponds.

Months	(IW) pH						(PW) pH					
	S_1	S_2	S_3	S_4	S_5	S_6	S_1	S_2	S_3	S_4	S_5	S_6
May	7.51	7.81	7.89	7.71	8.04	7.64	8.78	8.08	7.94	7.72	7.77	7.78
June	7.47	8.44	8.07	8.01	7.8	7.47	8.87	7.97	7.97	7.91	7.74	7.91
July	7.54	7.81	7.93	7.83	7.96	7.55	7.6	7.56	7.84	7.72	7.61	7.67
August	7.51	7.75	7.75	7.62	7.11	7.60	7.61	7.84	7.70	7.64	7.82	7.98
September	7.49	7.94	7.56	7.51	7.80	7.79	7.48	7.68	7.81	7.61	7.88	8.13
Average	7.50	7.95	7.84	7.74	7.74	7.61	8.072	7.83	7.85	7.72	7.768	7.900
Minimum	7.47	7.75	7.56	7.51	7.11	7.47	7.48	7.56	7.70	7.61	7.61	7.67
Max	7.54	8.44	8.07	8.01	8.04	7.79	8.87	8.08	7.97	7.91	7.88	8.13

The maximum value for (IW) was8.443 at Jun in second pond (S2) due to grazing cattle around water stream and minimum was 7.115, For (PW) the maximum value was 8.875 in first pond (S1) at Jun due to electric power cut off for more than 9 hour also there were amount of phytoplankton in pond was growing, that farm used surface well as source of water when power cut water pump stopped water changing also stopping, and minimum value was 7.481. According the international organization and researchers guides there were no big value of pH that making stress on fish growing when comparing average all pond with optimum pH range.

4.1.4. Electric conductivity (EC)

While in five months study and testing both and test the value of EC were plays in desirable value suitable for fresh water fish aquaculture, in the (Table 4.4) showing that there were not any big or lowest values passing through desirable range, for (IW). Maximum value 585 at August in fifth pond (S_5) and minimum value was 228µs/cm at August in third pond (S_3), The maximum value for (PW) in first pond (S_1) at September was 757 µs/cm and sixth pond (S_6) at September and minimum was 233µs/cm in pond S4 at June.

According to (Nathan and Thomforde, 2004) Desirable Range 100-2,000 µs/cm Acceptable Range 30-5,000 µs/cm. 20-1500 µs/cm (Abowei, 2010). Conductivity of freshwater varies between 50-1500 µs/cm (Boyd, 1979)

Table 4.4. Electric Conductivity (EC) µs/cm value range in (IW) and (PW) in different pond (S) in different months.

Months	(IW)EC µs/cm						(PW)EC µs/cm					
	S_1	S_2	S_3	S_4	S5	S_6	S_1	S_2	S_3	S_4	S_5	S_6
May	530	365	375	345	507	408	375	380	280	278	436	433
June	510	271	246	291	558	405	725	260	245	233	542	455
July	516	271	245	328	566	408	557	298	245	290	545	443
August	497	320	228	310	585	408	524	483	242	243	589	757
September	571	290	424	403	582	406	757	336	503	276	505	470
Average	524.8	303.4	303.6	335.4	559.6	407	587.6	351.4	303	264	523.4	511.6
Minimum	497	271	228	291	507	405	375	260	242	233	436	433
Max	571	365	424	403	585	408	757	483	503	290	589	757

Maximum value for (IW) 585 µs/cm at August in fifth pond (S_5) and minimum value was 228 µs/cm at August in pond third pond (S3), the maximum value for (PW) in sixth pond (S_6) at august was 757 µs/cm, ($S_{1)}$ at September was 757 due to salt addition and minimum value was 233µs/cm in fourth (S_4) at June due to increase water level and water flow to decrease water temperature in 31ºC. When we compare the values with other data the ranges were paly in acceptable ranges.

4.1.5. Salinity (Sa)

Salinity is one importance factor for osmoregulation between ionic fish environment and fish body, in (IW) maximum value was 0.2 ppm and minimum value was 0 ppm, highest value of salinity were 0.3 ppm in (PW) as shown in (Table4.5) and minimum value was 0ppm.

In first pond water (S_1) at June and September also pond (S6) at August had 0.3 ppm as maximum range due to salt additional as disinfectant and fourth pond (S_4) and 0 ppm as minimum value in fourth pond (S_4) whole months due to large amount of water flow to ponds to controlling water temperature its due to remove effect of salt additional.

Table 4.5. Salinity (SA) value and ranges in (IW) and (PW) in different pond location (S) in different months.

Months	(IW)SA ppm						(PW)SA ppm					
	S_1	S_2	S_3	S_4	S_5	S_6	S_1	S_2	S_3	S_4	S_5	S_6
May	0.2	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0	0	0.1	0.1
June	0.2	0	0	0	0.2	0.1	0.3	0	0	0	0.2	0.1
July	0.2	0	0	0.1	0.2	0.1	0.2	0.1	0	0	0.2	0.1
August	0.2	0.1	0.1	0.1	0.2	0.1	0.2	0.1	0	0	0.2	0.3
September	0.2	0	0.1	0.1	0.2	0.1	0.3	0.1	0.2	0	0.2	0.1
Average	0.2	0.04	0.06	0.08	0.2	0.1	0.22	0.08	0.04	0	0.18	0.14
Minimum	0.2	0	0	0	0.2	0.1	0.1	0	0	0	0.1	0.1
Max	0.2	0.1	0.1	0.1	0.2	0.1	0.3	0.1	0.2	0	0.2	0.3

4.1.6. Total dissolved solid (TDS)

Total dissolved as other parameter were took in both and. (Table 4.6) showing the maximum value for (IW) was 371 ppm in third (S3) at August and minimum value was149 ppm at July in S3, for (PW) maximum value were 464 ppm in both ponds (S6) at August and (S1) at September and minimum was 143 ppm in fourth (S4) at June.

Table 4.6. TDS value and ranges in (IW) and (PW) in different pond location (S) in different months.

Months	(IW)TDS ppm						(PW)TDS ppm					
	S1	S2	S3	S4	S5	S6	S1	S2	S3	S4	S5	S6
May	315	223	229	211	311	250	225	227	171	170	267	265
June	314	164	151	178	342	249	445	159	150	143	333	279
July	315	166	149	201	346	250	339	183	151	178	334	271
August	303	196	371	190	360	251	319	296	149	149	381	464
September	348	178	258	247	356	249	464	206	309	169	310	291
Average	319	185.4	231.6	205.4	343	249.8	358.4	214.2	186	161.8	325	314
Minimum	303	164	149	178	311	249	225	159	149	143	267	265
Max	348	223	371	247	360	251	464	296	309	178	381	464

4.1.7. Hardness

In (Table 4.7) showing a different ranges of Hardness in water source and ponds water in different s in five months (May to September), maximum value in (IW) for water hardness parameter 290ppm in fifth (S_5) at August and minimum value in fourth (S_4) at August was 105ppm. In (PW) the maximum value was 266ppm in fifth pond S_5 at September and minimum value was 102ppm in third pond (S_3) at July.

Table 4.7. Hardness value and ranges in (IW) and (PW) in different ponds location (S) in different months.

Months	(IW)Hardness ppm						(PW)Hardness ppm					
	S_1	S_2	S_3	S_4	S_5	S_6	S_1	S_2	S_3	S_4	S_5	S_6
May	245	165	148	112	125	130	112	120	105	132	205	125
June	250	135	117.5	135	257.5	197.5	105	115	105	107.5	230	200
July	260	142	120	140	262	200	230	130	102	128	244	210
August	260	170	150	105	290	206	150	160	110	170	260	237
September	278	150	198	200	282	218	178	162	126	126	266	210
Average	258.6	152.4	146.7	138.4	243.3	190.3	155	137.4	109.6	132.7	241	196.4
Minimum	245	135	117.5	105	125	130	105	115	102	107.5	205	125
Max	278	170	198	200	290	218	230	162	126	170	266	237

According to (Bhatnagar and Devi, 2013) acceptable range for hardness value was >20 ppm, desirable range 75-150 ppm, <20, >300 makes stress. In other hand (Nathan and Thomforde, 2004) suggests 50-150 ppm as desirable range. (Santhosh, 2007) Recommended 30-180 ppm for carp fish culture. While comparing mean value of Hardness were not reached 300 ppm as making stress on fish. Because the source of hardness get from calcium and magnesium in an aquatic body along with other ions such as aluminum, iron, manganese, strontium, zinc, the soil of ponds also water source have amount of calcium ionic.

4.1.8. Ammonia (NH_3)

In (Table 4.8) for all ponds in whole 5 months sampling period for all location were 0.00ppm as max and mini value for ammonia testing. Ponds waters were at 00 ppm as min value and 0.03ppm as max value.

Ammonia source in ponds culture coming from fish wastes fed decay analyze organic matter. According (Pilminaq, 2008) prefer less than 0.02 ppm. (Santhosh, 2007) Recommended to not exceed in 0.1ppm, (Anita Bhatnagar, 2013) appointed 0-0.05 as acceptable range 0-<0.025 as desirable more than 0.3ppm make stress. (FAO, 1993) determined in acute toxicity tests in the range of 0.1 to 1 ppm NH_3 for cyprinid fish. The maximum admissible ammonia (NH_3) concentration is 0.05 ppm.

Table 4.8. Ammonia (NH_3) value and ranges in (IW) and (PW) in different ponds location (S) in different months.

Months	IW NH_3 ppm						PW NH_3 ppm					
	S_1	S_2	S_3	S_4	S_5	S_6	S_1	S_2	S_3	S_4	S_5	S_6
May	0	0	0	0	0	0	0	0	0	0	0	0
June	0	0	0	0	0	0	0	0	0	0	0	0
July	0	0	0	0	0	0	0	0	0	0	0	0
August	0	0	0	0	0	0	0	0	0	0	0	0
September	0	0	0	0	0	0	0	0	0.03	0	0	0
Average	0	0	0	0	0	0	0	0	0.006	0	0	0
Min	0	0	0	0	0	0	0	0	0	0	0	0
Max	0	0	0	0	0	0	0	0	0.03	0	0	0

Absence of NH_3 was recommending to good water quality. in Whole 5months water analyzing for both IW &PW maximum value and minimum value were 00 ppm, in one sample as in (Table 4.8) at September third location (S_3) PW max value was0.03ppm due to grazing sheep on whole water source line 10 hour before sampling All water sampling were clear from NH_3 due to good inflow water 6-12 inch/2500m^2 of ponds, in comparing of mean value of Ammonia with recommending criteria it wasn't exceeded.

4.1.9. Nitrite (NO_2)

Nitrite is coming from nitrification of ammonia and also decay organic matter, (Table 4.9) showing values of Nitrite in sampled water, for (IW) the maximum value was 95.9 ppm at September in third (S_3), and minimum value was 00ppm, in (PW) the maximum value was 1.93ppm at June in pond of second (S_2) and the minimum value was 00ppm.

Nitrite is a by-product of oxidized unionized NH_3 or ionized NH_4+, conversion of NH_3 or NH_4+ into NO_2. This process is completed through nitrification bacteria found naturally. The toxicity of nitrite is dependent on chemical factors such as the reduction of calcium chloride-, bromide- and bicarbonate ions, and levels of pH, dissolved oxygen and ammonia.

According to Bhatnagar et al., (2004) 0.02-1.0 ppm is lethal to many fish species, >1.0 ppm is lethal for many warm water fishes and <0.02 ppm is acceptable.

Table 4.9. Nitrite (NO_2) value test in (IW) and (PW) in different ponds location (S) in different months.

Months	(IW)NO_2 ppm						(PW) NO_2 ppm					
	S_1	S_2	S_3	S_4	S_5	S_6	S_1	S_2	S_3	S_4	S_5	S_6
May	0	0	0	0	0	0.0982	0	0	0	0	0.1014	0.165
June	0	0	0	0	0	0	0	1.9348	0	0	0	0
July	0	0	0	0	0	0	0	0	0	0	0	0
August	0	0	0	0	0	0	0	0	0	0	0	0
September	0	0	95.9	0	0.09	0.088	0	0	0	0	0	0
Average	0	0	19.18	0	0.018	0.03724	0	0.38696	0	0	0.02028	0.033
Minimum	0	0	0	0	0	0	0	0	0	0	0	0
Max	0	0	95.9	0	0.09	0.0982	0	1.9348	0	0	0.1014	0.165

According to (Bhatnagar and Devi, 2013) acceptable range is 0.02-2ppm, desirable less than0.02ppm and more than 0.2 ppm making stress. Santhosh (2007) Recommend to not exceeding in 0.5ppm for carp culture. Nathan and Thomforde (2004) appointed to 0-1 ppm as desirable range less than 4 ppm as acceptable range.

For (IW) the maximum value was 95.9 ppm at September in third (S_3) it refer to farm was using brunch river in whole river line was cultured by different plants, weed were grow on stream water source, this value of NO_2 it refer to decay grass and organic cattle waste, and minimum value was 00 ppm, in (PW) the maximum value was 1.934 ppm of pond in second (S_2) as 1.93ppm due to panted rice farm around area of pond lands also pond was near from village mostly domestic animal were seen around, this value refer to decay grasses and animal wastes, the minimum value was 00ppm. As comparing average of data which were took from ponds with other all of them not exceeded in 0.1 ppm just pond in (S_2) the reason was explained before.

4.1.10. Nitrate (NO_3)

In sampling water to both and there were different level of Nitrate, the maximum value for (IW) was 24.66 ppm at sixth position (S_6) in Jun, and minimum value was00 ppm, for (PW) 44.17ppm and minimum value was 0ppm, as shown in (Table 4.10).

Nitrate is formed through nitrification process oxidation of NO_2 into NO_3 by the action of aerobic bacteria. According to Santhosh (2007) nitrated is not harmful for aquatic animal in high concentration but appointed to 0.1- 4.5 ppm acceptable range.

FAO (1993) considered 80 ppm to be the maximum admissible nitrate concentration for carp. According to Nathan and Thomforde (2004) nitrate is nontoxic to fish is not a health hazard except at exceedingly high levels above 90 ppm.

Table 4.10. Nitrate (NO_3) value and ranges in (IW) and (PW) in different pond locations (S) in different months.

Months	(IW) NO_3 ppm						(PW) NO_3 ppm					
	S_1	S_2	S_3	S_4	S_5	S_6	S_1	S_2	S_3	S_4	S_5	S_6
May	0	0	0	0	0	0	0	0.0273	0	0	0	18.67
June	13.9304	0.831	1.0693	4.1643	4.8754	24.667	0	0.1115	0	0.1425	0	15.22
July	13.94	0.034	0	1.91	3.42	15.52	44.17	7.603	6.04	12.78	14.06	16.00
August	16.257	14.77	6.199	1.8	3.13	13.88	0	0	0	0.012	0	0.013
September	17.23	0.02	9.32	7.27	0.16	13.14	0	0.026	0	0.024	0.036	10.09
Average	12.27148	3.131	3.31766	3.02886	2.31708	13.4414	8.834	1.55356	1.208	2.5917	2.8192	12.00
Minimum	0	0	0	0	0	0	0	0	0	0	0	0.013
Max	17.23	14.77	9.32	7.27	4.8754	24.667	44.17	7.603	6.04	12.78	14.06	18.67

In first (S_1), (IW) were always had higher value and ranges due to use surface well as water source it was not cleaned from Hay and algal also the land is agriculture had good amount of organic matter, In sixth position (S_6) at Jun record high level 24.66 ppm it was refer to cleaning wool on water source (spring). For (PW) in first location (S_1) at July had 44.17ppm it was high value if compare it with itself data from other months and other ponds due to decreasing water level to 50 cm (normally was 130 cm). The sixth pond (S_6) pond had higher value every month than other ponds data, because that farm was used other year for fish farming and not cleaning well to new fish farming season.

4.1.11. Chloride (Cl^-)

Water sampling analyzing for 5 months were showing in (Table 4.11) for Cl criteria, the maximum value for (IW) was 28.958ppm at Jun in second (S_2) and minimum value was 0 ppm in fourth (S_4) at May, for (PW) analyzing in first (S_1) at May maximum value was 284.41 ppm and minimum 0.0217 ppm in sixth position (S_6) at May. Chloride is a common component of most waters and is beneficial to fish in maintaining their osmotic balance also it use as disinfectant against harmful bacteria showing a little high level of (Cl^-) in due to using surface well as water source for ponds and drinking water they add Salt as disinfectant and water cleaner for well, in (IW) water analysis (S_1) mostly had greater value comparing to other water resource because water coming from surface well and they adding salt as disinfectant, also S_2 at Jun had maximum value 28.958 ppm comparing whole (IW) data refer to mixing stream with drain poultry farm, they washed at final stage of cleaning by high amount of salt the drain water was mixing with Zharawa river (distance between poultry farm and pond less than 1km).

Table 4.11. Chloride (Cl^-) value and ranges in (IW) and (PW) in different ponds location S in different months.

Months	(IW) Cl^- ppm						(PW) Cl^- ppm					
	S_1	S_2	S_3	S_4	S_5	S_6	S_1	S_2	S_3	S_4	S_5	S_6
May	18.4071	0.0536	10.1054	0	0.0204	0.0524	117.6345	4.6576	0.077	37.891	0.0241	0.0217
June	15.0157	28.958	5.7018	5.3568	4.7448	5.637	284.41	8.9301	13.8076	16.6696	48.445	8.6981
July	14.73	4.48	5.71	4.69	11.06	2.74	38.27	22.05	7.06	12.99	18.002	33.2
August	6.347	4.0316	4.16	4.361	2.72	3.046	72.83	61.69	69.32	78.25	54.32	58.06
September	23.51	5.03	0.1	3.22	3	3.06	178.8	5.39	104.86	6.79	7.58	32.34
Average	15.60196	8.51064	5.1554	3.5255	4.3090	2.907	138.38	20.543	39.024	30.518	25.674	26.463
Minimum	6.347	0.0536	0.1	0	0.0204	0.0524	38.27	4.6576	0.077	6.79	0.0241	0.0217
Max	23.51	28.958	10.1054	5.3568	11.06	5.637	284.41	61.69	104.86	78.25	54.32	58.06

For (PW) analyzing the first pond water mostly use Salt as diseases prevention, the high level of (Cl^-) was 284.41ppm in June as shown in (Table 4.11) refer to flip a coach of salt to pond at distributing salt on ponds.

4.1.12. Phosphate (PO_4)

Water analyzing for phosphate (PO_4) were showing in (Table 4.12) the maximum value for (IW) was 4.033 ppm in second (S_2) at Jun and minimum value was 0ppm, for (PW) 3.68ppm as maximum value in forth (S_4) at September and 0ppm as minimum value. According Bhatnaga and Devi (2013) 0.03-2 ppm is acceptable range 0.01-3ppm desirable, and more than 3 ppm make stress, the range 0.005 to 0.5 ppm is desirable for pond culture (Nathan and Thomforde, 2004).

Table 4.12. phosphate (PO4) value and ranges in (IW) and (PW) in different pond location S in different months.

Months	(IW)PO_4 ppm						(PW) PO_4 ppm					
	S_1	S_2	S_3	S_4	S_5	S_6	S_1	S_2	S_3	S_4	S_5	S_6
May	0	0	0	0	0	0	0	0	0	0	0	0
June	0	4.0337	0	0	0	0	0	0	0	0	0	0
July	0	0	0	0	0	0	0	0	0	0	0	0
August	0	0	0	0	0	0	0	0	0	0	0	0
September	0	1.95	0	0	0	2.44	0	2.13	0	3.68	2.1	2.23
Average	0	1.19674	0	0	0	0.488	0	0.426	0	0.736	0.42	0.446
Minimum	0	0	0	0	0	0	0	0	0	0	0	0
Max	0	4.0337	0	0	0	2.44	0	2.13	0	3.68	2.1	2.23

4.1.13. Sulfate (SO_4)

The parameters for sulfate analyzing were different as shown in (Table 4.13), for (IW) maximum value was 122.89 ppm at June in (S_5) and minimum value was 0ppm, the maximum value sulfate for (PW) was 132.634 in (S_5) at Jun and minimum value was 0 ppm.

Fish tolerate a wide range of sulfate concentrations, and levels of sulfate above 500 ppm (Nathan and Thomforde, 2004), the amount of sulfate in (S_5) for quality analyzing122.89 ppm refer to fountain of Saruchawa it contain amount of Sulfur was different according seasonal changing. Maximum value (PW) was 132.634 ppm as shown in (Table 4.13) in S_5 at June refer to using Copper Sulphates ($CuSO_4$) as disinfectant.

Table 4.13. Sulfate (SO_4) analyzing, Value and ranges in (IW) and (PW) in different ponds location (S) in different months.

Months	(IW)SO_4 ppm						(PW) SO_4 ppm					
	S_1	S_2	S_3	S_4	S_5	S_6	S_1	S_2	S_3	S_4	S_5	S_6
May	0	0	0.218	0	0	0	41.63	0	0	0	0	0
June	26.12	15.86	16.3789	21.00	122.89	12.91	44.26	22.58	21.23	21.00	132.63	22.34
July	23.25	13.32	14.62	17.4	93.7	8.43	22.09	17.09	15.25	24.37	107.25	127.25
August	21.98	0	16.44	19.77	117.55	7.82	17.25	18.98	22.12	15.3	9.972	16.33
September	24.25	0.01	22.43	26.14	0.022	7.132	0	0.021	0	20.92	120.02	9.46
Average	19.12	5.84	14.01	16.86	66.83	7.25	25.04	11.7358	11.721	16.319	73.97	35.07
Minimum	0	0	0.218	0	0	0	0	0	0	0	0	0
Max	26.12	15.86	22.43	26.14	122.89	12.91	44.26	22.588	22.12	24.37	132.63	127.25

4.2. Proximate Analysis of Studied Fish Meat

4.2.1. Moisture

Data analysis for moisture ratio or percentage ratio in common carp meat in studied ponds explained that the last fish pond (S_6) had highest amount of Moisture (75.937 %) comparing other ponds, maximum value for moisture was in (S_1) 75.937 % and minimum was in sixth fish pond (S_2) 70.498 % as seen in (Table 4.14)

Table 4.14. Proximate analysis moisture ratio of studied common carp meat.

Earthen ponds	Moisture %
S_1	$74.934^a \pm 0.038$
S_2	$70.498^a \pm 0.041$
S_3	$72.981^a \pm 0.045$
S_4	$71.08^a \pm 0.037$
S_5	$73.953^a \pm 0.054$
S_6	$75.937^a \pm 0.051$

Mean value with different superscripts with in a column differ significantly ($P \leq 0.05$).

The percentage of water in common carp meat is (60–86 %) (Cirkovic et al., 2002).

4.2.2. Protein

Data analysis for protein ratio or percentage ratio in common carp meat in studied ponds explained that the pond S_3 had highest value and maximum of protein (16.8%) comparing other ponds and minimum was in (S4) 13.2 % as shown in (Table 4.15).

Table 4.15. Proximate analysis for Protein ratio of studied common carp meat.

Earthen ponds	Protein %
S_1	$13.400^{ab} \pm 0.090$
S_2	$16.200^{a} \pm 0.101$
S_3	$16.800^{a} \pm 0.185$
S_4	$13.200^{b} \pm 0.038$
S_5	$16.600^{a} \pm 0.069$
S_6	$15.400^{a} \pm 0.074$

Mean value with different superscripts with in a column differ significantly ($P \leq 0.05$).

The data analysis explained that comparing pond S_3 with S_4,S_1 all other ponds had significant value ($p<0.05$), While comparing pond S_3 with ponds S_2, S_5 and S_6 there are no significant ($p>0.05$).

Protein ratio content in common Carp meat is in range from 14 to 20 % (Cirkovic et al., 2010; Trbovic, 2009; Cirkovic, 2010). Although some authors state that this range is slightly higher and amounts from 13 to 25 % (Vladau et al., 2008).

The higher Protein ratio in fish pond S3 as shown in (Table 4.15) over other ponds refer to given fish meal for 3 months also surrounding pond by many plants and fruit trees also on pond had lights at night it was due to tract insect toward ponds it will be a good source as natural food for fishes, and minimum value of protein was in fish pond S_4 13.2 % due to that pond was given poultry feed with extra oil and human food wastage.

4.2.3. Fat

Data analysis for fat ratio in common carp meat in studied ponds explained that the pond S1 had highest amount of comparing to other ponds, Maximum value for fat ratio was in fish pond (S_4) 13.363 % and minimum value was in (S_6) 6.335 % as shown in (Table 4.16), while comparing the value of data analysis for fat in fishes meat in pond S4 with other ponds had significant value ($p<0.05$), also comparing value of S_1 with S_6, but comparing S_2 with S_1,S_3,S_5 also comparing S_1 with S_5,S_3 had no significant values ($p>0.05$), also comparing S_3 with S_5,S_6 as well as comparing S_5 with S_6 had no significant values as shown in (Table 4.16).

Table 4.16. Proximate analysis for fat ratio of studied common carp meat.

Earthen ponds	Fat %
S_1	$9.890^{b} \pm 0.313$
S_2	$10.189^{b} \pm 0.252$
S_3	$7.652^{bc} \pm 0.183$
S_4	$13.363^{a} \pm 0.097$
S_5	$7.622^{bc} \pm 0.352$
S_6	$6.335^{c} \pm 0.292$

Mean value with different superscripts with in a column differ significantly ($P \leq 0.05$).

Different age, breeding systems and food are caused wide ranges of fat content in carp from 2.3 to 16.8 % (Miroslav, 2011; Ljubojevic et al., 2012). Expect farmers were used same feed(poultry feed grad 2)contain higher ratio of fat (5-7 %)comparing to fish feed (1-1.5 %), the distinction fat ratio in fish pond S4 as shown in (Table 4.16) over other ponds refer to the farmer was fish monger it due to decreasing stocking density/m^3 and decreasing competition on natural foods, it caused to fast growing of fishes, also that farm didn't infected by diseases the ponds (S_1,S_2,S_3,S_5) had rather close value of fat ratio the environment and fish stocking density are same, the fishes in pond S_6 had lowest fat ratio due causes mentioned before as observed in (Table 4.16).

4.2.4. Ash

Data analysis for Ash ratio or percentage ratio in common carp meat in studied ponds explained that the fishes in pond S3 had highest amount and maximum value of Ash contain (2.355 %) comparing with other ponds and minimum value was in (S_5) 1.018% as showing in (Table 4.17), while comparing value of fat in fish meat in S_3 with S_1, S_2, S_5 have significant value ($p<0.05$), expect that there are no significant value in comparison among other ponds fish in Ash contain in carp meat ($p>0.05$).

Table 4.17. Proximate analysis for Ash of studied common carp meat.

Earthen ponds	Ash %
S_1	1.068^{b} ±0.118
S_2	1.074^{b} ±0.097
S_3	2.335^{a} ±0.545
S_4	1.599^{ab} ±0.407
S_5	1.018^{b} ±0.093
S_6	1.561^{ab} ±0.359

Mean value with different superscripts with in a column differ significantly ($P \leq 0.05$).

4.3. Organoleptic Evaluation of Fish Meat

4.3.1. Tenderness

Data analyses of tenderness evaluations for common carp meat, (S_5) got 4.800 score as highest and maximum value and (S_4) as lowest value 3.00 as shown in (Table 4.18), the data analysis explained that comparing value of fish meat in pond S5 with S_1, S_3, S_4, S_6, had significant values ($p<0.05$), but the comparisons among other fish ponds had no significant values ($p>0.05$) as shown in (Table 4.18).

4.3.2. Juiciness

Data analyses for juiciness evaluations for common carp meat (S_5) got 4.200 as highest value and (S_1) as lowest mean with minimum value 3.400 as shown in (Table 4.18).in data analysis explained comparison among all ponds for juiciness there were not significant value among them ($p>0.05$) as observed in (Table 4.18).

4.3.3. Flavors

Data analyses for flavors evaluations for common carp meat evaluation (S_5) got 4.600 as highest value and (S_4) as lowest value 3.600 as shown in (Table4.18), the data analysis also explained the comparisons between fish ponds meat for flavor evaluations they were had no significant value among them ($p>0.05$) as shown in (Table4.18).

4.3.4. Overall acceptability

Data analyses for Overall acceptability evaluations for common carp meat (S_5) got 4.800 as a maximum value and (S_4) as lowest score 3.600as shown in (Table 4.18), the data analysis explained the comparison among fishes meat S_5 with S_1, S_3, S_4 had significant values ($p<0.05$) instead of these comparisons among other fishes meat had no significant values ($p>0.05$) as shown in (Table 4.18).

Table 4.18. Organoleptic (sensory) evaluation for common carp meat.

Treatments	Tenderness	Juiciness	Flavor	Overall acceptability
S_1	$3.600^{b} \pm 0.152$	$3.400^{a} \pm 0.263$	$4.000^{a} \pm 0.177$	$3.800^{a} \pm 0.220$
S_2	$4.000^{ab} \pm 0.177$	$4.000^{a} \pm 0.250$	$4.000^{a} \pm 0.177$	$4.400^{ab} \pm 0.124$
S_3	$3.800^{b} \pm 0.220$	$3.800^{a} \pm 0.220$	$3.800^{a} \pm 0.220$	$3.800^{b} \pm 0.118$
S_4	$3.000^{b} \pm 0.236$	$3.600^{a} \pm 0.248$	$3.600^{a} \pm 0.317$	$3.600^{b} \pm 0.152$
S_5	$4.800^{a} \pm 0.093$	$4.200^{a} \pm 0.106$	$4.600^{a} \pm 0.119$	$4.800^{a} \pm 0.093$
S_6	$3.600^{b} \pm 0.248$	$3.600^{a} \pm 0.152$	$4.000^{a} \pm 0.177$	$4.200^{ab} \pm 0.199$
5 =extremely like; 4 = like; 3 = neither like nor dislike; 2 = dislike; 1 = extremely dislike				

Mean value with different superscripts with in a column differ significantly ($P \leq 0.05$).

4.4. Fish Rearing Projects in Ranya

However fishery in Ranya started at 1960 the fisher men were coming from middle and south of Iraq, but for people around the Dukan Lake was started in 1966-1967. So the fish farming in Ranya zone was started in 2001 they were built five ponds in Drmanaw village because the owner was set in another city and haven't good information on fish farming so the farm was sold after 2 years, (Table 4.19) explain the ponds , most ponds found in Qladze district include 27 projects mostly built around Little Zab then Saruchawa coming in second grade had 17 farms due to big fountain and best land for agriculture activity, in both Sangasar and Zharawa 12 projects 6 farms for each one was found as shown in (Table 4.19; Table 4.20) because of topographic of land is not suitable for fish farms however they had good water resources if they build it near river shore sometimes were damaging by flood which is coming through mountain and valley before harvesting season.

Table 4.19 Fish rearing projects in Ranya.

Position	No. of projects	Area of projects	Total area (m^2)	Source of water
Qaladze	27	451886	538243	Surface well + Brook
Zharawa	6	94337	125448	Brooks
Sangasar	6	71015	76982	Well + Surface well + Stream
Chwarqurna	9	127363	153893	Well + Surface well +Stream
Hajiawa	8	107200	139148	Stream
Saruchawa	17	227847	254305	Stream
Total	73	1079648	1288019	

4.4.1. Number and ratio of fish projects in Ranya

In Pshdar zone have many river, watershed, and brooks the biggest one is Little Zab or Khase River coming from Iran its length 62km from border to Dukan Lake (or 58 Km depend on Dukan Lake water level) it make local district boundary with both Dukan and Sharbazher districts, most fish pond lay on it or a round it ponds were recorded. Many villages lay on it and busy with agriculture and animal breeding and fish farming they are use river water source directly to ponds or indirectly by using big digging as surface-well, leaking water through sandy-gravel land strand.

At Qaladze district there is Chomi Halsho River no pond on it, and Chom-Khrka brook just small pond detected 500m² at Allan Village totally 88 ponds in 27 farms were recorded total area of ponds were 451886m² and total stocking density were 412650.

In Zharawa River it have many ponds from Duchoman until Kalsonan village also around Zharawa Sub-district found a few ponds using deep well as water resource or brunch from Zharawa River directly or indirectly coming from rice fields, ponds in 6 farms were recorded in total fish stocking density were 53300 in total area of 94337 m^2 .

At Sangasar 12 ponds in 6 farms were recorded stocking denesty 73500 in 71015m^2, three of them located on (Ga-rfen River), and other using deep well or stream or Khandaka River.

At Ranya town no pond was found however it has big fountain water resource (Qulla Fountain) it’s completely using for Drinking water and vegetables irrigation. Also it has Sarkapkan River but it’s mostly disappearing through passing Gravel-sandy duct near Astrilan village.

At Chwarqurna Sub-district 31 ponds in 9 farms were recorded stocking density 83000fihes in 16200m^2 mostly using on Saruchawa water channel streams until Qraniagha village. 9 Ponds of them located On Baiz-Agha River.

In Hajiawa sub-district 32 ponds in 8 farms were recorded total stocking density68790 fishes in 107200 m^2, they are mostly on Saruchawa fountain streaming brunches.

In Betwata zone 40 ponds in 17 farms were recorded, total stocking density 164800 in to total area 227847m^2, they are mostly on Saruchawa fountain streaming brunches which is lay in Saruchawa lands.

At studing period totally 73 projects were recorded mostly not surveyed by ministry of agriculture and other office or organization. In (Table 4.20) explained that 36 % of projects are found in Qladze district, firstly this region is far rather than other places and it has suitable places for fish farming and best water resources, however the amount reared fish in that zone were extra sufficient in district market it also sending to whole around market because it has best acceptable taste and flavor like natural carp fish, that reason caused to expanded fish farming in last three years ago if market price is suitable it reach more than 100 projects in next 2 years, in second grade was Saruchawa it has good land and water resources for agricultures activity it shown increasing fish farming in two years ago from three project to 17 project because of insufficient of natural fishing of Dukan lake and crowd of citizen around it.

Table 4. 20. Percentage of projects with projects number in Ranya Zone.

Districts and sub-districts	Number of project found	Percent %
Qaladze	27	36.9863
Zharawa	6	8.219178
Sangasar	6	8.219178
chwarqurna	9	12.32877
Hajiawa	8	10.9589
saruchawa	17	23.28767
Total	73	100

4.4.2. General properties of fish rearing projects in Ranya

In (Table 4.21) summed up fish farming in Ranya zone, mostly the ponds area are 2500m^2 (a donem) stocking density are 3500 fishes, in that case the farmers haven’t information on fish farming or they harvest fishes partially, in other hand there 1000 fishes/pond or stocking density 0.4 fish/m^3, the cost of project depend on closed from water resource, kind of land and authorization.

Table 4.21. Ponds information per project

Properties of the projects	Ranges of projects	Mean
Stocking density/ ponds in each project	1000- 3500	2250
Volume of water used to projects (Inch)	4-12	8
Fish ponds depth	70cm – 200cm	135
Stocking density (fish/ m^3)	0.4- 3	1.7
Cost of ponds construction($)	20000-30000	25000

4.4.3. General view on fish projects in Ranya

Farmers took experience in a few years they realized in low density fish gave fast growing and good mass, in some pond maximum fish weight reached 4kg in 210 days as showed in (Table 4.22). The total amount of production is depend on area of farm, stocking density, water resources, kind of feed, farmers information, quality of fingerlings. According the (Table 4.22) the lowest period of farming was 180 days it mean the average weight reared fish was reached 2 kg and more, over 2kg has fast selling in markets but delay from 210 days and more due to disease or cold water or low protein in diet or high stock density.

Table 4.22. General views on fish projects in Ranya.

Characteristics	Ranges	Mean
Rearing period/ day	180-210	195
Project production/ kg	7000 – 47700	2.745
Daily weight gain/ g	10.277 – 17.333	13.805
Weight(g) after 6 month	514-2640	1577

4.5. Survey of Fish Projects in Ranya

4.5.1. General information of fish projects in Ranya

The earthen ponds in Ranya zone as explained in (Table 4.23) the age of farmers were between 20-65 years, most of them were completed secondary school or illiterate, the bachelor degree between 1-2 farmers, according to (Table 4.23) most pond are made in year 2014 . In Chwarqurna sub-district found elder pond which is made in 2001 but a few times changed to land and ponds then in Saruchawa sub-district was made in year 2004, with in 73 recorded projects only five project were licensed.

Table 4.23. General information on farmers in Ranya zone ,(Il) for illiterate (Pr) for primary school,(Se)for secondary school,(Di) for Diploma,(Bc) for bachelor, yeas (Y), no (N).

District /sub-district	Owner age (Years)		Academic Achievement					Experience In Fish Farming (Years)		Built Date	Family Individual Working	Fish Specialist		License	
	Range	Average	Il	Pr	Se	Di	Bc	Range	Average		Range	Y	N	Y	N
Qladze	20-65	42.5	-	16	10	-	1	1-9	5	2008-2016	1-6			1	
Zharawa	28-52	35		3	3			2-5	3.5	2010-2015	2-6				
Sangasar	28-45	36.5	1	3	2			3	3	2014-2017	1				
Chwarqurna	30-61	45.5	2	5	2			4	4	2001-2017	1-5			2	
Hajiawa	28-55	41.5		4	2		2	3	3	2014-2016	2			1	
Saruchawa	25-56	40.5	4	9	4			1-13	7	2004-2016	1-8			1	

4.5.2. Investment costs

Cost for pond construction in different range according to nearest from district, and kind of land, (Table4.24) explained the area of pond between 0.7-3 Donum (Dn) and total area of project between 0.7-28 Dn, also the investment cost for project depend on area of land, source of water, kind of land, and private or license.

In (Table 4.25) explained the cost of equipment and cost of equipment such as feeder, aerator and water pump the unit is depend on area of ponds and number of ponds per projects, In Qladze and Zharawa and Chwarqurna found surface well and deep well the cost were $30000-$12000 for surface well and deep well respectively. The equity capital also has different range the lowest is $30000 and highest $300000 its depend on area of project and service for project rental or private.

4.5.3. Operating costs

Mostly projects were managing by their owner or worker families include children or man and wife or young single as worker and guide. In (Table 4.26) explained the projects in Ranya zone, six months period was noted end time for fish farming its depend on good growth good weight gain of fish and suitable marketing price, the wages or salary for single worker is $520 but it's for shorter period about 6 months or more but for whole worker family in 12 months $420 monthly for 12 months mostly include that projects there were operating by workers family and has different fish ages with different size and number of ponds per project mostly the owner of project has extra work or he was fish monger.

Table 4.24. Explain the areas of ponds and projects in Ranya zone and investment.

District sub-district	ponds		Pond area (Dn)		Pond construction Cost($)		Total area of ponds(Dn)		Total investment cost for ponds($)	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Qladze	1-9	5	1-3	1.5	900-2000	1450	1-28	4.5	20000-100000	55000
Zharawa	1-13	7	1-23	12	900-1000	950	1-23	12	20000-40000	30000
Sangasar	1-3	2	1-3.5	2.25	800-1500	1150	1-3.5	2.25	30000-50000	40000
Chwarqurna	1-6	3.5	1-4	2.5	1000-1500	1250	1-15	8	30000-60000	45000
Hajiawa	1-9	5	0.7-2	1.35	900-1000	950	0.7-16.5	8.6	10000-90000	50000
Saruchawa	1-3	2	0.7-3	1.85	900-1100	1000	0.7-25	12.85	10000-100000	55000

Table 4.25. Investment cost of pond equipments.

District sub-district	Feeders number		Cost one feeder ($)	Aerators numbers		Value one aerator ($)	Well and S.W	Well and S.W Cost ($)	Water pump cost ($)	Equity capital ($)		Electric wages/farming period($)	
	Range	Average		Range	Mean					Range	Mean	Range	Mean
Qladze	1-60	30.5	40	1-27	14	112	1	3000-12000	330	30000-300000	165000	150-1500	825
Zharawa	1-45	23	40	3-12	7.5	112	1	3000-12000	330	30000-60000	45000	150-1000	575
Sangasar	1-27	14	40	2-4	3	112	1	3000-12000	330	60000-90000	75000	150-1000	575
Chwarqurna	1-16	8.5	40	1-10	5.5	112		3000	330	30000-90000	60000	150-1000	575
Hajiawa	1-32	16.5	40	1-14	7.5	112			330	10000-150000	80000	150-1200	675
Saruchawa	1-55	28	40	1-21	11	112			330	10000-200000	105000	150-1700	925

Table 4.26. Operating project cost annually and monthly wages for workers and family individual.

District sub-district	workers		Salary($) /month		working Period (month)		Total salary payment to end production($)
	Family	Workers	Range	Mean	Range	Mean	
Qladze	1-9	1-2	450-520	485	6-12	9	4050
Zharawa	1-13	1-2	520	520	6	6	2700
Sangasar	1-3	-	-	-	-	-	-
Chwarqurna	1-6	1	450	450	6-12	9	4050
Hajiawa	1-9	1	450	450	12	7.5	5400
Saruchawa	1-3	1-3	450	450	12	12	5400

4.5.4. Fingerlings used

Fingerlings mostly reared in pond around October and November in high stoking density such as 3-6 fingerling/m^3 it will be ready to next year to transport on ponds, normal stocking denisty1-2/m^3 they will be in good weight at next year at March to May at that time is forbidden fish hunting period they sell in good price. According to study period and survey of all ponds were starting farming in 45-100g because it pass hazard weather changing and better growing rather than fingerlings, seldom found small fingerling in ponds it was refer to cheaper price when farmer cant able to purchase half handsize (65-120g) fish or there were not found acceptable fish size in hatcher. (Table 4.27) show that stocking density were 1800 as lowest and 100000 as highest it's depend on area of ponds and number of pond per farm also it's depend on experience on fish breeding.

The range of half hand size fish between 45-120g/fish the lower weight refer to starting in earlier season of farming and got in cheaper price they will sell to other ponds in 2-3 month later. The weight 70-120 g refer to delay staring in farming caused by delay cleaning ponds or new construction or purchasing from other ponds or hatchers haven't fish. The price between $0.2- 0.4 depend on fish size and supply with demand in hatcher also on season of farming, in the beginning of season were expensive and end season with cold season were cheaper. Also cost of half hand size per farm depend on area and number and starting farming period per farm big farm always has empty pond at near end season an purchase fish in very suitable price but medium farm and smaller purchase in a little higher price. The daily weight gain as shown in (Table 4.27) show that between 8-17g/day depend on natural food in water, feed quality, stocking density and diseases infection frequently, mortality between 1000- 6000 fishes in whole farming season they were also depend on stocking density per farm, climate changing ,wild enemy, electric power cut off it was due to stopping water changing and oxygen depletion by stopping aerators also depend on diseases infection frequently and used ineffective treatment or harmful drugs.

Table 4.27. Quantity stocking density fish per farm average weight cost of it and mortality.

District sub-district	Stocking density /farm		Average weight of half handsize fish (g)		price($)		Cost of half Handsize fish per farm($)		Daily weight gain(g)		Total Mortality	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Qladze	3000-100000	51500	25-70	47.5	0.2-0.4	0.3	1200-14000	7600	8-17	12.5	2000-6000	4000
Zharawa	9000-14000	12500	45-65	55	0.24-0.4	0.32	3360-3600-	3480	9-13	11	600-2000	1300
Sangasar	2000-25000	13500	45-65	55	0.24-0.4	0.32	800-8000	4400	13-15	14	1000-1500	2250
Chwarqurna	2000-16000	9000	50-120	85	0.28-0.36	0.32	800-6400	3600	8-12	10	900-3000	3450
Hajiawa	1300-20000	16500	45-60	52.5	0.28-0.36	0.32	364-5600	44482	9-14	12.5	2000-3000	2500
Saruchawa	1800-38700	20250	35- 70	52.5	0.2-0.4	0.3	720-11610	6165	8-13	11.5	1500-7000	

4.5.5. Feeding frequency

Feeding frequency per each pond and farm depending on fingerling size, stocking density, climate changing, hygienic situation, number of feeder and amount feed in feeder. (Table 4.28) showing information on feeding times during farming period and also feed price, in daily feeding lowest is 10 kg and highest is 500 kg depend on pond area and number of ponds per farm also stocking density, the farming period range 6-12 months as partial harvesting and marketing price has effect on farming period. feed price however changing in season and currency value but due to feed factory found in Ranya zone and feed ingredient mostly culture in Ranya zone so there is no effective changing in price 510 for common feed poultry as show in table $600-700 due to private feed ingredient request and importing feed.

Table 4.28. Representing feeding times, farming period and feed price.

District Sub-District	Feeding Times/Week		Daily Feeding Amount(Kg)/Farm		Farming Period (Month)		Feed Price ($)/Ton	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Qladze	1-3	2	50-500	275	6-12	9	510	510
Zharawa	1	1	30-300	165	6-9	7.5	510-700	605
Sangasar	1	1	20-200	110	6-12	9	510-700	605
Chwarqurna	1-2	1.5	10-240	125	9-12	10.5	510-600	555
Hajiawa	1-3	2	50-200	125	6-12	9	510	510
Saruchawa	1-2	1.5	20-150	85	6-12	9	510	510

4.5.6. Treatments and Disinfections Used During Production Season

Before the beginning of farming and end marketing fish disinfectant mostly used to pond cleaning from infection and prepare for next year, at climate changing mostly at end of spring and beginning fall seasons most pond were infected and high amount of chemicals treatment were use. (Table 4.29) showing the kinds of disinfectant and drugs were used by farmers the amount of using and costs depend on area of ponds and number of ponds per each project also the infected ponds frequently.

Table 4.29. Treatments and disinfectant used by farmer and costs.

treatments and disinfections	unit	price($)	Total cost($) of using/project	
			Range	mean
salt	ton	$65/ton	200-1500	850
$CuSO_4$	Pakage,Kg	$10	10-60	35
$KMnO_4$	Kg	$10	10-1000	505
Benzalkonium chloride (BKC)	bottle	$10	10-950	480
Teracyclin	Package 200g	$25/200g	10-50	30
Calsium hypochloride	Powder(g)	$5/200g	5-30	17.5

4.5.7. Revenues and incomes

Acceptable fish weight for marketing were 1.5-3 kg, the price depend on fish weight and clear from any disease symptoms, season, supply and demand especially at forbidden fishing period it will reach $3.6/Kg the value between $2.8-3.6/Kg. (Table 4.20) explain percentage expecting fish production, 48% of total fish production were in Qaladze because this area have best source of water and lands also acceptable fish flavors and taste most product were selling in area by shift marketing , in second grade was Saruchawa 19% of total fish production and last both are Sangasar 9% and Zharwa by 6% in total fish production however have best reputation in fish kind in both taste and flavor due to topography of land not allowed to constructing more ponds Chwarqurna in middle grade there are delay in fish production due to fishes has muddy taste.

5. CONCLUSION AND RECOMMENDATION

This study hold many important indicators that overlapping in fish farming, there are some points were cleared in results should be mentioned in both level of local and international level it have multi-faceted study in more than one subject and there are many aspects needs more researching.

Fishery was started by hunted fish in Little Zab, rivers, brooks and atribtary, but fishery in Ranya as main job started at 1960 year after completing embankment of Dokan Dam, the fisher men were coming from middle and south of Iraq, but for people around the Dokan Lake was started in 1966-1967, before that the veliger were worker or assitance with fishermen. The fish farming in Ranya zone in ponds was started in 2001 they were built 5 ponds in Drmanaw village because the owner was set in another city and haven't good information on fish farming so the farm was sold after 2 years.

Fish pond farming is new work to demand fish and sufficient market in Ranya zone, however product are sending to other cities and zone but there are several reasons limited growing fish farming, Inexperience farmers had bad effect on fish production in Ranya zone, working out of farming recommendation by high stocking density, ineffective treatment, bad pond construction, insufficient aerator with many other lack, however Ranya zone have best source of water and water quality the land topographic limiting pond construction especially in Zharawa and Sangasar sub-districts.

Using branches of rivers and brooks has advantage by available rich natural foods for fish also has disadvantage such as transporting diseases from wild fish to farm fish, other reason increasing stocking density, effecting on water quality also it make competition on feed consumption. Founding wild fish enemy such as Otter in Saruchawa zone and south of Sangasar were due to harassment farmers also it cause ponds infection.

Although using surface water source or deep well is most safe method. It had also disadvantage like poor or clear in natural foods. Feed price and quality of feed were limiting ability of farmers, however natural foods in rivers and streams rather passing fish from hazard feed quality. The range feeding to get 1kg fish meat is between 2.5-3.5 kg. Some farmers (out of studied ponds) appointed to different weight gain at harvesting season such as 4-5 kg in 6-7 months while fingerling were 40-55 g, it was depending on weather season, kind of feed (it must be fish feed , protein ratio more than 30 %), and health of fish. But special fish feed cost more than $ 800-900/ ton. It will due to unprofitable job for farmers because generally at harvesting season now fish were sell in $2.5-3/ kg on farm freshly.

The economic crisis in northern of Iraq since 2014 has lethal effect on all jobs and trading and marketing. Natural growing fish in market around Dukan Lake due to weak fish price in same zone. In whole 73 farms, only a few farmers had fish farming as main job mostly had extra works, they rear fish on luck and neglectful farming.

Ranya Zone or Raparin administration has many water Resources Rivers, brooks, fountain Lake, and barrage all of them are fresh water and drinkable. The natural water resources are rich by natural foods for fish breeding also water parameters in good ranges proofing it.

Laboratory tests and analyzes led to the clarification and simplification of the comparison between all water quality parameter in fish ponds and water sources, they were played in optimum ranges while comparing with standards of the organizations Local and international, even observing many different ranges but it not has bad effect on fish growing or they were short time stress effects, also in fish meat analyzing and organoleptic evaluation good result were observing in short time (only in six or seven months) in most articles point to same fish growing result in two or four years.

At survey time and sampling period observing many lacks in fish farming in earthen ponds, most land are private and used neglected for culture and fish farming, or used out of recommendation, so they need evaluating all aspects before starting fish farming such as water analysis, soil testing, and hazard of floods, etc. Also throwing trashes, expired drugs or chemical element to sewages or water resources or throwing pesticide bottle in river especially in shore zones.

At sampling period make direct contacting with fish farmers, over all problems discussed before they were some restriction point it must be considering seriously to improving best yield of aquacultures such as; separating channel from outlet water channel to controlling diseases and quarrel between farmers include fish farmers. Marketing arrangement by governmental or private sectors in end of fish farming season to selling fish in suitable price it will be good support for farmers and interesting in fishery. Increasing fish hatchery in good seeds and big amount of fingerlings to controlling fingerling prices, best yield and breeding time. Opening micro biologic center to check in fish diseases and recommending using most effective treatment in lower cost.

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APPENDIX 1

EXPANDED TURKISH SUMMARY
(GENİŞLETİLMİŞ TÜRKÇE ÖZET)

RANYA'DAKİ (KUZEY IRAK) TOPRAK HAVUZLARDA YETİŞTİRİLEN PULLU SAZANIN (*CYPRİNUS CARPİO* L.) BESİNSEL VE VERİMLİLİK YÖNLERİNİN KARŞILAŞTIRILMASI ÜZERİNE BİR ÇALIŞMA

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GİRİŞ

Dünya nüfusunun özellikle son yıllarda ivme kazanarak artması; bilhassa gelişmişlik düzeyi düşük ülkelerde ekonomik ve sosyo-politik problemlerle birlikte, hayvansal proteine dayalı beslenme gereksinimlerinin yeterli ve dengeli şekilde karşılanamaması gibi sorunları da beraberinde getirmiştir. Doğal kaynakların birçok bölgede düzensiz ve kontrolsüz kullanımı ile birlikte, ekosistemler de büyük yaralar almaya başlamıştır. Bu olumsuz şartlar, ihtiyacı karşılayabilmek için doğal stoklara alternatif olarak, kontrollü yetiştiricilik sistemlerinin geliştirilmesini de beraberinde getirmiştir. Bu kapsamda, çeşitli balık türlerinin açık veya kapalı mekanlarda, yarı entansif, entansif ve hiper entansif olarak yetiştiricilikleri yapılmaktadır. Açık mekanlarda yapılan yetiştiricilik sistemlerinde, off-shore ve dip kafesleri kullanıldığı gibi, balıkların ticari yemlere ek olarak doğal besinlerle de beslenmesini ve et kalitesinin artmasını sağlayan toprak havuzlar ve lagün bölgeleri de kullanılmaktadır.

Bölgesel olarak ele alındığında, özellikle 2010'dan sonra hızlı nüfus artışına bağlı olarak, Kuzey Irak şehirlerinden bilhassa Süleymaniye ve Erbil'de balık etine olan ihtiyacın artması; göllerde doğal olarak yetişen balıklardan elde edilen çeşitli balık etlerine olan talebi fazlasıyla arttırmıştır. Dukan Gölü'ndeki aşırı avcılık faaliyetlerinden dolayı, üretim miktarı balık pazarı için yeterli ve sürdürülebilir değildir. Dukan Gölü'nün kuzeyinde yer alan Ranya Bölgesi (Kuzey Irak), kaliteli tatlısu kaynakları ve çok çeşitli doğal balık yemekleriyle iyi bir üne sahiptir. Bu bölgede, subtropikal iklim sazangillerinin büyümesi için, su sıcaklık değerleri yılın 5-6 ayı boyunca en uygun seviyelerdedir. Bu nedenle, yetiştiricilik amacıyla, toprak havuzların kurulmasında hızlı bir artış görülmüştür.

MATERYAL ve YÖNTEM

Bu çalışmada, Ranya Bölgesi'ndeki (Raparin Yönetimi) pullu sazanın (*Cyprinus carpio* L.) verimlilik yönlerinin, farklı bölgelerde seçilen altı çiftliğin havuz dinamiklerinin ve balıkların büyüme ve et kalitesi gibi parametrelerinin karşılaştırılarak belirlenmesi amaçlanmıştır. Bu amaçla; Khasa, Kawe-babasan, Kalsonan, Sangasar, Saruchawa ve Darmanaw köylerindeki toprak havuzlar seçilmiştir. Çalışma, yetiştiricilik dönemi ile hasat mevsimi arasındaki beş aylık (Mayıs-Eylül arası) dönemde gerçekleştirilmiştir. Aylık olarak, giriş suları (GS) ve havuz sularından (HS) su örnekleri alınmıştır. Su sıcaklığı (ºC), çözünmüş oksijen (DO), pH, elektriksel iletkenlik (EC), tuzluluk (Sa), toplam çözünmüş katılar (TDS), sertlik, amonyak (NH3+), nitrit (NO2), nitrat (NO3-), klorür (Cl-), sülfat (SO4) ve fosfat (PO4-) gibi bazı temel su parametrelerinin analizleri Süleymaniye Üniversitesi Laboratuvarı'nda yapılmıştır. Ayrıca, ağırlık kazanımını, yem dönüşüm oranını (FCR), balık etindeki nem, yağ, ham protein ve kül oranlarını belirlemek ve ayrıca duyusal analizler (yumuşaklık, sululuk, lezzet ve genel kabul edilebilirlik) yapabilmek için; hasat döneminde, serpme ağ kullanılarak her havuzdan rastgele altışar adet balık alınmıştır. Tüm yetiştiriciler aynı ticari yemi kullandığı için, yem rasyonuna bağlı sonuç karşılaştırması yapılmamıştır.

BULGULAR

Ölçümü yapılan fizikokimyasal parametrelerin ortalamaları giriş suyu ve havuz suyu için, 21.23/26.45 ºC (GS/HS) su sıcaklığı; 7.93/6.11 ppm ÇO (GS/HS); 7.73/7.85 pH (GS/HS); 405.63/423.5 EC (GS/HS); 0.11/0.11 ppt Sa (GS/HS); 255.7/259.9 ppm TDS (GS/HS); 188.23/162.01 ppm sertlik (GS/HS); 0/0.001 ppm NH3 (GS/HS); 3.2/0.07 ppm NO2 (GS/HS); 6.625/4.83 ppm NO3 (GS/HS); 6.66/46.76 ppm Cl

(GS/HS); 21.65/28.97 ppm SO4 (GS/HS) ve 0.28/0.33 ppm PO4 (GS/HS) olarak bulunmuştur.

Farklı balık havuzlarından alınan balık eti örneklerinin ortalama nem oranları (75.937 – 70.498%) arasında istatistiksel açıdan anlamlı farklılık bulunmazken ($P>0.05$), yağ oranı (13.36 - 6.33%), protein oranı (21.79 - 10.40%) ve kül oranı (2.35 - 1.01%) değerleri anlamlı derecede farklı bulunmuştur ($P<0.05$) (Tablo 1.4). Balık etinin kalitesini değerlendirmek için gerçekleştirilen duyusal analizler, yumuşaklıkta (5 üzerinden 4.8-3.0) ve genel kabul edilebilirlikte (5 üzerinden 4.8-3.6) anlamlı farklar olduğunu ($P<0.05$); sululukta (5 üzerinden 4.2-3.4 on 5) ve lezzette (5 üzerinden 4.6 ila 3.6) anlamlı farklar olmadığını ($P>0.05$) göstermiştir.

Tablo 1. Farklı toprak havuzlardan alınan balıkların etlerindeki nem oranları

Toprak havuzlar	% Nem
H_1	$74.934^a \pm 0.038$
H_2	$70.498^a \pm 0.041$
H_3	$72.981^a \pm 0.045$
H_4	$71.08^a \pm 0.037$
H_5	$73.953^a \pm 0.054$
H_6	$75.937^a \pm 0.051$

Tablo 2. Farklı toprak havuzlardan alınan balıkların etlerindeki protein oranları

Toprak havuzlar	% Protein
H_1	$13.400^{ab} \pm 0.090$
H_2	$16.200^a \pm 0.101$
H_3	$16.800^a \pm 0.185$
H_4	$13.200^b \pm 0.038$
H_5	$16.600^a \pm 0.069$
H_6	$15.400^a \pm 0.074$

Tablo 3. Farklı toprak havuzlardan alınan balıkların etlerindeki yağ oranları

Toprak havuzlar	% Yağ
H_1	$9.890^b \pm 0.313$
H_2	$10.189^b \pm 0.252$
H_3	$7.652^{bc} \pm 0.183$
H_4	$13.363^a \pm 0.097$
H_5	$7.622^{bc} \pm 0.352$
H_6	$6.335^c \pm 0.292$

Tablo 4. Farklı toprak havuzlardan alınan balıkların etlerindeki kül oranları

Toprak havuzlar	% Kül
H_1	1.068^{b} ±0.118
H_2	1.074^{b} ±0.097
H_3	2.335^{a} ±0.545
H_4	1.599^{ab} ±0.407
H_5	1.018^{b} ±0.093
H_6	1.561^{ab} ±0.359

SONUÇ

Süleymaniye ve Erbil'de artan nüfus ile birlikte balık etine olan talebin sadece doğal kaynakların kullanımıyla karşılanamayacağı ve yetiştiricilik faaliyetlerinin daha arttırılması gerektiği düşünülmektedir.

Yapılan çalışmada, 5-7 aylık yetiştiricilik dönemi süresince ağırlık kazanımının, optimum su sıcaklığı değerlerinin de etkisiyle, gayet yüksek olduğu ve bölgenin özellikle sazan yetiştiriciliği açısından son derece uygun olduğu görülmüştür. Ayrıca, balık etinin lezzetinin belirlenmesine yönelik yapılan duyusal analizler sonucunda da oldukça başarılı sonuçlar elde edilmiştir.

Bölgenin hem su kaynaklarının bolluğu hem de iklimsel elverişliliği sebebiyle sazan yetiştiriciliği için son derece uygun olmasına rağmen, verimlilik açısından eksikliklerin olduğu görülmüştür ve aynı durum, üreticiler tarafından da dile getirilmiştir. Su kaynaklarının daha verimli kullanılması, su giriş ve çıkışlarının revize edilerek özellikle hastalıkların bulaşma riskinin minimize edilmesi, su kaynaklarına beşeri kaynaklı kirleticilerin atılmasının mümkün mertebe önlenmesi ve bu kaynakların temiz tutulması gerekliliği görülmüştür.

Bölgede akuakültür verimliliğin ve kalitesinin arttırılması için, kapsamlı çalışmaların yapılmasına, teknik yönden daha gelişmiş sistemlerin kullanılmasına ve çevre bilinciyle su kaynaklarının temiz tutulmasına ihtiyaç olduğu görülmüştür.

Anahtar kelimeler: Duyusal değerlendirme, Et kalitesi, Ranya, Sazan, Su kalitesi, Toprak havuz.

CURRICULUM VITAE

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