Sana'a University Journal of Applied Sciences and Technology https://journals.su.edu.ye/index.php/jast
Vol. 2 | No. 1 | Page 30 – 40 | 2024 |
ISSN : 2958-9568
Doi: 10.59628/jast.v2i1.693

Study of environmental parameters of some water tanks and their aquaculture possibility from Sana'a governorate, Yemen

Ebtisam F. Shamsan[1,*], Hisham M. Nagi[2] and Mona M. Nagi[3]
[1]Department of Biological Sciences, Faculty of Science, Sana'a University, Sana'a, Yemen.
[2]Department of Environmental Sciences, Faculty of Petroleum and Natural Sciences, Sana'a University, Sana'a, Yemen.
[3]Sana'a Water and Sanitation Local Corporation (SWSLC), Sana'a, Yemen.
Corresponding author: *e.shamsan@su.edu.ye

ARTICLE INFO
Article history:
Received: Oct 24, 2023
Accepted: Dec 2, 2023
Published: Jan, 2024

KEYWORDS
1. Fresh water Tanks
2. Aquaculture
3. Water Quality
4. Yemen

ABSTRACT
Freshwater bodies in dams play an important role in providing local communities with several needs. Its aquatic ecosystems may help them in improving their socio-economic life, including aquaculture operations. Analyzing the water quality is an essential criterion for protecting aquatic ecosystems. The present study has investigated the water quality of selected two tanks (*i.e.*, Kamaran & Mesaibeeh water tanks, Sana'a Governorate, Yemen) to ensure their suitability to be used as a fish culture. Water sampling was conducted at monthly intervals between April 2013 and March 2014, and analyzed for the most important physio-chemical parameters to check their quality. The results of water's physio-chemicals of the two studied sites in the present investigation have shown suitable water quality conditions for fish culture concerning temperature, DO, pH, and TDS. Essential nutrients, for aquatic organism's growth (nitrate, nitrite, and phosphate), have been found at acceptable values in the two studied sites. The present study has shown a very good possibility for freshwater tanks to be used in aquaculture activities that may play an important role in providing a new source of aquatic food in the studied area and improving the socio-economic condition of the surrounding communities as well.

CONTENTS

1. Introduction:

Freshwater ecosystems, when managed appropriately, provide major services, such as fish production, water supply, nutrient transport, health benefits, and recreational value [1]. They are also used for domestic and irrigation purposes and provide ecosystems for aquatic life, particularly fish. Dams and reservoirs are constructed in small freshwater bodies such as streams and rivers. They are planned to meet several needs of humans such as energy generation, agricultural irrigation, supply of water, and flood control [2].

The term Water quality is frequently used to refer to criteria for assessing water. The physical, chemical, and biological properties are essential and important to test the water before it is used for drinking, domestic, agricultural, or industrial purposes, their analysis is important to protect the natural ecosystem [3]. Water quality determines the success or failure of an aquaculture operation [4]. One or more of these factors may affect the fish's physiological activities performed in the water, consequently, their survival, and health condition [5].

The potential sources of water contamination can be either natural like geological conditions and microorganisms, or anthropogenic resulting from industrial and agricultural activities [6]. This water contamination can affect the water quality and consequently human health as well as the ecosystem. Hence, water quality influences the distribution, abundance, and activities of freshwater organisms as well [7]. The continued degradation of water resources due to anthropogenic sources necessitates a guideline in selecting sites for aquaculture using water quality as a basis [4].

Low water quality may cause some common problems in the water ecosystem. These problems can be related to the floral organisms such as excessive algal blooms and plant overgrowth, noxious smells, or dead and dying fish. These undesired conditions can affect the health and growth of fish in natural and artificial ecosystems. On the other hand, good water quality is essential for survival and adequate fish growth [8]. Water quality in fish ponds is affected by the interactions of several chemical components [9] and climate [10]. Understanding basic water chemistry and physical parameters is necessary to prevent these problems [11], and may lead to better water quality management [12]. Subsequently, this fact should be taken into consideration for the success of fish farming.

It is also important to understand the sources and basic pathways of nutrients in water. There is a direct correlation between available nutrients and populations of algae and aquatic weeds. The most important nutrients in aquatic systems are phosphorus (P) and nitrogen (N) in the forms of phosphates (PO_4), nitrites (NO_2), and nitrates (NO_3) [11]. The main sources of nutrients in ponds are bottom silt, dead vegetation, landscape debris, runoff from the surrounding area, poorly functioning septic systems, and wastes from livestock and waterfowl.

Fish production is in decline in many parts of the world and not in concert with the market demands, this reflects on the fish costs in the markets and draws attention to the importance of building up artificial fish culture in different water ecosystems to meet the increasing human demands. This type of investigation becomes more significant especially if the fish culture practice is not common in a country like Yemen. According to data collected from the General Administration of Irrigation, Ministry of Agriculture, the number of water facilities in Sana'a- Yemen they reached 195 dams and tanks/reservoirs. Out of these, two tanks were chosen to study their water quality. The present research study aims to test the water quality of the two investigated tanks to ensure their suitability to be used for fish culturing. It is well noticed that there is a scarcity of information and past investigations related to this scientific field in the country.

2. Material and Methods

Study area

Sana'a governorate is located between 14° 43′ - 15° 59′ N latitudes and 43° 30′ - 45° 07′ E longitudes. Two sites were selected to be studied; the first site is *the Kamaran* freshwater tank (site1), which is located to the south of Sana'a City at 15° 16′ N and 44° 11′ E. This dam was built in 2005 with a storage capacity of 370,000 m^3. The second site is called *Musaibeeh* tank (site2) located 15 km to the east of Sana'a city at 15° 23′ N and 44° 19′ E. *Musaibeeh* tank was constructed in 2001, holding about 178,989 m^3 storage capacity. Both the tanks have muddy ground with a good volume of water throughout the year. These freshwater tanks are used for irrigation. The study sites are illustrated in Figure 1.

Figure 1. Location Map of Kamaran and Musaibeeh Water Tanks.

Water Analysis

Water sampling was conducted in the period from April 2013 to March 2014 monthly. Three random water samples were collected from each site each month and analyzed for physio-chemical parameters namely, temperature, total dissolved solids (TDS), salinity, dissolved oxygen (DO), and pH. Nutrients such as nitrates, nitrites, and Phosphate were also estimated. Water temperature was measured on the site with a mercury thermometer and the values are expressed as degrees centigrade (°C). Salinity was estimated using the Refractometer. The values are expressed as part per thousand (psu). Dissolved oxygen (DO) was estimated following standard Winkler's method and the values are expressed in mg/l. pH level was measured immediately in the field using a portable pH meter. Total dissolved solids (TDS) were estimated in the field, whereas nutrients were estimated in the laboratory.The data was analyzed for the difference between the parameters of both studied sites. The comparison was performed using the two-tailed t-test. Statistical program Graph pad prism was used.

3. Results

The results of water's physio-chemical parameters (monthly values, mean ± SD) of the two studied sites in the present investigation are shown in Table (1).

In the present research study, the temperature of the samples collected from the site1 varied from 21.88 °C in July 2013 to 16.00 °C in December 2013, while at site2, it ranged between a maximum of 21.29 °C in July 2013 and a minimum of 13.00 °C in the month of November 2013. Generally, at both sites, the temperature was low during winter (December – January), and was at its maximum during summer months (June – July). The average water temperature during the sampling period was recorded to be 19.06 °C and 17.66 °C from site1 and site2, respectively (Figure 2). There was a slight variation in the temperature values between the two tanks.

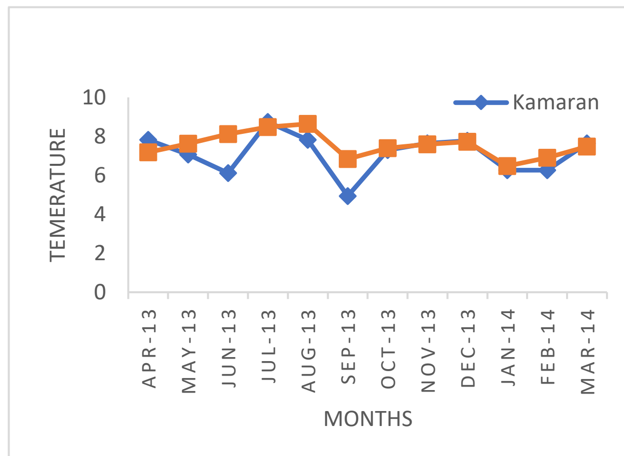

Figure 2. Monthly variation in water temperature during April 2013 – March 2014.

Dissolved oxygen values fluctuated in the range of 0.13 mg/l in September 2013 and 8.65 mg/l during May 2013 at site1. The concentration increased from April and reached its first peak (8.65 mg/l) in May 2013, and further fluctuated down to June 2013. Variations in DO values were observed from June to September 2013 as it gradually increased until August before it showed a sudden drop in September 2013 and later it gradually increased to reach the concentration of 8.10 mg/l in November 2013. However, DO values declined from November onwards till January 2014. The concentration showed a gradual increase until the month of March 2014. The average concentration of DO during the present study was estimated to be 4.47 mg/l.

At site2, the DO concentrations ranged between 0.09 mg/l and 7.23 mg/l with the minimum in July and maximum in May 2013, respectively. The average DO concentration during the present investigation was recorded to be 3.61 mg/l. DO increase from April to reach its highest concentration in May 2013, however, its concentration gradually decreased until it reached its minimum concentration in July 2013. An increase was recorded in August and a sudden drop was observed in the next month. Later, the DO concentration showed a slightly gradual increase until the month of January 2014, and then it gradually decreased in concentration in February and March 2014.

Figure 3 depicts the monthly variations in DO concentration during the sampling period of the present study.

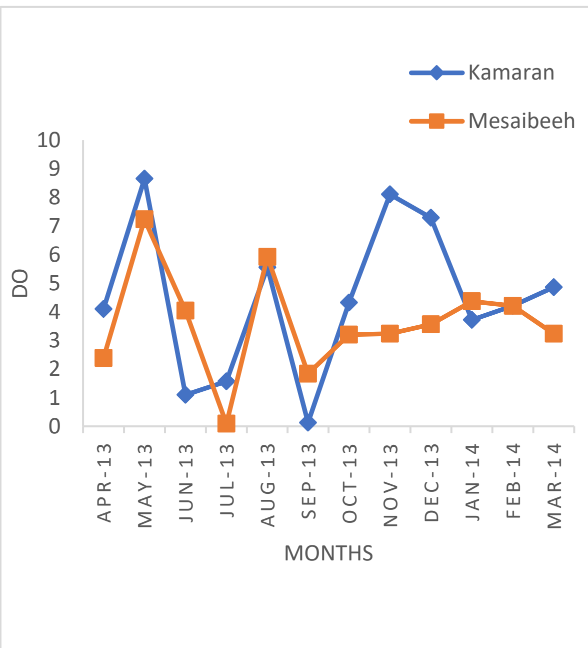

Figure 3. Monthly variation in the concentration of DO in water during April 2013 – March 2014.

In this investigation, pH values showed marked fluctuation at site1. Its values ranged from 4.94 in September 2013 to 8.74 in July 2013, with an average of 7.12. A gradual decrease in pH was recorded from April to June 2013 followed by a sudden increase in July. Again, it showed a gradual decrease to its minimum in September. It increased in October 2013 and remained stable until December. In January and February 2014, pH decreased to 6.27 and again it increased in March (Figure 4). At site2, pH values ranged from 6.48 in January 2014 to 8.64 in August 2013, with an average of 7.48. pH values increased slightly from April 2013 until their maximum in August. Then, it decreased in September, and again it increased gradually until December before dropping to its minimum in January 2014. From January to March, it showed a gradual increase (Figure 4).

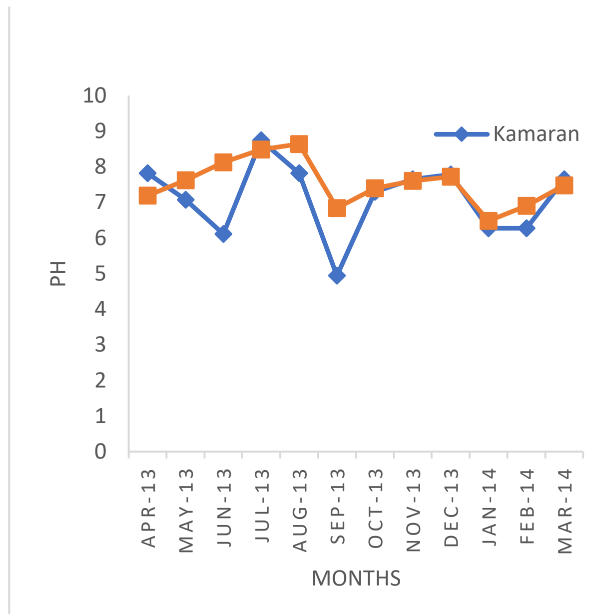

Figure 4. Monthly variation in water pH during April 2013 – March 2014.

The salinity of water ranged from 0.06 psu to 2.00 psu, with an average of 0.56 psu, and from 0.12 psu to 3.00 psu at Kamaran and Mesaibeeh, respectively. At Kamaran, water salinity was low during the months from April until November and then it gradually increased in later months (December – March). The same situation has been observed at the Mesaibeeh tank. The water salinity remained low during the same months as Kamaran station (April – October) with an exception as salinity increased in November and then again decreased in December 2013 (Figure 5). The water salinity increased slightly after that till March 2014.

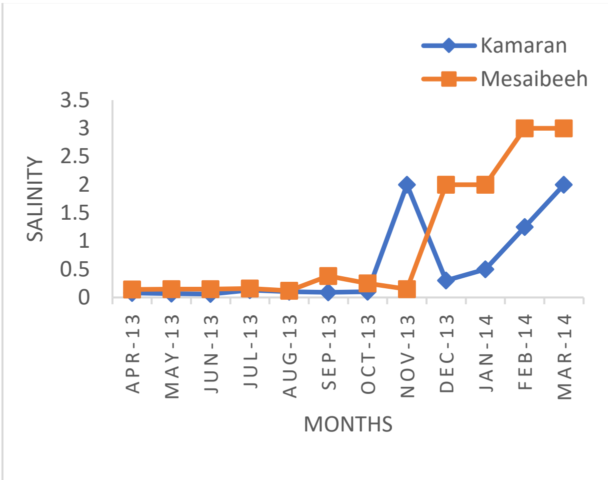

Figure 5. Monthly variation in water salinity during April 2013 – March 2014.

Total Dissolved Solids (TDS) values showed slight variations at site1 during the study period (Figure 6). The values were ranging from 85 mg/l to 144.6 mg/l. The mean concentration of TDS in this site during the *present* investigation was found to be 125.1 mg/l. With regards to site2, TDS showed a marked fluctuation during the present study. During the first 4 months, TDS showed a slight increase in the values then dropped down slightly in August before jumping to its maximum value that was recorded during the present investigation (500 mg/l) in September 2013 (Figure 6). After that, it gradually decreased to reach its minimum value of 215.2 mg/l in December 2013. Then it was increasing gradually until the end of the investigation. The TDS mean concentration during the present study was calculated to be approximately 235.33 mg/l in site2.

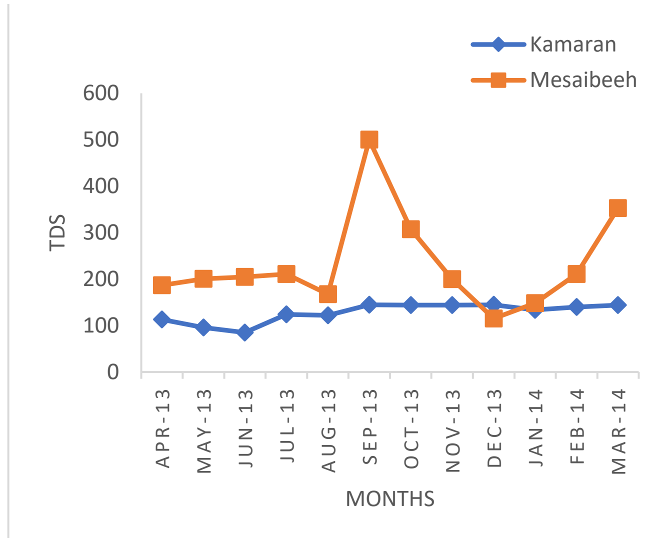

Figure 6. Monthly variation in the concentration of TDS in water during April 2013 – March 2014.

Table 1: Kamaran & Mesaibeeh Tanks: Environmental Parameters

Month	Temperature (°C)		DO (mg/l)		pH		TDS (s/l)		Salinity (psu)	
	Site1	***Site2***	***Site1***	***Site2***	***Site1***	***Site2***	***Site1***	***Site2***	***Site1***	***Site2***
Apr 2013	19.42	18.77	4.10	2.39	7.82	7.19	113	187	0.08	0.14
May 2013	19.81	17.66	8.65	7.23	7.07	7.62	96	200.6	0.07	0.15
Jun 2013	20.07	19.00	1.10	4.04	6.11	8.12	85	205	0.06	0.15
Jul 2013	21.88	21.29	1.57	0.09	8.74	8.48	124	211	0.13	0.16
Aug 2013	19.31	18.50	5.55	5.92	7.82	8.64	122	167.8	0.10	0.12
Sep 2013	19.08	16.72	0.13	1.84	4.94	6.84	144.5	500	0.09	0.38
Oct 2013	19.04	16.00	4.32	3.20	7.30	7.40	144.3	307	0.10	0.25
Nov 2013	19.00	13.00	8.10	3.24	7.65	7.60	144	200	2.00	0.15
Dec 2013	16.00	15.00	7.29	3.56	7.78	7.72	144.6	115.2	0.30	2.00
Jan 2014	18.00	18.00	3.72	4.37	6.27	6.48	134	148	0.50	2.00
Feb 2014	18.20	21.00	4.21	4.21	6.27	6.90	140	211	1.25	3.00
Mar 2014	19.00	18.00	4.86	3.24	7.65	7.48	144 `	353	2.00	3.00
Mean	**19.06**	**17.75**	**4.47**	**3.61**	**7.12**	**7.48**	**125.1**	**235.3**	**0.56**	**0.96**
S.D.	***2.348***	***1.380***	***1.834***	***2.685***	***0.6496***	***1.038***	***105.5***	***20.57***	***1.180***	***0.7534***

Nutrients: The present investigation has estimated different essential nutrient compounds, which are presented in Table 2.

Table 2: Concentration of Nutrient compounds in Kamaran & Mesaibeeh Tanks.

Month	NO_3^- (mg/l)		NO_2^- (mg/l)		PO_4^{-3} (mg/l)	
	Site1	*Site2*	*Site1*	*Site2*	*Site1*	*Site2*
Apr 2013	-	-	-	-	-	-
May 2013	16.40	0.50	0.33	0.10	3.87	5.13
Jun 2013	24.80	13.25	0.18	0.01	4.39	3.65
Jul 2013	14.03	16.10	0.02	0.02	4.02	2.57
Aug 2013	24.60	26.84	0.00	0.19	3.38	2.06
Sep 2013	18.60	25.10	0.02	0.03	6.66	6.02
Oct 2013	16.32	18.27	0.04	0.06	4.31	4.56
Nov 2013	14.20	15.67	0.09	0.09	2.35	2.01
Dec 2013	12.34	13.20	0.08	0.01	2.30	1.41
Jan 2014	11.4	10.56	0.03	0.01	2.49	1.24
Feb 2014	19.10	2.40	0.001	0.06	2.13	1.76
Mar 2014	21.20	0.00	0.03	0.05	1.85	2.03
Mean	**17.54**	**12.90**	**0.075**	**0.067**	**3.43**	**2.95**
S.D.	**4.59**	**9.15**	**0.099**	**0.054**	**1.42**	**1.63**

Nitrate values were observed to fluctuate in different months during the period of the present study in both tanks (Figure 7). The range of values was between 11.4mg/l and 24.8 mg/l in site1 with an average value of 17.54 mg/l, the highest value was recorded in June 2013 and the lowest was in January 2014. While, the highest value of NO_3^-, at site2, was observed during August 2013 (26.84 mg/l), and the lowest value was recorded during March 2014 (0 mg). The average value of Nitrate in site2 was estimated to be 12.90 mg/l.

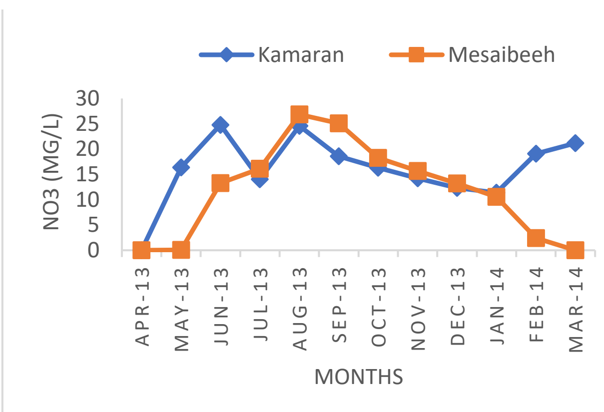

Figure 7. Monthly variation in the concentration of Nitrates (mg/l) in water during April 2013 – March 2014

The results of nitrite evaluation in the present study showed that values ranged from 0.00 mg /l to 0.33 mg /l at site1. At site2, NO_2^- concentrations showed, more or less, a similar trend to that from site1 and ranged between a minimum of 0.01 mg /l to a maximum of 0.19 mg /l (Figure 8). The average values during the study period were estimated to be 0.075 mg/l and 0.067 mg/l in site1 and site2, respectively.

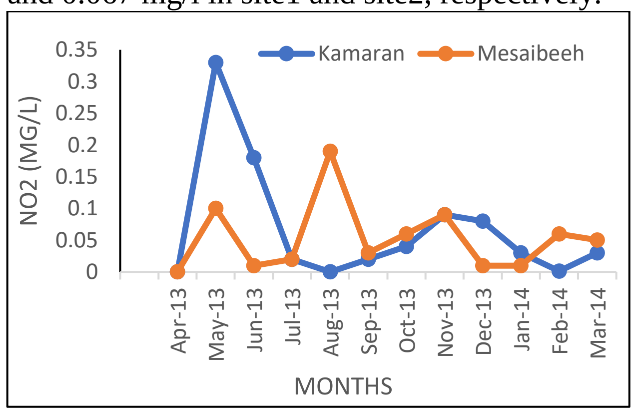

Figure 8. Monthly variation in the concentration of Nitrite (mg/l) in water during April 2013 – March 2014.

Values of phosphate in the present investigation ranged between 6.66 mg /l and 1.85 mg /l at site1, while it was observed to vary from 6.02 mg /l to 1.24 mg /l at site2. Overall, the highest concentrations of PO_4^{-3} at both stations were observed during May and September 2013 (Figure 9). The average concentrations of PO_4^{-3}

in site1 and site2 were calculated to be 3.43 mg and 2.95 mg, respectively.

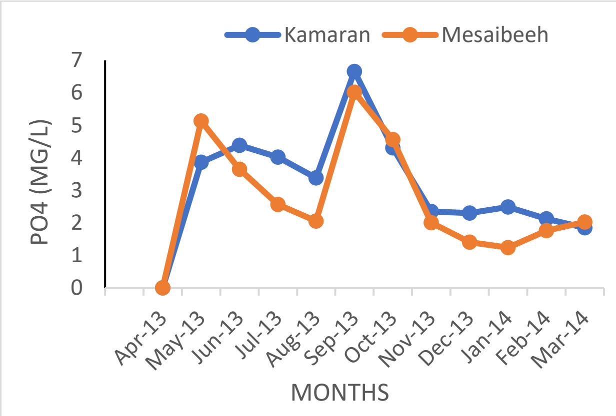

Figure 9. Monthly variation in the concentration of Phosphate (mg/l) in water during April 2013 – March 2014.

4. Discussion

Fish farming has become very popular in recent years as this process provides local communities with subsistence food. Water quality plays an important factor in culturing aquatic organisms. Poor or good quality water could affect the health and growth of these aquatic organisms. Physio-chemical parameters of water may indicate the water quality that can be beneficial for both irrigation and aquaculture purposes. Efficient aquaculture production depends upon maintaining acceptable water quality conditions in culture units [13].

Water temperature is one of the major factors affecting the freshwater ecosystem, and it represents an important factor that determines the acceptability of water for human consumption and uses. It regulates the level of dissolved oxygen and metabolic activity rates of fish [14] and other aquatic organisms as well. Identifying the species to be cultured in a specific water tank depends essentially on the optimum aquaculture temperature of that particular species [15].

Any fluctuation in temperature and other parameters in any water dam may result from the negative impact of the dam construction on the ecosystem [2]. The water temperature of both tanks was generally in the range recommended for aquaculture as documented by Choudhary *et al.* [16] and De [17], who reported the optimum temperature of water for fish culture to be ranged between 20 and 30 ºC. Likewise, Mou *et al*. [18] reported temperatures at a similar range when they studied the water quality of some selected hatcheries.

Ogunbanwo [19] mentioned that temperatures from 28 – 32 ºC suit major carp, while Santhosh and Singh [20] stated that a temperature between 24 and 30 is suitable for carp culture. Along the same line, Shyamala *et al.* [21] also considered the temperature between 24.75 to 28.5°C as a suitable range for commercial fish production. The result reported by Goran *et al* [22] ranged from 21.4 to 26.7 °C, which was also in agreement with the result of the present study.

DO plays an important role as an environmental parameter for the growth, survival, distribution, behavior, and physiology of aquatic life [18]. Barnabe [15] mentioned that the oxygen concentration in the natural environment varies from 8 mg/l in cold waters to 4.5 mg/l in tropical waters. It could fluctuate daily and seasonally depending on temperature, salinity, and pressure variations. According to Bhatnagar *et al.* [23], and Bhatnagar and Singh [24], a DO level of more than 5 mg /1 is essential to support good fish production. Parker [25] reported that water must contain enough dissolved oxygen, which should be between 4-8 mg/l for most aquatic animals. The results of the present study were consistent with the previous studies, they showed a sufficient amount of water DO in most months of the year. The average of DO throughout the year during the research study was found to be 4.47 and 3.61 mg/l in site1 and site2, respectively. Such values indicate that the studied sites are suitable and considered promising sites for fish farming.

It is worth mentioning that there was one abnormal reading of DO (0.13 mg/l) in site1, and (0.09 mg/l) in site2 as well, the reason behind this could be a high level of degradation that led to consume oxygen during that time or it was a practical error. Any way these readings didn't make much change in the average values.

The term pH refers to the concentration of hydrogen ions and is a measure of whether a substance is an acid, a base, or neutral. The pH of some freshwater ponds can change during the day, but this change can be tolerated by fish. These fluctuations are due to photosynthesis and respiration by plants and animals. The value of pH affects most of the metabolic activities of aquatic organisms [26]. The water of the fish farm must not be too acidic or too alkaline, and the best pH for fish production ranges between 6.5 and 9.0 [25]. According to USEPA [27], a pH range of 6.5-9.0 units would be suitable for the protection of aquatic habitats, and values less than 6.5 may be harmful to many fish species [28]. The growth of the fish is affected by pH between 4 and 6, while the pH level that affects the reproduction is greater than 9 (9 – 10) as mentioned by Parker [25], and mortality may occur at pH less than 4 and higher than pH 10. All the pH values in the present study were in the optimum range for fish health except for the value of 4.94 during September in site1. The pH values obtained in the present study are adequate for aquatic life including fish within the range of 6.5-8.5 recommended by Egemen [29].

Salinity is the dissolved salt content of a water body. It is a strong contributor to conductivity and helps determine many aspects of the chemistry of natural waters and the biological processes within them. Salts can be toxic to freshwater plants and animals like fish. Freshwater wetlands typically have a salinity measure of less than 0.5 ppt, Barnabe [15] also classified the aquatic environment of salinity 0.5ppt or less as freshwater and 0.5 - 3ppt as oligohaline.

In the current investigation, salinity was measured to be in a normal range for freshwater in both tanks (Figure 5), with an exceptional increase in some months; November, February, and March in site1 and December to March in site2, in which the salinity was raised to 2 psu and 3 psu in both tanks, respectively. During this, rainfall is scarce as Yemen is characterized by a rainy season during summer when it is affected by the monsoon. During winter, evaporation is higher than precipitation which leads to increased values of salinity. Moreover, it seems that water runoff which has increased during those months has been washed with salty materials resulting either from the nature of the soil or from the agricultural lands upstream. However, salinity in the studied sites was in normal values reported by Barnabe in most months of the year.

The total dissolved solids (TDS) in water represents the total concentration of dissolved substances in water. It is a measure of all inorganic and organic matter found in water [30]. The proportions in which these compounds are present create a balanced solution. The concentration and composition of TDS in natural water depend on the geology of the watershed, precipitation, and evaporation [31]. The standard level of TDS for fisheries is about 165 mg/l and the suitable range is 160 to 200 mg/l for growth and production [32,33]. Biotic communities and biodiversity could be affected by the concentration of TDS in the aquatic environment [34]. The amount of 2,000 mg/l TDS in natural water is known to affect sensitive species and young individuals of other species. Although, concentrations that are too high or low can be harmful to fish and may affect growth or cause death, some species like catfishes are capable of tolerating high levels of TDS that may reach 6,000 – 11,000 mg/l [25].

Weber-Scannell and Duffy [34] reviewed several studies that dealt with the effects of TDS on aquatic organisms. All the reviewed studies of the effects of elevated TDS on freshwater plants, algae, bacteria, and invertebrates reported higher values of TDS concentrations that could negatively affect the aquatic organisms. Furthermore, James [35] stated that the maximum TDS value of 400 mg/l is permissible for diverse fish production in aquaculture. Accordingly, those values far exceed the TDS values reported in the present study. In general, the TDS concentration during the present study was found to be safe on several aquatic organisms. The average TDS values found are 125.11 and 235.33 mg/l in site1 and site2, respectively**.** This clearly indicates that the two studied sites could be safe sites for fish culture from the TDS concentration point of view.

Nutrients:

Nutrients play an important role in the aquatic system, hence, for successful pond management, their role benefits must be understood. Since the most important nutrients in aquatic systems are phosphorus (P) in the forms of phosphates (PO_4^{-3}), and nitrogen (N) in two forms nitrates (NO_3^-) and nitrite (NO_2^-), this investigation is designed to estimate these compounds for their great significance for the growth of plants and animals in the aquatic systems.

Nitrates (NO_3^-) is an inorganic component that is the stable form of combined nitrogen for oxygenated systems. It is not normally dangerous and considered nontoxic to fish, nor for human health, unless it is reduced to nitrite, and considerably less toxic than other nitrogen waste compounds [36]. Although nitrate levels in surface and groundwaters are generally a few milligrams per liter it is usually higher than those of ammonia and nitrite in both freshwater and marine ecosystems as well [37]. However, fish can tolerate several hundred mg/l of nitrate [25]. Elevations in the level of nitrate appear in the water as a result of human activities. As mentioned by Follett *et al.* [38] the sources of nitrate in surface waters may include geologic deposits, wild-animal wastes, precipitation, septic system drainage, feedlot drainage, dairy and poultry production, municipal and industrial waste, and fertilizer.

Ideally, nitrate levels in a freshwater aquarium should be kept below 20 mg/l but levels from 0 – 40 ppm are mostly safe for fish, while concentrations greater than 80 mg/l could be toxic. These nutrients are usually a sign of a cycling tank, overfeeding, overcrowding, or other poor fish aquarium maintenance. Long-term exposure to sub-critical concentrations of nitrate stresses fish, making them more susceptible to disease, interfering with the growth of the young, and decreasing the likelihood of reproduction [39]. Julio *et al.* [37] reported that nitrate concentrations were raised up to approximately 800ppm before they became lethal to guppy, it is recommended to keep less than 80-100ppm nitrate in the fish tanks. Nitrate values were observed to fluctuate in different months during the period of the present study in both tanks with an average of 17.54 and 12.90 mg/l in site1 and site2, respectively. The values were below permissible limits for fishponds (*i.e.*, 50 ppm) as reported by Goran *et al.* [22]. According to [40], there is no concentration effects on fish have been reported at nitrate levels below 100 mg NO_3^-/l. The fluctuating values of nitrates in this study could be attributed to wild-animal wastes, precipitation, and fertilizers used in the surrounding/ nearby agricultural area. However, nitrate was found in acceptable amounts for fish life, in both tanks.

Nitrite is the univalent radical NO_2^-, which contains nitrogen in a relatively unstable oxidation state [41]. It resulted when nitrifying bacteria process ammonia as a kind of biological filter. It may lead to fish suffocation even when the oxygen level is sufficient in water [42]. It also can cause stress in fish if it exceeds 0.75 ppm and can be toxic if the level is greater than 5 ppm in water. Evaluation of nitrite concentrations in the present study showed that average values were estimated to be 0.075 mg/l and 0.067 mg/l in site1 and site2, respectively. These results were found to be acceptable and suitable for the life of fish in both tanks.

Phosphate (PO_4^{-3}) represents one of the minor constituent anions, which occur in concentrations less than 0.1 mg/l in natural surface and well waters. Like nitrate, phosphate is considered harmless if we ignore its role in promoting the growth of undesired algae in the water [25]. Phosphorus is widely used as an agricultural fertilizer and as a major constituent of detergents. Important phosphorus contribution to surface waters comes from run-off and sewage discharge. In other cases, limit values of 0.2 mg/l for salmonid and 0.4 mg/l for cyprinid in Ireland [43]. The phosphate values obtained in the present study are normal for aquatic ecosystems within the recommended range of 0.05-0.3 as mentioned by Cirik and Cirik [44]. According to Bulut *et al*. [45], when phosphate concentration is over 0.30 mg/l, it means that eutrophication occurs in the lake. The average concentrations of PO_4 in site1 and site2 were calculated to be 3.43 mg and 2.95 mg, respectively. However, although the values were higher than the recommended during some months, the phosphate was at a good value during most months of the study period.

Statistical analysis that is used for comparing all the studied parameters between site1 and site2 using t-test analysis showed that the only environmental parameter observed to be significantly different between the two tanks is TDS ($p < 0.05$). The other environmental parameters (water temperature, DO, pH, and salinity) and nutrients (NO_3, NO_2, PO_4) of both tanks did not show any significant differences ($p > 0.05$, r^2) among the months of the study period.

5. Conclusion

Freshwater tanks could be used for several purposes including fish farming and other aquatic organisms. Create jobs and support the economic situation of poor communities. The present research study has found that both Kamaran and Mesaibeeh freshwater tanks are suitable for fish farming. Analysis of physio-chemical parameters of water samples, i.e., temperature, salinity, dissolved oxygen, pH, and total dissolved solids, in addition to nutrient analysis, showed that their values were within permissible limits for farming aquatic organisms. These results suggest that the studied sites promising ones for fish farming.

6. References

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