ISSN: 1343-4292
Volume 140, Issue 04, July, 2022

Health safety of use water for livestock and poultry watering: A case study of water for Al-danvali valley and Tigris river in Mosul city. north Iraq.

Mhmood fayz M. Al-Mashhadany[1], Abdulazeez Younis T. Al-Saffawi[2]

Dept. of Biology, coll. of Educt. for Girls, Mosul University[1]
Dept. of Biology, coll. of Educt. for Pure Scince. Mosul University[2]

ABSTRACT— The health safety of the waters of the Danvali Valley and the Tigris river in Mosul city for watering livestock and poultry were studied. Samples were collected from ten sites and at a rate of one sample per month from October 2020 to November 2021 to measure each of the physical, chemical and biological properties according to international standard methods with the application of the weighted sub-index (WQI) model for water quality assessment. The results indicated that the WQI values of the valley water increased to reach (937.9, 1198, 1146, 10386) during the winter, spring, autumn and summer seasons consecutively. Thus, the waters of the valley and the Tigris River are from the category of water unfit to very poor for watering livestock and poultry. The deterioration in quality is mainly attributed to the high organic load of the waters of the valley and the Tigris River, which amounted to (8-19.2) (2.7-12.2) ppm, as well as the number of faecal coliform bacteria ranged between (158-778) and (146-777) cells. 100 ml^{-1} consecutively. The study recommended not to use water for irrigation of livestock and poultry because of its negative impact on animal health and productivity.

KEYWORDS: Aldanvali valley Sub-Index WQI, Livestock watering.

1. INTRODUCTION

Water is a blessing from God on creatures for its vital role in the activities that occur inside the bodies of living organisms [1], so a good quality of water must be provided for livestock watering in order to maintain the health and productivity of livestock and poultry (production of meat, milk, eggs, etc.), as well as its importance for growth, lactation and reproduction. Unfortunately, the belief There is a common mistake among citizens, especially third world countries, that animals can drink any kind of water, even polluted ones. But the shocking fact is that it prefers clean and healthy water and is averse to drinking poor quality water, but it is forced to drink poor quality water when thirsty and the lack of clean water to meet its water requirements, which negatively affects its health and productivity [2], [3].

Relatively cold drinking water plays a role in relieving the heat pressure of the bodies of livestock and poultry, especially during the hot months of the year, as well as the processes of water evaporation from the skin or through the breathing process, which moderates the body heat and maintains livestock activities. As for high salinity water, it negatively affects health and productivity. Animals are in addition to the various dangerous diseases that they infect [4], as the rate of increase in production reaches 23% for animals irrigated with pure water compared to animals that drink salt water [5], and turkey is one of the most affected poultry High salinity of drinking water.

In general, the amount of water needed by livestock varies according to the following factors [6]:

1- The size and enormity of the animal.

2- Amount of feed handled.
3. Growth stage and age of the animal.
4. Air temperature.

The consumption of poor quality water by animals will lead to disease while reducing their feed intake and thus reducing their productivity of meat, milk and eggs, which negatively affects the profits of breeders as well as the national economy [7], [8]. For example, high levels of sulfates, specifically magnesium sulfate salts, in Livestock water lead to diarrhea and a lack of desire to drink at first, but the effects ($MgSO_4$) are exacerbated to more serious, such as paralysis of young calves because sulfate ions in the presence of copper and molybdenum ions lead to the occurrence of reactions that ultimately lead to brain damage in animals [4]. As for contamination with microbial pathogens, it has a significant impact on the health of livestock and poultry and its infection with diseases that can be transmitted to humans through infected animal products. Generally, drinking clean and healthy water increases its resistance to diseases, so breeders must provide clean water and, when necessary, treat contaminated water because processing costs are recovered by increasing production in a short time [6], [9], [10].

2. Materials and Methods

2.1 General description Location of the Study

Al-danvali valley is one of the natural valleys to transfer rainwater to the Tigris river. with the passage of time and the expansion of Mosul city with neglect and lack of application of deterrent laws, the local residents dumped wastewater into the valley instead of discharging it to septic tanks, bringing the valley discharge rate between (134.04 to 154.6) m^3 per minute, which reflects negatively on the Aquatic Ecosystem of the Tigris river. As the valley transfers waste water from Al-Khadra, parts of the Aden, Al-Bakr quarters, the left side industry, Al-Ghufran quarter etc. The valley passes through agricultural lands whose water is used to irrigate crops and watering animals sometimes until it meets the Tigris river, south of Mosul city.

2.2 Methodology

10 sites were selected to collect water samples (7) of them on the valley, the rest on the Tigris river) using clean polyethylene bottles and sterile vials for microbial assays, to measure the physical properties (temperature, salinity) and chemical (pH, total hardness, alkalinity, dissolved oxygen, organic ion load, positive and negative ions, with bacterial tests conducted based on international standard methods [11], [12]. Table (1) and Figure (1) shows the characteristics and locations of collecting water samples.

2.3 Determination of Sub-Index (WQI)

The Weighted Sub-Index (WQI) model was used on eleven parameters to determine the degree of pollution and the suitability of the waters of the valley and the Tigris river in the study area for watering livestock and poultry, as indicated by [13- 15], where a weight (wi) is given for each characteristic (1-5) according to the degree of its impact on

Table (1) Characteristics of the study area and water sample collection sites

Station	Latitude	Longitude	Altitude (m)	Uses
1	36º35′58″	432092	265	irrigation, livestock and poultry watering
2	36º3634	432101	265	
3	36º3522	431991	260	

ISSN: 1343-4292
Volume 140, Issue 04, July, 2022

4	36º3520	431966	260	
5	363458	431973	255	
6	363346	431843	252	
7	363257	431727	238	
8	363260	431685	233	
9	363186	431730	226	
10	363178	431731	226	

Figure (1) A satellite image of the sites for collecting water samples

water quality. For example, the weight is given to potassium ions 1 because their concentration in the studied water is relatively low, while the weight is given 5 for faecal bacteria as shown in the table (2)

The value of the WQI index is estimated by calculating the relative weight (RWi) first, then calculating the Quality rating (QRi), then calculating the Sbi sub-index, and finally, the value of the water quality index is estimated as in the following equations [14- 16]:

$$RWi = \frac{wi}{\sum wi}$$

Table (2) the weight (wi) and relative weights (Rwi) of the studied parameters to estimate (WQI).

Param.	S. limit	wi	Rwi
TCº	20-28	3	0.07317
PH	6-8.5	4	0.09756
EC_{25}	1000	5	0.12195
DO	5	5	0.12195
BOD_5	5	5	0.12195
T.Alk.	820	2	0.04878
Na^+	300	3	0.07317
K^+	20	1	0.02439
PO_4^-	2.15	4	0.09756

SO_4^-	300	4	0.09756
F.coli	100	5	0.121950
∑		41	1.000000

$$QRi = \frac{Ci}{Sti} \times 100$$

$$Sbi = Rwi \times QRi$$

$$\text{Sub-index (WQI)} = \sum_{i=1}^{n} Sli$$

Where: Ci: parameter concentration for the studied water., Sti: The standard level allowed for each parameter.

After that, the comparison is made with the classification of water quality that he referred to [17], [18].

Table (3) Classification of water quality according to the values of WQI.

WQI values	≤ 50	50 to100	100 to200	200 to300	≥ 300
Category	Exc.	Good	Poor	Very P.	Unfit
Class	I	II	III	IV	V

3. Results and discussion

The results shown in Tables (4,5, 6.7) indicate that the values of the water quality index (WQI) for water of Al-danvali valley were high during the winter, spring, summer and autumn seasons, reaching 973.9, 1198, 1207, 1038, as it is considered a category of unsuitable water for livestock and poultry watering, while the water of the Tigris river in the site (8, 10), the water quality is of a very poor category. This deterioration in quality is mainly due to the high values of Sbi for each of the organic load, which amounted to 46.83, 46.83, 40.986, 38.66 during the study seasons, respectively, and the total

Table (4): Sbi values and pollution index (WQI) for the studied water during the winter season

Sites / Param.		Al-danvali valley							**Tigris river**		
		1	2	3	4	5	6	7	8	9	10
T˚C		3.323	4.085	4.085	4.085	4.085	4.085	4.085	3.384	3.567	3.476
PH		9.366	9.366	9.626	9.496	9.366	9.366	9.366	10.02	9.756	10.02
EC25		8.146	8.268	8.280	8.134	8.353	9.975	8.610	5.341	6.354	5.524
DO		7.073	4.878	6.098	8.049	5.854	7.805	4.634	23.66	14.88	17.80
BOD		46.83	27.32	25.37	19.51	27.32	19.51	25.37	11.22	29.76	24.39
TA		12.82	12.96	17.53	13.98	13.50	18.00	13.98	9.615	11.93	9.343
Na		1.602	1.667	1.837	1.650	1.748	2.041	2.081	0.797	1.350	0.861
K		1.499	1.138	1.341	1.211	1.211	1.378	1.549	0.695	0.890	0.646
PO4		17.74	2.360	3.040	1.633	5.990	4.175	6.307	1.089	2.541	1.180
SO4		5.203	4.813	4.260	5.496	3.772	3.707	4.780	2.383	3.076	2.387
F.COLI		525.6	358.5	709.8	756.0	892.7	864.6	552.4	208.5	279.2	263.4
WDI	Value	639.2	435.4	791.3	829.2	973.9	944.6	633.2	276.7	363.3	339.0
	Class	V	V	V	V	V	V	V	IV	V	IV
	Status	Unfit	Unfit	Unfit	Unfit	Unfit	Unfit	Unfit	V.P	Unfit	V.P

Table (5): Sbi and pollution Index (WQI) values for the studied water during the spring season.

Sites	Al-danvali valley	**Tigris river**

ISSN: 1343-4292
Volume 140, Issue 04, July, 2022

Param.		1	2	3	4	5	6	7	8	9	10
T˚C		1	2	3	4	5	6	7	8	9	10
PH		7.770	7.622	7.713	7.622	7.805	7.591	7.256	5.945	6.646	6.494
EC25		9.236	9.106	9.106	9.106	8.976	9.106	9.106	9.756	9.366	9.756
DO		9.098	9.780	9.756	9.366	10.37	12.68	12.04	5.183	7.122	5.463
BOD		2.439	2.195	5.122	5.122	3.415	1.463	3.415	16.59	9.024	12.68
TA		43.90	45.85	46.83	43.90	38.05	45.85	46.83	6.585	21.22	19.51
Na		16.37	15.68	16.64	16.78	16.84	18.07	18.55	10.91	13.71	10.77
K		1.744	1.921	1.835	1.817	2.079	2.500	2.311	0.774	1.451	0.878
PO4		1.951	1.524	1.646	1.646	1.646	2.073	2.109	1.128	1.189	0.854
SO4		18.61	1.679	3.494	10.39	8.939	14.70	13.16	1.634	2.904	1.225
F.COLI		5.301	6.244	5.431	4.618	4.650	4.813	3.740	2.293	3.129	2.693
WDI	Value	354.4	343.1	647.5	573.3	1198	1068	642.9	238.8	413.6	289.8
	Class	V	V	V	V	V	V	V	IV	V	IV
	Status	Unfit	Unfit	Unfit	Unfit	Unfit	Unfit	Unfit	V.P	Unfit	V.P

alkalinity, which reached (18.0, 18.55, 16.78, 17.18) and phosphate ions, which amounted to (17.71, 18.61, 22.28, 14.89).

The same was the case with F. Colif bacteria, where the values of Sbi reached 892.7, 1095, 1050, 956.16) respectively. As well as a rise in the Sbi values of dissolved oxygen, especially during the summer, to reach (60.98). The same is true for the waters of the Tigris River, as the values of Sbi are relatively high for most parameters, but they are less than in the waters of the valley as shown in the tables.

Table (6): Sbi and pollution Index (WQI) values for the studied water during the summer season

Sites / Param.		Al-danvali valley							**Tigris river**		
		1	2	3	4	5	6	7	8	9	10
T˚C		9.146	9.146	9.146	9.146	9.146	9.146	9.238	6.341	7.256	6.86
PH		9.366	9.236	9.366	9.886	9.236	9.236	9.366	9.886	9.496	9.626
EC25		8.976	7.573	8.915	8.951	9.195	12.05	11.73	5.171	6.890	5.659
DO		60.97	60.98	60.97	60.98	60.98	60.97	60.97	16.83	8.537	13.66
BOD		39.02	40.98	38.05	37.07	36.01	38.05	37.07	7.805	17.56	13.90
TA		16.71	14.39	15.13	15.62	15.82	16.78	16.78	10.43	12.07	10.80
Na		1.592	1.567	1.506	1.506	1.610	2.354	2.165	0.659	1.207	0.713
K		1.951	1.707	1.707	1.707	1.683	1.890	2.073	0.701	1.067	0.762
PO4		22.28	2.541	5.990	7.033	9.801	18.79	19.20	0.908	2.677	1.361
SO4		5.756	4.976	5.496	3.935	3.447	4.260	3.285	2.270	2.647	2.068
F.COLI		264.6	339.0	495.1	504.9	1050	428.0	192.7	234.1	302.4	189.0
WDI	Value	440.4	492.1	651.4	660.8	1207	601.6	364.6	295.1	371.8	254.4
	Class	V	V	V	V	V	V	V	IV	V	IV
	Status	Unfit	Unfit	Unfit	Unfit	Unfit	Unfit	Unfit	V.P	Unfit	V.P

Table (7): Sbi and pollution Index (WQI) values for the studied water during the autumn season

Sites / Param.	Al-danvali valley							**Tigris river**		
	1	2	3	4	5	6	7	8	9	10
T˚C	7.927	8.140	8.018	8.018	7.835	7.713	7.835	6.707	7.012	7.226
PH	8.976	8.976	9.106	9.106	9.106	9.106	9.106	9.496	9.236	9.366
EC25	8.439	8.720	8.646	8.512	8.463	12.68	12.06	4.159	6.463	5.451
DO	4.146	4.146	4.146	0.976	0.976	0.976	0.976	14.15	8.537	11.71
BOD	27.32	30.00	27.31	24.63	26.01	20.80	33.66	9.757	15.93	13.99
TA	15.41	14.05	14.46	14.73	14.87	17.18	16.78	10.09	10.91	9.956

Na		1.520	1.618	1.537	1.537	1.618	2.374	2.358	0.683	1.236	0.756
K		2.279	1.869	1.829	1.869	1.869	2.155	2.317	0.813	1.210	0.935
PO4		14.89	0.726	4.946	5.899	6.081	8.123	8.440	0.227	0.635	0.454
SO4		5.495	3.772	3.675	3.317	3.132	3.935	3.740	1.551	2.286	1.880
F.COLI		547.6	956.1	441.5	751.2	874.4	491.5	687.8	320.7	459.8	210.1
WDI	Value	644.0	1038	525.1	829.8	954.4	576.5	785.1	378.3	523.2	271.8
	Class	V	V	V	V	V	V	V	V	V	IV
	Status	Unfit	Unfit	Unfit	Unfit	Unfit	Unfit	Unfit	Unfit	Unfit	V.P

The results of laboratory analyzes of the concentration of each of the dissolved oxygen and the organic load shown in the two figures (2, 3) confirm the significant decrease in the concentration of dissolved oxygen in the water of the valley, ranging from (0.0 to 3.2) mg. l^{-1} to be absent in the summer in the water of the valley, Also, its decrease in the waters of the Tigris River is less than the permissible limits for watering livestock and poultry in site 9 as a result of the effect of the waters of the valley that flow into the river. to raise the concentration of dissolved oxygen to the permissible limits for drinking at site 10 due to the factors of dilution and diffusion and this is due to the high concentration of organic materials that lead to oxygen consumption and this explains the annoying smell emanating from the valley, especially during the summer [18].

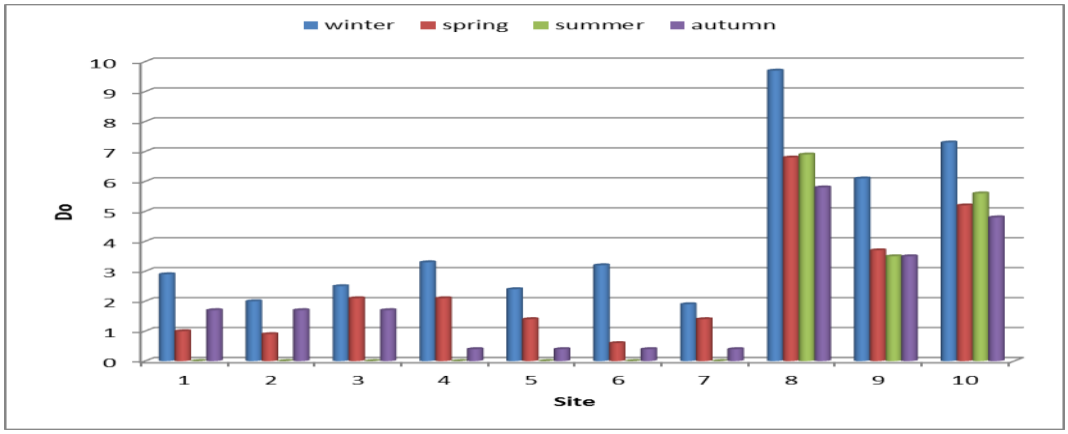

Figure (2): Average Do of the waters of the Danville Valley and the Tigris River for the seasons

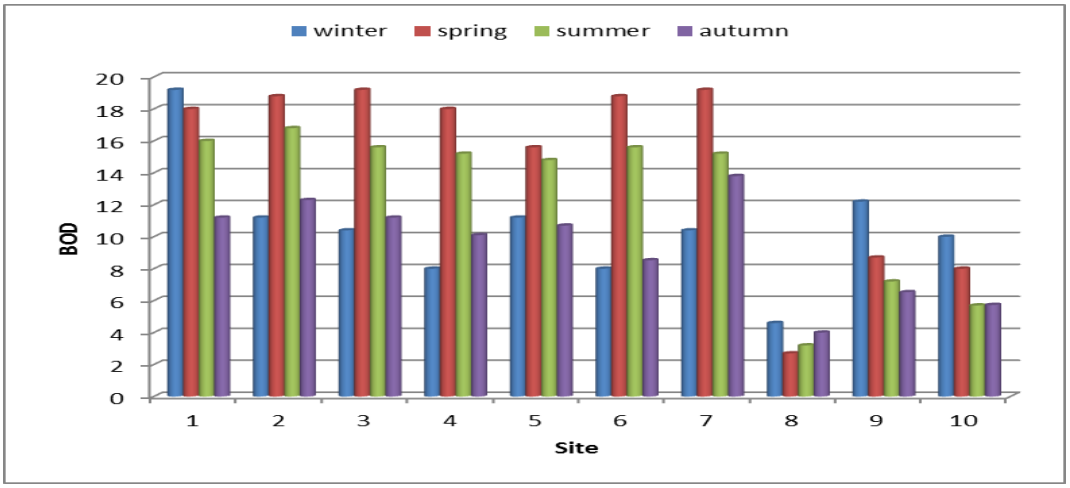

Figure (3): Average (BOD) of the waters of the Danville Valley and the Tigris river for the seasons

This is confirmed by the values of the BOD_5, whose rates ranged between (8 to 19.2) mg. l^{-1} during the study period, as well as its higher rates than the permissible limits in the waters of the Tigris river at site 9

ISSN: 1343-4292
Volume 140, Issue 04, July, 2022

and 10, reaching (12.2 to 10.0) mg. l^{-1} liter respectively due to the effect of the water of the valley.

Also, the relative increase in the concentrations of the total alkalinity of the valley water during the winter, spring, summer and autumn seasons, as shown in the figure (4) to reach (205 ± 14.05, 272 ± 37.5, 246 ± 33.4, 246 ± 11.5) mg. l^{-1} respectively, and this increase in concentration is due to the processes of biological decomposition by microorganisms of organic compounds to form organic acids and carbonic acid, which dissolves carbonate salts in the valley, which increases the alkalinity of water as in the following equations [8], [19], [20]:

$$4CH3COOH + 8H \longrightarrow 5CH4 + 3CO2 + 2H2O$$

$$\text{Organic} + O_2 \xrightarrow{Microorganisms} \text{Organic Acid} + H_2CO_3 ++$$

$$CO_2 + H_2O \longrightarrow H_2CO_3$$

$$H_2CO_3 + CaCO_3\downarrow \rightarrow Ca(HCO_3)$$

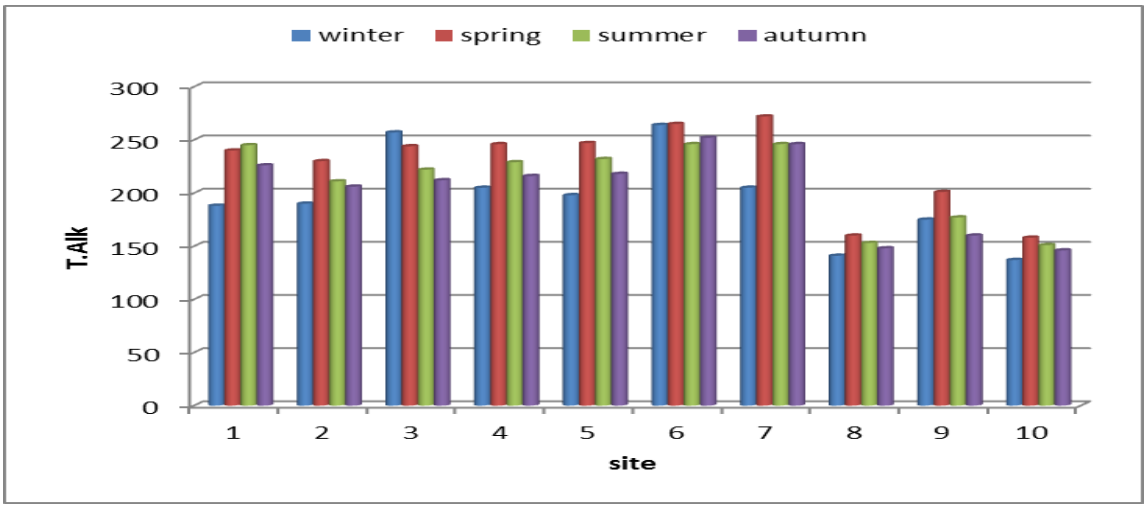

Figure (4): Average T. Alkalinity. of the waters of the Danville Valley and the Tigris River for the seasons (ppm).

Since the pH values in the studied water did not exceed 8.3 shown in Figure (), the causes of alkalinity in the studied water are (HCO_3) bicarbonate ions [10]. It is also noted from the figure that the range of fluctuations in the values did not exceed (0.7) as a result of For the high buffer capacity of Iraqi water [21].

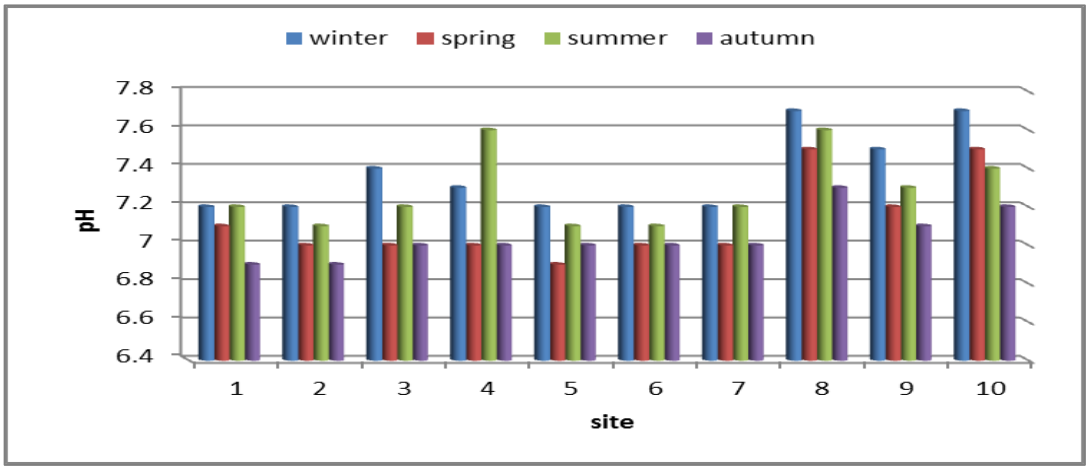

Figure (5): Average pH values of the waters of the Danville Valley and the Tigris River for the seasons

As for the high temperature, it gives the water an undesirable taste and smell in addition to increasing the growth of bacteria and microbes, which negatively affects the water quality [22]. The rates shown in Figure (6) indicate that the average temperature was relatively high most of the study period to exceed the permissible limits for drinking by 75% of the studied samples except for the winter season, which negatively affects the activity and grazing of livestock and poultry, which affects their productivity (Schroeder, 2015). This rise is due to the influence of climatic factors and the oxidation-reduction reactions that occur in the water of the valley, while the temperature of the Tigris river water in the study area was relatively low and within the permissible limits for the drinking of animals due to the drainage of the sub-water of the Mosul Dam lake [23].

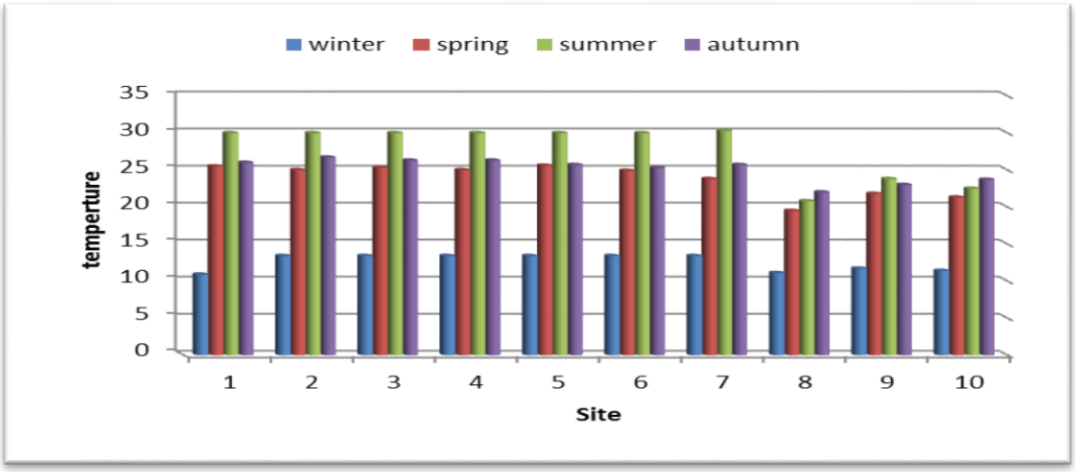

Figure (6): Average temperatures of the waters of the Danville valley and the Tigris river for the seasons

As for the average electrical conductivity values, they did not exceed (1040) uS. cm^{-1} during the four seasons, while they were relatively few in the waters of the Tigris river as in Figure (7). This rise in values is due to the discharge of sewage water. High salinity levels increase oxidative stress, which leads to damage and reduced male reproductive performance. In addition, it increases inflammation, which promotes inflammation of the placenta, and has a harmful effect on pregnancy by affecting the transfer of nutrients to the fetus [24].

Finally, the results of contamination with fecal coliform bacteria shown in Figure (8) indicate that the numbers of numbers in the waters of the valley ranged between (195 to 898) x 10^3 cells. 100 ml^{-1} due to the discharge of domestic wastewater into the valley.

It is also noted that the number of fecal bacteria in the waters of the Tigris river at site 9 increased by between 29 to 43 % compared to site 8 (a comparison site) as a result of the effect of the Danville valley waters on the river, which indicates the possibility of the presence of bacterial pathogens such as (pathogenic strain) *E. coli Salmonella spp.*, Campylobacter), viral (Hepatitis A, Hepatitis E) and parasite (Cruptoridium, Giardia).

ISSN: 1343-4292
Volume 140, Issue 04, July, 2022

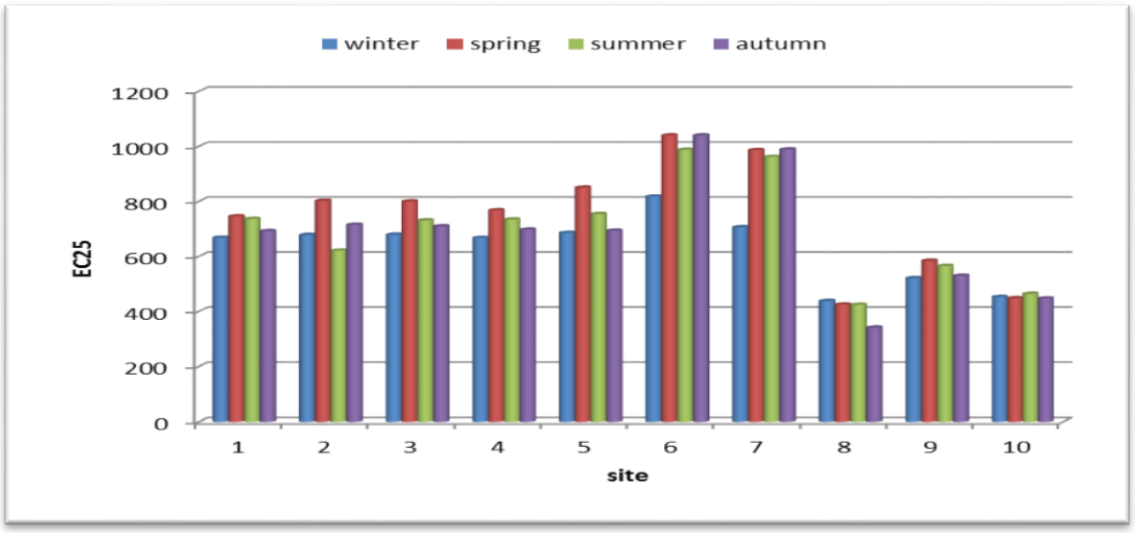

Figure (7): Average (EC_{25}) of the waters of the Danville Valley and the Tigris River for the seasons (uS. cm^{-1}).

These pathogens may be transmitted to humans by consuming infected animal products. Watering animals with clean water increases their resistance to diseases and their productivity [10], [25]. In general, the studied water is not suitable for drinking livestock and poultry in its current condition.

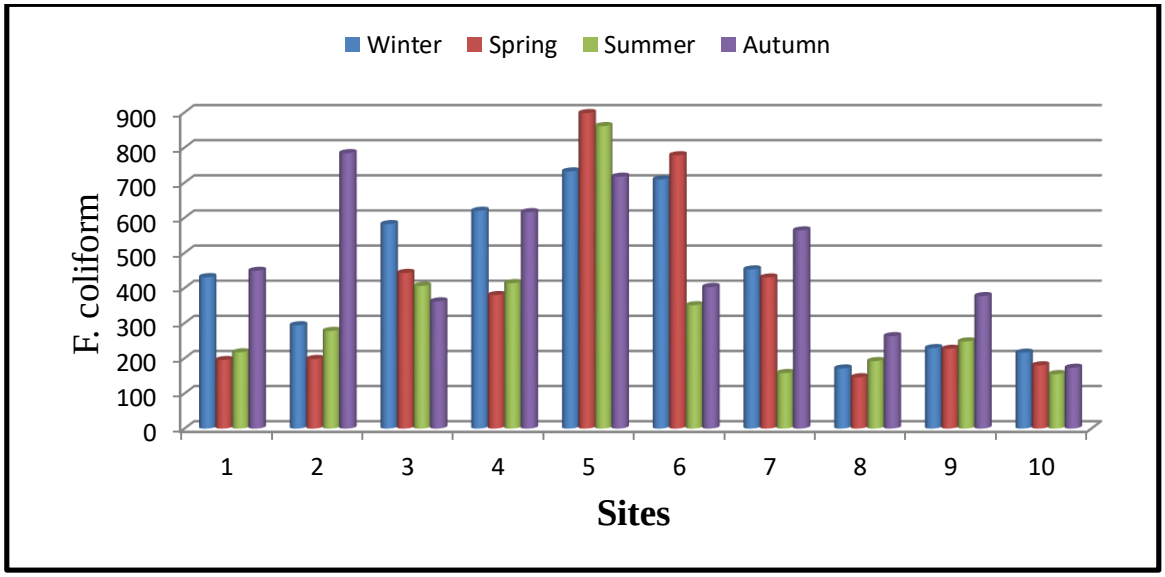

Figure (8): Average number of F. coliform bacteria of the waters of the Danville valley and the Tigris river for the seasons ($\times 10^3$cell. 100 ml^{-1}).

4. Conclusions and Recommendations

The results of the water quality index for the Danville valley and the Tigris river in Mosul city for watering livestock and poultry showed that all the studied water are from the category of water that is not suitable to very poor for watering, as a result of low dissolved oxygen and its absence in the summer, which leads to changing the paths of biological decomposition and the formation of harmful substances for animals and the aquatic environment. With high concentrations of most of the studied parameters, especially the organic load, total alkalinity, microbial contamination, etc., which affects the health and productivity of livestock and poultry, and the effects are more on poultry chicks. Therefore, we recommend not to use these sources

and use pure and treated water to protect livestock and poultry and increase the economic returns for farmers.

5. Acknowledgments
The researchers thank the presidency of the University of Mosul, represented by Prof. Dr. Qusay Kamal Al-Din Al-Ahmadi, Deanship of the College of Education for Pure Sciences, and the College of Education for Girls for the facilities provided for researchers to work in the laboratories of the University of Mosul.

6. References

[1] Radi, R.H and Ali Abdulhamza Al-Fanharawi, A.A. (2022). Water quality assessment of Sawyer river using some environmental indices BNIHS.. 140(02): 1751-1768.

[2] Al-Saffawi, A.Y.T, Ibn Abu Abu bakar, B.S.U, Al-Asaaf, A.Y.R, Hussaini, M and Ibrahim, U.A (2020). Ground water Quality Assessment of Nimrod for Livestock and Poultry Consumption. Uniport Journal of Engineering and Scientific Research. 5: 120 – 127..

[3] Tausifi, M.A. Shahzad, F. Bhatti, J.A. Qamar, S. Khalique, A. Rahman, H. Ali, H.M. Hussain, A. (2018). Effect of water quality on production performance of lactating Nili-Ravi buffaloes. Turkish J. of Veterinary and Animal. Sci., 42: 543-548. doi:10.3906/vet-1703-88.

[4] Schroeder, J.W. (2015).Water needs and quality guidelines for dairy cattle. NDSU and U.S. Department of Agriculture Cooperating: 1-3.

[5] Lardner, H. A., Kirychuk, B. D., Braul, L., Willms, W. D., and Yarotski, J. (2005). The effect of water quality on cattle performance on pasture. Australian J. of Agricultural Research., 56(1): 97-104.

[6] Al-Saffawi, A.Y.T., Al-Taay, N.D.S. and Kaplan, A.Y.H. (2021). Qualitative assessment of groundwater for livestock and poultry watering: A case study of water wells in Hamdaniya district, Nineveh governorate, Iraq. IOP Conf. Series: Earth and Environmental Science 735 (2021) 012018. doi:10.1088/1755-1315/735/1/012018

[7] Campos, S.V., Nascimento E.,de S. and Gisela de A.,U. Water quality criteria for livestock watering – a comparison among different regulations. 806-2636. Doi: 10.4025/ actascianimsci.v36i1.21853

[8] Al-Bahar, B.M.A.Qualitative evaluation of the water of Al-Manara village using weighted mathematical models. MSC Thesis College of Education for Girl, University of Mosul. Iraq.

[9] Al-Saffawi, A.Y.T. (2018).Assessment of groundwater for irrigation and domestic suitability by using (WQI) in Singiar district eastern of Mosul city. Iraq. Mesopo. Environ. j., Special Issue F: 75-84. www.bumej.com

[10] Al-Saffawi, A.Y.T., Al-Assaf A.Y.R., and Talat R.A.(2020) Valuation of water quality for livestock and poultry watering: a case study of groundwater in some areas of Mosul city, Iraq. Nippon Journal of Environmental Science,1(2):1-7. https://doi.org/10.46266/njes.1006

[11] APHA, A.W. (1998). "Standard Method for Examination of Water and Wastewater". 20th ed., Washington, DC, USA.

[12] APHA, AWWA and WCPE (2017). "Stand Method for Examination of water and wastewater American public Health Association , 23RD ed., Washington DC, USA.

[13] Pashaeifar,M.;Dehghanzadeh,R.;Ebrahim R.;Rafieyan O.(2021)Spatial and temporal assessment of groundwater quality and hydrogeochmical processes in Urmia lake Basin ,Iran.(8).doi:10.2166/WS.2021.180

[14] Yenugu, S.R. Vangala, S. and Badri,S. (2020). Groundwater quality evaluation using GIS andwater quality index in and around inactive mines, Southwestern parts of Cuddapah basin, Andhra Pradesh, South India HydroResearch 3: 146–157. https://doi.org/10.1016/j.hydres.2020.11.001

[15] Socha, M. T. Ensley, S. M. Tomlinson, D. J.and Ward, T. (2003). Water composition variability may affect performace. paper presented at the 2003 Intermountain Nutrition Conference, Salt Lake city. Utah, Published in feedstuffs, June 9, 10,12 and 16.

[16] Nsabimana, A., Li, P., He, S., He, X. S. M., Alam, K. and Fida, M.(2021) Health risk of the shallow groundwater and Its suitability for drinking purpose in Tongchuan, China. Water 2021, 13, 3256-3265. https://doi.org/10.3390/w13223256

[17] Talat, R.A., Al-Assaf, A.Y.R. and Al-Saffawi. A.Y.T. (2019). Valuation of water quality for drinking and domestic purposes using WQI : Acase study for groundwater of Al-Gameaa and Al-Zeraee qaurters in Mosul city/Iraq. IOP Conf. Series: Journal of Physics: Conf. Series 1294 (2019) 072011. doi:10.1088/1742-6596/1294/7/072011

[18] Al-Shanoona, R.A.A., Al-Maathide, A.T.H. and Al-Asaaf, A.Y.R. (2020). The environmental status of Tigris river in Mosul city. Northern Iraq. Plant Archives. 20 (1): 3051-3056.

[19] Al-Saffawi, A.Y.T. and Al-Sinjari, W.E.A. (2018). Assessment of water quality for irrigation by using water quality index (IWQ index) in Al- Kharrazi Valley at Mosul city. Iraq. Al-autroha for Environ. Sci. 5: 57-71. (In Arabic).

[20] Ramadhan, O.M., Al-Saffawi, A.Y.T. and Al-Mashhdany, M.H.S. (2018) Assessment of Surface Water Quality for Irrigation using WQI model; A Case Study of Khosar and Tigris Rivers. International Journal of Enhanced Research in Science Technology and Engineering, 7(3): 63- 69.

[21] Al-Hamadany, M. A.A., Al-Saffawi, A.Y.T. and Al-Shaherey, Y.J. (2021) Sanitary safety of Alssahirun water supply plant and residential neighborhoods covered by water distribution using NSFWQI model. Accepted in the `1st Int. Conf. on advanced Res. in pure and Applied Sci. Al-Mothanna University, Iraq., and published in AIP Conference Proceeding :(ISSN 0094-243X).

[22] World Health Organisation. (2011) Guidelines for Drinking Water Quality 4th ed. Geneva, Switzerland. Retrieved from: http://www.who. int/watersanitation_health /dwq/ gdwq3rev/en/index.html.

[23] Al-Assaf, A.Y.R. and A.Y.T. Al-Saffawi (2018). Quality assessment of Tigris river water by using (WQI) For drinking with in Nineveh Governorate. 9th periodic conference of the Center for Scientific Research Dams and Water Resources Mosul University. 27-28 November, 2018: 189-200.

[24] Abdelnour, S.A, Abd El-Hack, M.E., Noreldin, A.E., Batiha, G.E., Beshbishy, A.M., Ohran, H., Khafaga, A.F., Othman, S.I., Allam, A.A. and Swelum, A.A. (2020). High Salt Diet Affects the Reproductive Health in Animals: An Overview. Animals. 10: 590 -605. doi:10.3390/ani10040590

[25] Umar, S., Munir, M. T., Azeem, T., Ali, S., Umar, W., Rehman, A., and Shah, M. A. (2014). Effects of water quality on productivity and performance of livestock: A mini review. Veterinaria, 2(2): 11-15. https://www.researchgate.net/publication/284550968