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The Study of The Physico - Chemical Parameters and Bacteriological Examination of Tural Acrothermal Spring, (Dist-Ratnagiri), Maharashtra, India

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ABSTRACT: A hot water spring is produced by the emergence of geo-thermally heated groundwater that rises from the Earth's crust. Tural hot water spring is located at village Tural, 10km North of Sangameshwar, a tehsil place in Ratnagiri district of Maharashtra, India. Tural is acrothermal spring where the water temperature is 61.5 - 62ºC. Physicochemical analysis of the hot spring water was carried out on the seasonal basis (pre and post monsoon) from the main source during year 2015. The parameters like Temperature, turbidity , Total solids; Total Dissolved Solids, Total Suspended Solids and Electrical Conductivity were studied. The chemical parameters included pH, total alkalinity and total hardness. Ionic parameters such as calcium, phosphate, sulphate, chloride, iron, sodium, potassium, magnesium, nitrate, fluoride, bicarbonate were analyzed. Trace elements like manganese, lead, copper, lithium were also analyzed. Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD) were also estimated. Biological parameters tested were Standards Plate Count (SPC) for bacteria, Most Probable Number (MPN) for coliforms . Present investigation highlights the physicochemical and bacteriological parameters of Tural hot water spring. These parameters were compared with WHO potability parameters and it was observed that water was non-potable in nature.

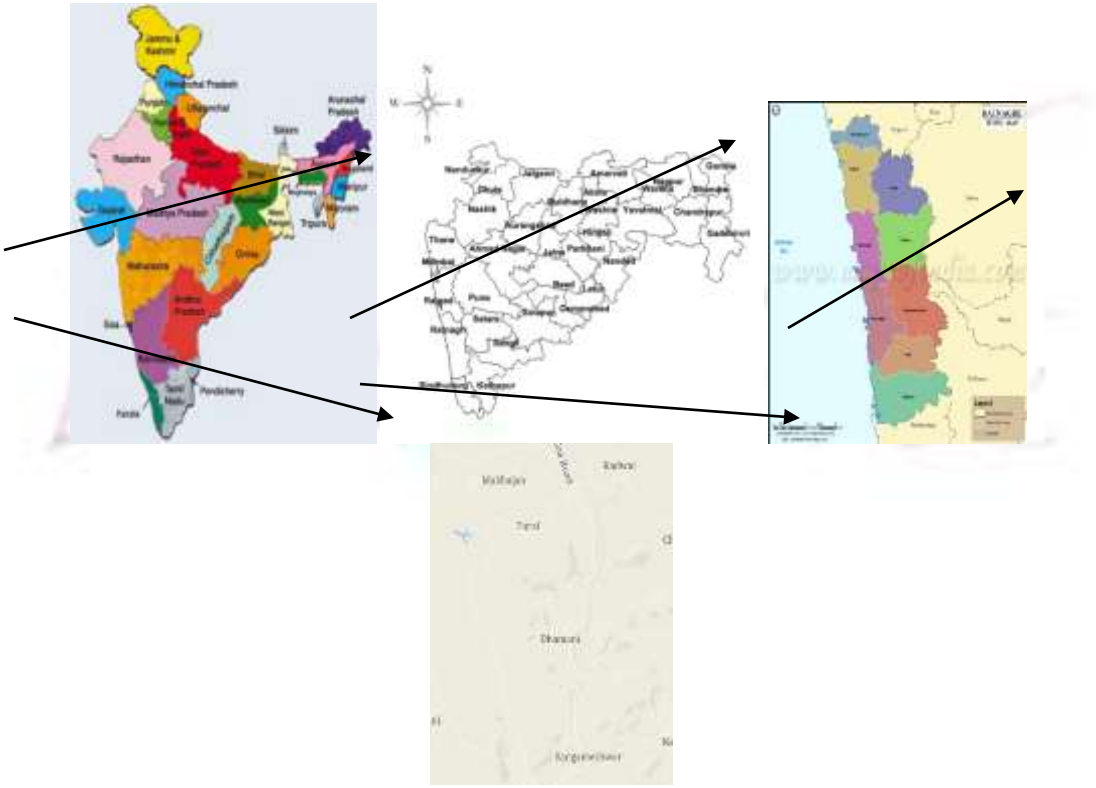
KEYWORDS: ***Hot water spring; physicochemical parameters; WHO; Standard Plate Count (SPC); Most Probable Number (MPN).***

I. INTRODUCTION

Tural hot water spring is located at Tural village 10 km North of Sangameshwar, in the Ratnagiri district of Maharashtra, India. It is adjacent to National Highway 17 (NH-17). Geographically it is in the west of the Western Ghats hill range and lies between 17º14' North latitude and 73º33' East longitude. It is situated on the banks of the tributary joining Shastri river. (Fig-1)

According to the classification proposed by Vouk (1950), the thermal springs having temperature range of 30-50ºC is "Euthermal". Hot springs having 50-70ºC temperature range are "Acrothermal". So Tural hot spring is acrothermal spring. Cement tank is constructed around the hot spring to protect the sprouts from human interference. Tural acrothermal spring shows flow of 1000 gallon/h.

The physical and chemical parameters of groundwater play a significant role in classifying and assessing water quality. Hydro-chemical study helps to specify suitability for industrial, agricultural, drinking and irrigation purpose of water. The temperature and pH of Tural hot spring shows no detectable change throughout the year.



India Maharashtra Ratnagiri Tural

Fig.1: Location map of study area of Tural hot water spring, Ratnagiri, Maharashtra, India

Heat capacity of water is highest of all common solids and liquids. Water is great heat moderator. Springs that discharge water which has a temperature above that of the normal local groundwater are called thermal springs (Todd , 1980). Most of the hot water springs are output of long crack in sedimentary rock. Tural thermal spring comes under southern coast of west cost of Maharashtra.

This study 24hysic24 on the goal of determining 24hysic-chemical characteristics of the hot water spring during the year 2015. Intermittent gas emission in the form of bubbles with sulphur smell was observed in the hot water tank which indicates sulphur contents.

II. MATERIALS AND METHODS

The water samples of Tural hot spring were collected from Ratnagiri district of Maharashtra in the month of May (pre monsoon period) and in month of October (post monsoon). The water samples from the surface area of the hot spring tank were collected in sterile Thermos stainless steel containers and collected samples were sealed and transported to the laboratory and kept in refrigerator for further analysis. Temperature was measured on the site by using a portable thermometer. The pH value was measured by using portable pH meter. The total solids of water samples were measured by Evaporation method. Total dissolved solids and Total Suspended Solids of water samples were measured by using Conductometry method.

Turbidity of water samples were measured by using Nephelometry method. Total alkalinity of water samples were analyzed by Acid titration method using hydrochloric acid. Total hardness, calcium hardness and magnesium hardness of water sample were determined by EDTA method and Erichrome black T reagent was used as an indicator. Phosphate and nitrate of water samples were estimated by U. V. Spectrophotometer method. Sulphate of water sample was analyzed by turbidometric method using titration. Chloride of water samples was measured by silver nitrate titration method. Sodium and Potassium of water samples were determined by Flame photometry method. The amount of Fluoride was analyzed by SPANDS method. Iron and bicarbonate of water samples were estimated by Thiocynate and acid titration methods, respectively. Trace elements such as Manganese, Lead, Copper and Lithium of water samples were estimated by using Atomic absorption spectrophotometry method. Dissolved Oxygen (DO), Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) were measured by Modified Wrinkler's method, Sodium thiosulphate titration method and open reflux methods, respectively.

All physic0-chemical parameters were analyzed by using standard procedures described by APHA (1995) and Trivedy and Goel (1986) in the laboratory.

The standard plate count (bacteria) and most probable number (Coliforms) were determined using Thermus agar media (ATCC 697) and MacConkey broth M007 (Hi Media pvt ltd.) (Cappuccino and Sherman, 2007).

III. RESULTS AND DISCUSSION

Physico-chemical characteristics of Tural hot spring water Ratnagiri, India are listed in Table-1 and Fig -2, 3 and 4.

Temperature- A temperature is an objective comparative measure of hot or cold, measured by thermometer. Temperature of Tural hot spring was recorded as 62ºC in pre monsoon and 59ºC in post monsoon having an average value of 60.5ºC. This temperature is relatively high as compared to other water bodies, so it is known as hot water spring.

Total Solids (TS)- Total solids is a measure of the total dissolved solids and total suspended solids in water. The obtained value of total solids was 1341 mg/L in pre monsoon and 543 mg/L in post monsoon.

Total Dissolved Solids (TDS)- TDS is a measure of the combined content of all inorganic and organic substances contained in a liquid in molecular, ionized or micro-granular suspended form. The TDS observed from water samples were 913 mg/L in pre monsoon and lowest 328 mg/L in post monsoon.

Total Suspended Solids (TSS)- TSS is the dry weight of particles trapped by a filter. It is water quality parameter used to assess the quality of water samples. The TSS recorded from water samples were 254 mg/L in pre monsoon and low 225 mg/L in post monsoon.

Electrical Conductivity (EC)- EC is the measure of a material's ability to allow the transport of an electric charge. The total obtained value was 1427 uS/cm in pre monsoon and 1290 uS/cm in post monsoon.

pH- pH is a measure of hydrogen ion concentration of a solution. The obtained pH value of water sample was 7.1 in pre monsoon and 7.6 in post monsoon.

Turbidity – Turbidity is the measure of relative clarity of a liquid. The total amount of turbidity found in water samples was 0.1 NTU in pre monsoon and 0.082 NTU in post monsoon.

Total alkalinity (TA)- Total alkalinity is the waters ability to neutralize acids. The total obtained values were 28 mg/L in pre monsoon and 22.1 mg/L in post monsoon.

Total hardness (TH)- Total hardness is the hardness of the mineral content of water that is irreversible by boiling. The obtained value of Tural water sample was 228 mg/L in pre monsoon and 148 mg/L in post monsoon.

Calcium hardness- Calcium occurs in water naturally. It is a determinant of water hardness because it can be found in water as calcium ions. The total amount of calcium found in water sample was 54 mg/L in pre monsoon and the lowest 16 mg/L in post monsoon.

Phosphate- Phosphate is a non-metallic element which is necessary for life and is found in rocks as inorganic phosphates. The total amount of phosphate present in water samples was 0.42 mg/L in pre monsoon and 0.39 mg/L in post monsoon.

Sulphate- Sulphate is combination of sulfur and oxygen is a part of naturally occurring minerals in some soil and rock formations that contain ground water. Hot spring has high sulphur content. The amount of sulphur in water sample was 83 mg/L in pre monsoon and 30.6 mg/L in post monsoon.

Chlorides- Chloride is an essential electrolyte present in body fluids and water. The estimated amount of chloride in water sample was 352 mg/L in pre monsoon and 410 mg/L in post monsoon.

Iron- Iron is lustrous silver grey metal which is dissolved readily in dilute acids. Iron may cause conjunctivitis and retinitis. The amount of Iron found in water sample was 0.198 mg/L in pre monsoon and 0.150 mg/L in post monsoon. Iron is hazardous as it persists in environment.

Sodium- Sodium is an element for all animals and some plants. The estimated amount of sodium in water sample was found 207 mg/L in pre monsoon and 297 mg/L in post monsoon.

Potassium- Potassium is an element necessary for body to work and function properly. The total obtained values are 9.3 mg/L in pre monsoon and 7.16 mg/L in post monsoon.

Magnesium hardness- Magnesium is responsible for water hardness. The total amount of magnesium obtained in water sample was 21mg/L in pre monsoon and 4 mg/L in post monsoon.

Nitrate- Nitrate is a polyatomic ion which dissolves in water. High levels of nitrate can cause severe health problems to animals and human beings. The average amount of nitrate found in water sample was 1 mg/L in pre monsoon and 0.92 mg/L in post monsoon.

Fluoride- Fluoride is a mineral that occurs naturally in all water sources. The obtained level 1.6 mg/L in pre monsoon and 1.7 mg/L in post monsoon indicates water is non-potable or not fit for drinking purpose. It may cause decay of tooth and skeletal fluorosis.

Bicarbonate- Bicarbonate is alkaline and vital component of pH buffering system of human body. The amount of bicarbonate found in water samples was 28 mg/L in pre monsoon and 31.2 mg/L in post monsoon.

Manganese- Manganese is a trace element responsible for accumulation of microbial growth in water. The estimated amount of manganese in water sample was 33.21 ppb in pre monsoon and 30 ppb in post monsoon.

Lead- Lead is a chemical element which on contamination poses a serious threat to safety of drinking water. The amount of lead found in water samples was 3150 ppb in pre monsoon and 2786 ppb in pos t monsoon.

Copper- Copper is a chemical element present in all sources of water. Copper when consumed in excess causes serious human health effect. The estimated amount of copper in water sample was found to be 48 ppb in pre monsoon and 15.6 ppb in post monsoon.

Lithium - Lithium is a chemical element which reacts with water. It is toxic when consumed in excess. The average obtained value of lithium found in water sample was 1540 ppb in pre monsoon and 728 ppb in post monsoon.

Dissolved Oxygen (DO) - DO is an important parameter to measure when assessing water quality. It is also produced as waste product of photosynthesis from phytoplankton, algae and aquatic plants. The estimated amount of DO in water samples was 3.2 mg/L in pre monsoon and 5.4 mg/L in post monsoon.

Biological Oxygen Demand (BOD)- BOD is the amount of dissolved oxygen needed by aerobic biological organisms to break down organic material present in water at certain temperature over a specific time period. BOD in water sample was found to be 6.0 mg/L in pre monsoon and 4.7 mg/L in post monsoon.

Chemical Oxygen Demand (COD)- COD is commonly used to indirectly measure the amount of organic compounds in water. The estimated amount of COD in water sample was 320 mg/L in pre monsoon and 223 mg/L in post monsoon.

The biological parameters analyzed were Standard Plate Count (SPC) and Most Probable Number (MPN), which showed that there was presence of coliforms (*E.coli*) in water sample probably due to human intervention. Tural hot spring water showed that SPC was found to be 4.5×10^4 CFU/mL in pre monsoon and 6×10^4 CFU/mL in post monsoon. The MPN/100 mL was detected in water sample as 23 MPN/100 mL in pre monsoon and 34 MPN/100 mL in post monsoon. The significant Lead content and MPN of coliforms indicate nonpotability of water (Table-2).

Sr. no	Water parameters	Unit	Methods	Pre monsoon	Post monsoon	Permissible limit by WHO (1993)	Mean ± S.D
Physical parameters							
1	Temperature		Thermometer	62ºC	59	0	60.5 ± 2.121
2	Total solids	mg/L	Evaporation method	1341	543	0	942 ± 564.2
3	Total dissolved solids	mg/L	gravimetric method	913	328	0	620.5 ± 413.6
4	Total suspended solids	mg/L	Gravimetric method	254	225	0	239.5 ± 20.50
5	Electrical conductivity	(uS/cm)	Conductometry	1427	1290	0	1358.5 ± 96.87
Chemical parameters							
6	pH		pH meter	7.1	7.6	6.5 - 8.5	7.35 ± 0.35
7	Turbidity	NTU	Nephelometry	0.1	0.082	6.0	0.091 ± 0.012
8	Total alkalinity	mg/L	Acid titration method	28	22.1	200	25.05 ± 4.17
9	Total hardness	mg/L	EDTA method	228	148	150 - 500	188 ± 56.56
Ionic parameters							
10	Calcium hardness	mg/L	EDTA method	54	16	75	35 ± 26.87
11	Phosphate	mg/L	spectrophotometry	0.42	0.39	---	0.405 ± 0.021
12	Sulphate	mg/L	Turbidometry method	83	30.6	500	56.8 ± 37.05
13	Chloride	mg/L	Silver nitrate method	352	410	250	381 ± 41.01
14	Iron	mg/L	Thiocynate method	0.198	0.150	0.3	0.174 ± 0.033
15	Sodium	mg/L	Flame photometry	207	297	200	252 ± 63.6
16	Potassium	mg/L	Flame photometry	9.3	7.16	---	8.23 ± 1.51
17	Magnesium hardness	mg/L	EDTA method	21	4	30	12.5 ± 12.02
18	Nitrate	mg/L	Spectrophotometry	1	0.92	0	0.96 ± 0.05
19	Fluoride	mg/L	SPANDS method	1.6	1.7	0.65-1.5	1.65 ± 0.07
20	Bicarbonate	mg/L	Acid titration method	28	31.2	0	29.6 ± 2.26
21	Manganese	ppb	Atomic absorption spectrophotometry	33.21	30.00	10	31.605 ± 2.26
22	Lead	ppb	Atomic absorption spectrophotometry	3150	2786	10	2968 ± 257.38
23	Copper	ppb	Atomic absorption spectrophotometry	48	15.6	10	31.8 ± 22.91
24	Lithium	ppb	Atomic absorption spectrophotometry	1540	728	10	1134 ± 574.17

25	DO	mg/L	Modified Wrinkler's method	3.2	5.4	4.6	4.3 ± 1.55
26	BOD	mg/L	Sodium thiosulphate titration	6.0	4.7	30	5.35 ± 0.91
27	COD	mg/L	Open reflux	320	223	4250	271.5 ± 68.58

Table-1. Physicochemical analysis of water sample from Tural hot water spring

Sr. no	Water parameters	Medium used	Pre monsoon		Post monsoon		Remark
1	Standard Plate Count	Serial dilution and spread plate method	4.5×10^4 CFU/mL		6×10^4 CFU/mL		Higher count
2	Most Probable Number MPN index/100ml	Double strengthand single strength MacConkey(M007) broth	23		34		Positive test
			Lower limit	Upper limit	Lower limit	Upper limit	
			7	70	12	93	

Table.2: Bacteriological parameters of hot spring water, Tural.

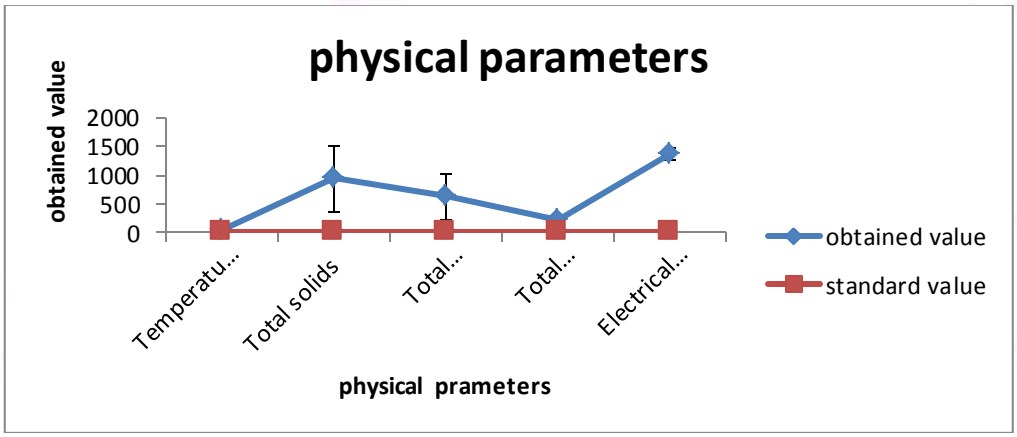


Fig.2: Comparison of standard values of potability (WHO) with obtained mean values of physical prameters of hot spring water

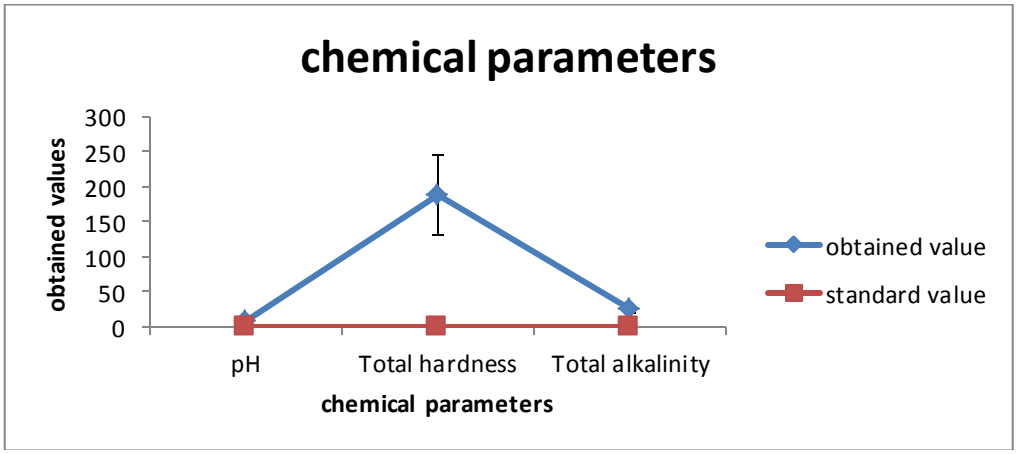


Fig.3: Comparison of standard values potability (WHO) with obtained mean values of chemical prameters of hot spring water

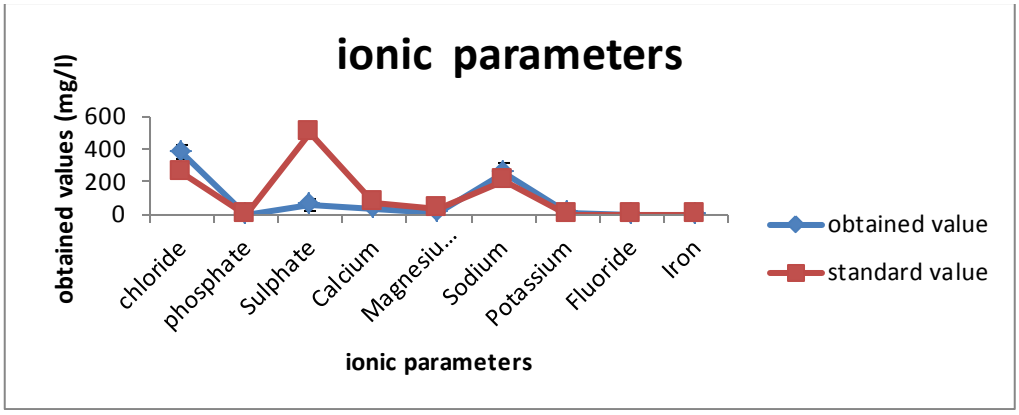


Fig.4: Comparison of standard values potability (WHO) with obtained mean values of ionic prameters of hot spring water

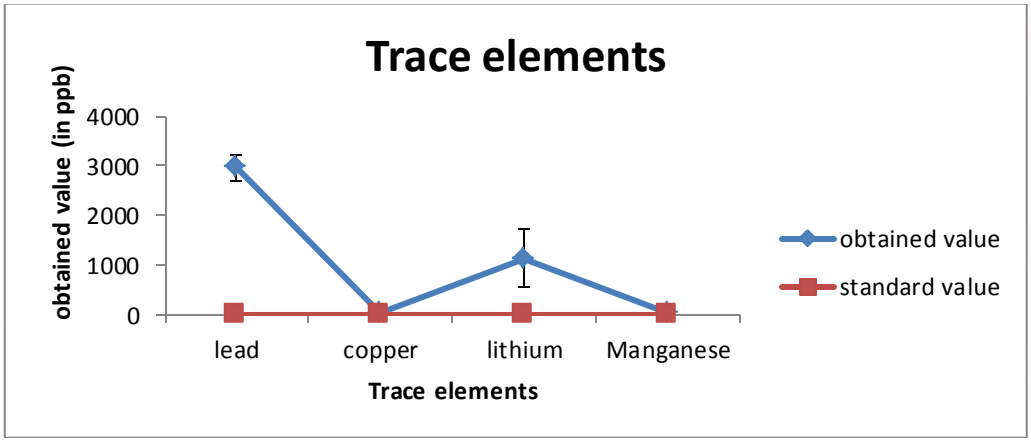


Fig.5: Comparison of standard values potability (WHO) with obtained mean values of trace elements of hot spring water

IV. CONCLUSION

We can conclude from the results of physico-chemical parameters that high water temperature, high amount of Sodium, Chloride, Fluoride, Sulphate present in Tural hot spring makes the water unfit for human consumption. The presence of Phosphate is one of the limiting factors for production of phytoplankton which increases the autotrophic activities in water body.

The Tural acrothermal spring water has been contaminated by presence of different micro-organisms and coliforms, which indicated that water is non-potable in nature, but water can be pre-treated before the use for removal of excess minerals and contaminant micro-organisms in order to make water suitable for drinking.

V. CONFLICT OF INTEREST

We authors have no conflict of interest.

VI. ACKNOWLEDGEMENT

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