Multiparametric Comparison of the Sacred Spring Waters of the Right Side of the Roman Forum by in Field and in Laboratory Chemical Analysis

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Abstract

The presented research deals with the first attempt for a characterization of spring waters, considered as sacred, outcropping in the right side of the area of the Roman Forum.

The main aim is to start the construction of a database of the various water outcrop of the entire area of the Roman Forum basing on chemical, physic-chemical and biological parameters.

The sacred waters were treated such as the classic mineral water springs i.e. According to IRSA recommendations

In order to dispel any doubt concerning a possible infiltration of mains water or of sewer, samples were taken also from standpipes located in the same area.

Introduction

The Roman area has been inhabited since prehistoric times for the presence of the Tiber river, its affluents and numerous springs many of which were exploited for drinking and therapeutic purposes. Many spring waters, some missing at present, are located to the left of the Tiber river, for this reason Rome was born there. Table 1 lists all the water springs outcropping in the area of the Roman Forum; the ones sampled for this research are highlighted in blue.

Tab.1: List of water sources in the area of the Roman Forum still visible or only cited in literature

Fons Juturnae	at the foot of the Palatine hill, in the middle of a square tank well preserved marble, dedicated to the nymph Juturna, close to the homonymous temple
Lapis Niger	was a part of the comitium, excavation below the black marble floor led to a very archaic monumental complex in which emerges the aquifer
Tabularium	it occupied the space between the temple of Jupiter on one side of the Capitoline Hill and the steps which led up past the Carcer to the Arc on the other.
Aedes Castoris	in the Forum, near the Temple of Vesta, stands what is left of the temple erected in honor of Castor and Pollux, the twin sons of Jupiter
Area VI	near Palatine an aquifer outcropped during the excavation campaign on the N-O slope of the Palatine, run out by the Dept of Sciences of Antiquity, "Sapienza", University of Rome
Fons Lupercal	at the foot of the Palatine N-O, emerged in the cave dedicated to Luperca to date not visible
Tullianum water	(by tullus, "spring of water") emerges in Carcer Tullianum, the floor of the lower environment. Tullianum is probably the most ancient Roman's construction survived
Lautole water	near Tullianum water, hot sulphur spring, which is no longer visible
Meta Sudans	a fountain that drains a small aquifer, whose site is viewable near the eastern entrance of the Roman Forum, near the Colosseum
Basilica Ulpia	it was at that time (II A.D.) the largest basilica of Rome, now in the underground emerges perhaps the ancient water spring
Templum Divi Romuli	the temple that Maxentius in 307 A.D. erected to his son Romulus. There is a water well to date with difficult access.

Two samples were also collected from standpipe located near Tullianum and Roman Forum.

pH, conductivity, ORP, Temperature at the source, room Temperature, O2, NO3, NH4. were measured in situ for all the samples while residue at 180 °C, suspended solids, colour, organic matter, anions, cations and carbonates were measured in lab. Biological analyses are running.

Materials & Methods

For in situ measurements we used 3 datalogger: HD2156.2 (from Deltaohm, Italy) equipped with the electrodes KP62 and SPT1GS, LabQuest (from Vernier LLC, USA) equipped with the electrodes DO-BTA, STS-BTA and ORP-BTA, NO_3-BTA, NH_4-BTA, datalogger LabQuest2 (from Vernier LLC, USA) equipped with electrodes ORP-BTA, NO_3-BTA, NH_4-BTA.

Anions and cations content were determined by a Metrohm 761-IC (Switzerland) equipped with AS9+AG9 columns (by Dionex USA) and an ICP-AES Vista RL-CCD (by Varian USA). UV-vis spectrophotometer Perkin Elmer Lambda 16 and cuvette Helmann (2, 10 e 100mm). Anion multi-element standard (Cl^-, NO_3^-, SO_4^{2-}), type II, CertiPUR, HC607686, from Merck. Deionised water ($\Lambda <$ 0.5 μS), high purity reagents and bench-top instruments were used.

Results

Tab.2: data coming from the in situ analyses

	Fons Juturnae	*Carcer Tullianum*	*Lapis Niger*	*Palatino*	*Basilica Upia*	*Foro standpipe*	*Tullianum standpipe*
pH	8.3	8.0	8.2	7.6	7.5	7.9	7.4
Λ (μS)	127.0	865.3	469.1	600.8	898.4	621.2	659.9
T_{air} (°C)	27.2	19.1	21.3	22	19.9	26.0	---
T_w (°C)	24.4	16.9	19.7	---	---	15.2	17.9
ORP	269.8	307.2	225.1	225.8	264.2	387.1	370.5
O_2	3.8	4.7	---	---	---	8.1	---
NO_3^-	1.0	27.3	---	---	---	1.9	---

From data in tab. 2 e fig 1, a more or less marked discriminating capability emerges; the 2 standpipes looks very similar, with all parameters in the range of mineral waters, while the 5 water outcrops significantly differ each other and with standpipes.

In all the outcropping waters the total ion content results higher than in the standpipes with the highest one in the *Basilica Ulpia* and *Carcer Tullianum* samples. Taking the "by eye" viewing, an unexpected very low presence of NO_3^- was found in the *Fons Juturnae* sample.

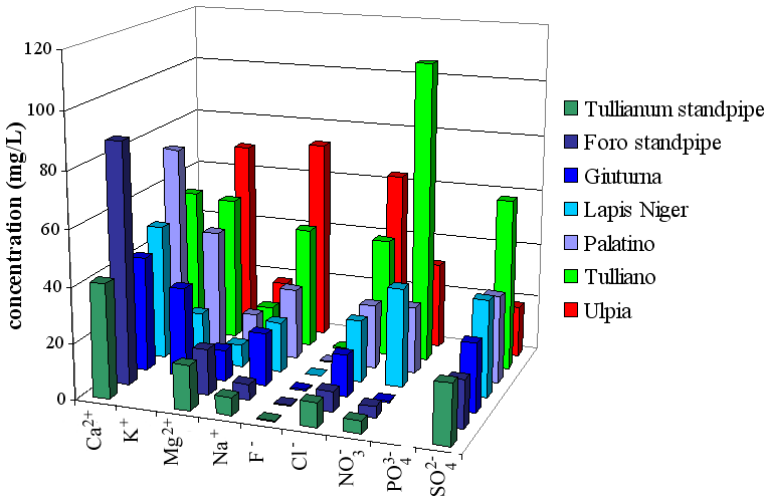

Fig. 1; Data on salt contents obtained by IC and ICP-AES

Conclusions

Further laboratory tests are running in order to better delineate the specific characteristics of each aquifer and therefore their possible differentiation. More sampling campaigns are needed, especially to take into account seasonable trends and to evidence correlation with meteo data, with particular attention to the rainfall. In order to fill a significant database, useful for a multivariate and/or chemiometric treatment, it is desirable the sampling of a higher number of outcropping and standpipes located near them.

References

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