

## COMMUNICATION

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## EFFECT OF MINERAL WATER OF HAMMAN AL-ALEEL ON THE VIABILITY OF BACTERIA

## 1. INTRODUCTION

Mineral and thermal springs are of great importance to mankind, in general, and to some nations in particular. In such countries like Czechoslovakia, Germany, Hungary, and Poland the regions with springs have been directly or indirectly developed into health resorts.

In Iraq there are 900 springs of which 39 are thermal [4]. These thermal springs are exploited in a primitive manner [8]. The major thermal spring is located at Hamman-Al-Aleel 20 km south of Mosul (fig. 1), and is frequented every year by thousands of people suffering from skin and other diseases. Records of curing properties of spring water encouraged the authors to test its effects on bacteria, and to analyse the water for constituents responsible for such effects. The analysis was made for the content of heavy metals, such as mercury, silver, lead, and zinc as well as iodine whose bactericidal effects have been established [1, 3].

## 2. MATERIALS AND METHODS

The effect of mineral water was studied on the following micro-organisms:

*Bacillus cereus*, *Bacillus subtilis*,

*Escherichia coli*, *Klebsiella pneumoniae*, *Pseudomonas pyocyaneus*,

*Shigella dysenteriae*, *Staphylococcus aureus*,

*Staphylococcus albus*, *Staphylococcus citreus*.

The culture media used during the experiments were obtained from Difco Laboratories, Detroit, Michigan, USA. Nutrient agar was employed for viable counts, and nutrient broth for initial growth and standardization of the inoculum.

The stock cultures were prepared by inoculating the nutrient broths and incubation for 8 to 12 hours at 310 K. Broth cultures were standardized to have an initial count of  $2-2.5 \times 10^6$  viable bacterial cells/cm<sup>3</sup>.

Water samples were taken at random from two springs located in the main bath area, were collected and transferred with a minimal delay to the Bacteriology Department of the College of Medicine. Water was filtered through Seitz filter paper (HP/Eks grade) and tested without delay.

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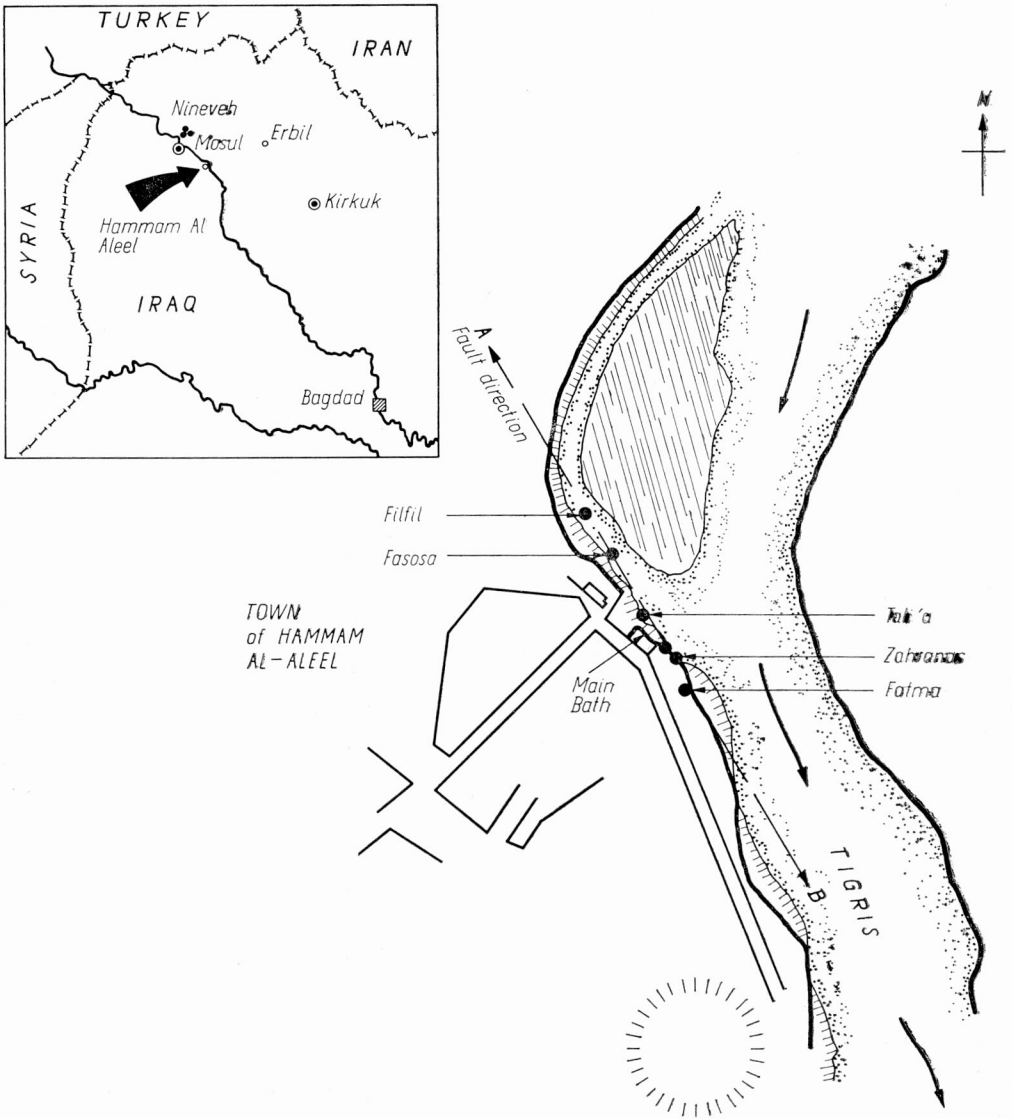


Fig. 1. Site location

1/2, 1/4, 1/8 and 1/16 dilutions of water sample were prepared by using sterile peptone water. To each dilution 0.1 cm<sup>3</sup> of the inoculum was added, the initial count being  $2-2.5 \times 10^4$  viable units/cm<sup>3</sup>. Tests of viability of cells were performed on peptone water alone used as a control. All test tubes were incubated at 310 K.

The effect of mineral water on the viability of micro-organisms was evaluated according to the following criteria:

1. It is considered as bactericidal effect if no micro-organisms are recorded in the first three (1/2, 1/4, 1/8) dilutions.

2. It is considered as a bacteriostatic in each of the first three dilutions the number micro-organisms was less than  $2.5 \times 10^4$  cell/cm<sup>3</sup>.

3. The mineral water is said to have no effect in destroying the micro-organisms or controlling their growth in all test tubes the counts were more than  $2.5 \times 10^4$  viable cell/cm<sup>3</sup>.

Chemical analysis were carried out by the Environmental Engineering Laboratory of the University of Mosul according to Standards Methods for Examination of Water and Waste Water [7].

### 3. RESULTS AND DISCUSSION

The analyses for constituents of interest were performed on water from the main bath and other three major springs: Zahra, Fasosa North and Fasosa South. Results of analysis are presented in table 1. Ain Kibreet another spa well known in this area, is located in the city of Mosul on the right bank of Tigris River. Analysis of mineral water from Ain Kibreet [5] is also reported in table 1. For comparative reasons the analysis of Tigris River [5] is presented in the same table.

Physical-chemical characteristics of mineral waters in relation to the river water

| Parameters                                      | Zahra |        | Faso-<br>sa | Main<br>bath | Ain<br>Kibreet | River<br>water<br>from<br>Tigris* |
|---|-------|--------|-------------|--------------|----------------|-----------------------------------|
|   | South | North  |             |              |                |                                   |
| Total solids, g/m <sup>3</sup>                  | 850   | 900    | 800         | 970          | 6240           | 450                               |
| pH values                                       | 7.4   | 7.1    | 7.2         | 7.5          | 6.0            | 8.0                               |
| Alkalinity                                      |       |        |             |              |                |                                   |
| g CaCO <sub>3</sub> /m <sup>3</sup>             | 191   | 172    | 188         | 182          | —              | 80                                |
| H <sub>2</sub> S, g/m <sup>3</sup>              | 72    | 62     | 106         | 44           | 220            | —                                 |
| CO <sub>2</sub> , g/m <sup>3</sup>              | 60    | 72     | 123         | 64           | —              | —                                 |
| Mg <sup>++</sup> , g/m <sup>3</sup>             | 33.19 | 17.5   | 20.09       | 23.5         | —              | —                                 |
| Ca <sup>++</sup> , g/dm <sup>3</sup>            | 56    | 54     | 70.6        | 71           | —              | 39                                |
| Na <sup>+</sup> , g/m <sup>3</sup>              | 46    | 32     | 40          | 33           | —              | —                                 |
| K <sup>+</sup> , g/m <sup>3</sup>               | 12    | 11     | 12          | 18           | —              | —                                 |
| Cl <sup>-</sup> , g/m <sup>3</sup>              | 64    | 73     | —           | 83           | —              | 14                                |
| SO <sub>4</sub> <sup>=</sup> , g/m <sup>3</sup> | 119.1 | 176.47 | 110.9       | 164.4        | 1641           | 85                                |
| PO <sub>4</sub> <sup>=</sup> , g/m <sup>3</sup> | 3.7   | 4      | 2           | 3.5          | —              | —                                 |
| SO <sub>3</sub> <sup>-</sup> , g/m <sup>3</sup> | 69    | 113    | 135         | 84           | —              | —                                 |
| S, g/m <sup>3</sup>                             | 1.0   | 1.0    | 1.5         | 2.0          | 12             | —                                 |
| Total hardness                                  |       |        |             |              |                |                                   |
| g CaCO <sub>4</sub> /m <sup>3</sup>             | 400   | 465    | 445         | 405          | 1820           | 200                               |

\* Main Stream

From the viewpoint of drinking water standards the concentrations of mineral constituents in the main bath and three major springs are not abnormally high, except for sulphur and hydrogen sulphide, and hardness of mineral salts in Ain Kibreet. Concentration is much higher than in Hammam Al-Aleel especially as SO<sub>4</sub>, SO<sub>3</sub> H<sub>2</sub>S, S, hardness and consequently dissolved solids are concerned. Local dwellers of the area believe that Ain Kibreet is more effective in curing skin diseases than Hammam Al-Aleel, especially if

the infected skin is lubricated with the black to yellowish mud (crystals of sulphur are abundant in this mud) taken from this spring. From the pharmacological point of view the most important constituent present in the spring water appear to be hydrogen sulphide,  $\text{Ca}^{++}$ ,  $\text{SO}_3$ , and  $\text{PO}_4$ .

In the treatment of skin diseases [1, 3] sulphur, zinc, bromide, and potassium chlorate are used. All these ingredients except for sulphide, are not present in mineral of Hammam Al-Aleel. According to Ramsay [6] hot water containing high concentration of  $\text{H}_2\text{S}$  is supposed to be beneficial to health and has been effectively used bringing relief in rheumatic pains. The temperature of mineral water of Hammam Al-Aleel varies between 313 and 330 K, thus it is believed that the presence of sulphur and high concentration of hydrogen sulphide contribute considerably to its therapeutic effects.

Bacteriological tests have revealed a bacteriostatic effect of mineral water on *Staphylococcus albus*. Some bacteriostatic effects on *Staphylococcus aureus* and *Staphylococcus citreus* were observed in the first experiment, being much lower in the subsequent ones. This may be explained by variation of  $\text{H}_2\text{S}$  concentration in the mineral water samples. No effect could be detected on Gram negative bacilli (*E. Coli.*, *Sh. dysenteriae*, *Ps. pyocyaneus*, and *Kl. pneumoniae*) or Gram positive bacilli (*B. cereus*, and *B. subtilis*).

### CONCLUSIONS

This study has revealed a bacteriostatic effect of mineral water of Hammam Al-Aleel on *Staph. albus* and a lower one on *Staph. aureus* and *Staph. citreus*. No effect on the viability of the bacilli bacteria was detected.

Therapeutic effect of mineral water may be due to its high temperature which promotes the circulation of blood especially in acute and chronic stages of diseases, and contributes to a better nutrition of tissues, as well as to acceleration of the action of microphages on the inflamed area. Direct contact of skin lesions with high concentrations of S,  $\text{H}_2\text{S}$ ,  $\text{SO}_3$ , and  $\text{SO}_4^-$  in mineral water has also a healing effect.

Another factor that should be considered is the role of solar UV radiation, since the patients take usually a very unique type of sun bath covering their bodies with hot sand for hours. Hot water relieves psoriasis, erythroderma, ichthyosis and removes scales. Its a sedative and tonic effect on nervous system have also been recorded. A complete rest and improved psychological conditions contribute to a great extent to the positive treatment of skin diseases.

### REFERENCES

- [1] BURROWS, *Textbook of micro-biology*, 19 Edition, Saunders Co., London 1968.
- [2] DOUDOROFF M., and ADELBERG E. A., *General microbiology*, 3rd Edition, U.K. Macmillan, 1971.
- [3] FROBISHER, *Fundamentals of microbiology*, 8th Edition, W. B. Saunders Co., London 1968.
- [4] Foundation of scientific research, Institute for Applied Research on Natural Resources and Unesco, Seminar on Ground Water, 10-15 March 1973.
- [5] KANBAR S. A., *Pollution and natural purification of Tigris River near Mosul*, Master's Thesis, University of Mosul.
- [6] RAMSAY W. L., BURLELY R. A., *Modern earth science*, Holt, Rinehart and Winston Inc. 1965.
- [7] Standard methods of examination of water and wastewater, American Public Health Association.
- [8] Utilization of minerals and thermal springs in Iraq, Institute for applied Research on Natural Resources, Preliminary Report, Technical Bulletin No. 58, March 1974.