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PHYSICOCHEMICAL AND BACTERIOLOGICAL CHARACTERISTICS OF POTABLE WATER IN A REGION OF INCREASED CANCER OCCURENCE

Well-water was investigated for those farms where the morbidity rate from malignancy was pronounced. For comparative purposes other farms were sampled where malignancy did not occur at all. The results obtained are discussed.

1. INTRODUCTION

The 10 year investigations in rural areas of the Cracow region within the programme of the Committee of Social Health of the Polish Academy of Sciences, Department in Cracow have shown that at some places the frequency of cancer cases is higher than the average [1–3], [5,7].

In recent years some components present in the air, water and soil are supposed to be factors stimulating the increased rate of sickness. The same is attributed to a low content of magnesium. It has been found that the ratio of calcium, potassium and magnesium ions present in water and soil is also essential. The increased content of potassium hinders the assimilation of magnesium.

On the other hand, numerous physicians stress the essential role of selenium as antioxidant diminishing the effect of oncogenic factors [3, 8, 9].

The presented investigations aim at answering the question whether a relation can be found between chemical composition of drinking water and the frequency of some neoplastic diseases.

To solve this problem a broad quality spectrum of the well water coming from farms has been analysed.

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2. MATERIAL AND METHODS

Well water from rural regions, characterised by high relation cancer morbility [2, 3, 5] was the subject of studies (wells number VI, VII, VIII). The water samples taken from he neighbouring settlements with infrequent cancer were used as a control (wells number IV, V).

After preliminary studies carried out in 1973 investigations started in May 1974 and were performed till November 1974. For 8 wells 10 series of analyses have been made. The parameters examined listed in Tables 1 to 3 were determined according to standards and regulations being in force in Poland. Macroelements presented in well-water samples were determined by standard analytical methods. Microelements have been analysed qualitatively by spectrographic emission technique and quantitatively (only selenium and mercury) — by atomic absorption technique using Atomspek-Singer for selenium, and Coleman Mass-50 for mercury [4, 6].

Full analysis of the microelements has been performed in four replications for each of the water samples taken on May 27, July 31, and September 16, 1974. Ten analytical series were made and the determinations were performed for every water sample 3 to 5 times.

3. RESULTS

Physicochemical and bacteriological analysis of water [10, 11] show some differences in particular wells variable also with time. Results of the qualitative spectrographic emission analysis of wells water sampled on May 27, 1974 is given in Table 1, and the corresponding diagram is presented in Fig. 1.

Table 1

Results of qualitative spectrographic emission analysis of well waters sampled on 27th May, 1974

Well No.	Content of microelements
I	Pb tr., Zn, Cu tr., Fe, Mn, Na
II	Pb, Zn tr., Cu, Fe, Ni, Mn, Na
III	Cu, Pb, Zn, Fe, Na, Mn tr.,
IV	Pb, Zn! Cu, Fe, Ni tr., Mn! Na
V	Pb tr., Zn, Cu, Fe, Ni, Mn, Na
VI	Pb tr., Zn, Cu, Fe tr., Ni tr., Mn, Na
VII	Pb! Zn! Cu, Fe, Mn, Na,
VIII	Zn, Cu, Fe, Ni, Mn, Na,

Note: Exclamation mark denites lines of density greater in the other spectra.
tr. = traces

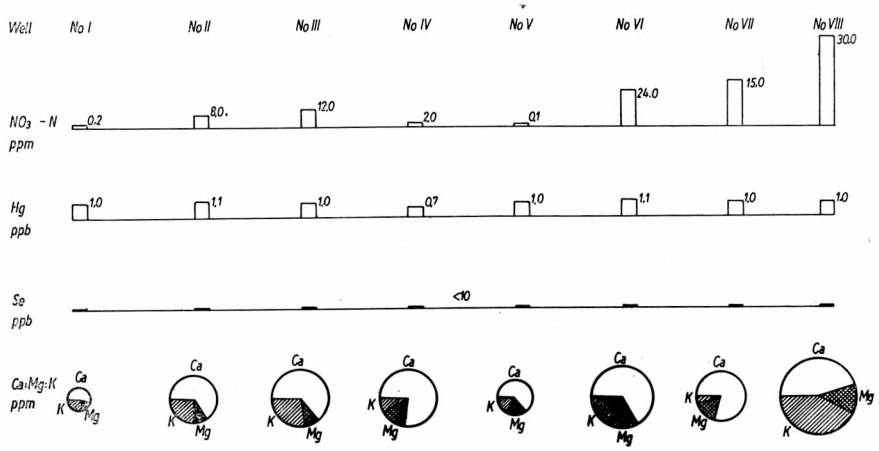

Fig. 1. The contents of nitrate nitrogen, mercury, selenium and relative abundance by weight of Ca, Mg, K in the water sampled from the wells on May 27, 1974

Rys. 1. Zawartość azotu azotanowego, rtęci i sodu w stosunku do zawartości wapnia, magnezu i potasu w próbkach wody pobieranych 27 maja 1974

Table 2

Results of physico-chemical analyses of well water sampled on May 27, 1974

Determination	Units	Well number							
		I	II	III	IV	V	VI	VII	VIII
Colour	mg/l Pt	12	7	17	5	15	5	3	7
pH		7.2	7.3	7.4	7.4	8.6	7.3	7.4	7.3
Total hardness	mval/l	1.6	8.7	11.1	13.9	3.0	18.4	13.6	19.4
Carbonate hardness	mval/l	1.2	5.7	6.9	8.8	3.1	10.6	8.1	9.8
Chlorides	mg/l Cl	7.8	50.4	103.6	87.3	12.8	131.3	75.2	195.9
Sulphates	mg/l SO_4	53.1	157.6	165.1	290.2	96.3	355.6	205.9	501.3
Fluorine	mg/l F	0.1	tr.	0.1	tr.	0.2	n.f.	n.f.	0.1
Total iron	mg/l Fe	0.9	tr.	tr.	0.1	0.15	0.05	n.f.	0.3
Manganese	mg/l Mn	0.05	tr.	tr.	0.2	0.05	tr.	tr.	tr.
Calcium	mg/l Ca	24.0	142.4	184.0	212.0	54.4	280.1	206.4	274.4
Magnesium	mg/l Mg	5.5	19.8	27.0	38.9	15.8	55.9	41.6	69.3
Potasium	mg/l K	9.5	51.3	76.0	20.9	15.2	77.9	11.4	269.8
Dry residue	mg/l	198	810	1048	1218	384	1747	1136	2188
Evaporation loss	mg/l	20	78	63	66	30	92	69	74
Suspended solids	mg/l	4	3	0	27	0	0	0	0
Free CO_2	mg/l	8.8	24.2	22.0	30.8	0.0	48.4	30.8	28.6
Agressive CO_2	mg/l	7.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dissolved oxygen	mg/l O_2	1.0	2.2	4.0	5.8	3.6	5.0	6.0	4.6
BOD_5	mg/l O_2	0.5	1.5	2.7	1.4	1.3	1.2	0.9	1.2
COD	mg/l O_2	0.7	2.5	3.9	1.5	1.2	3.0	1.1	3.0
Nitrate nitrogen	mg/l NO_3-N	0.2	8.0	12.0	2.0	0.1	24.0	30.0	60.0
Nitrite nitrogen	mg/l NO_2-N	0.001	0.003	0.01	0.008	0.07	0.006	0.015	0.007
Phenols	mg/l	0.01	tr.	n.f.	tr.	tr.	tr.	0.01	0.02
Index coli	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number of colonies on agar-agar	cm^{-3}	30	180	1600	50	120	60	260	120
Number of colonies on galatine	cm^{-3}	90	250	2100	80	210	110	310	180
Mercury	mg/l Hg	0.0010	0.0011	0.0010	0.0007	0.0010	0.0011	0.0010	0.0010
Selenium	mg/l Se	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Note: tr. = traces
n.f. – not found

Table 3

Variability of pollution concentrations in well No VIII

Determination	Units	Date of sampling (1974 year)									
		May 20	May 27	May 4	June 10	June 17	July 9	July 31	Sept. 16	Oct. 3	Nov. 14
Colour	mg/lPt	5	3	7	5	7	3	10	11	10.0	25.0
Reaction	pH	7.4	7.5	7.3	7.4	7.4	7.4	7.3	7.4	7.6	7.5
Total hardness	mval/dm^3	18.4	19.4	18.4	18.8	18.8	19.3	19.1	18.0	17.8	19.2
Carbonate hardness	mval/dm^3	9.8	9.8	9.8	9.5	9.5	10.3	10.6	10.4	9.5	9.6
Chlorides	mg/lCl	198.9	195.9	193.1	191.7	188.9	184.6	178.9	181.7	173.2	172.5
Sulphates	mg/lSO_4	474.6	501.3	498.0	492.0	453.6	444.5	408.3	457.7	332.1	409.1
Fluorine	mg/lF	0.15	0.10	0.15	tr.	tr.	0.08	0.1	0.1	0.2	0.1
Total iron	mg/lFe	0.05	0.3	tr.	0.05	0.015	n.f.	n.f.	tr.	tr.	tr.
Manganese	mg/lMn	tr.	tr.	tr.	tr.	0.05	n.f.	tr.	tr.	tr.	tr.
Calcium	mg/lCa	264.5	274.5	262.5	272.5	270.5	291.2	288.0	286.4	254.0	279.2
Magnesium	mg/lMg	63.2	69.3	64.4	62.6	64.3	71.0	76.6	45.0	62.6	62.0
Potasium	mg/lP	239.4	269.8	275.5	273.6	288.8	237.5	267.9	239.4	202.6	148.0
Dry residue	mg/l	2119	2114	2061	2023	2074	2248	2282	2267	2170	2070
Loss at dehydration	mg/l	93	74	81	89	92	112	123	121	86	115
Suspension	mg/l	0	6	0	0	0	0	0	0	0	0
Free CO_2	mg/l	37.4	28.6	41.8	30.8	24.2	39.6	39.6	41.8	27.5	30.8
Agressive CO_2	mg/l	0	0	0	0	0	0	0	0	0	0
Dissolved Oxygen	mg/l O_2	4.8	4.6	5.2	4.9	5.2	4.3	4.8	5.8	4.3	6.0
BOD_5	mg/l O_2	1.3	1.2	1.4	1.3	1.3	1.1	1.3	2.3	2.0	2.8
COD	mg/l O_2	3.2	3.0	4.3	4.0	3.1	3.8	3.8	3.3	4.3	4.0
Nitrate nitrogen	mg/l NO_3-N	12	60	48	45	30	48	80	35.0	35.0	80.0
Nitrate nitrogen	mg/l NO_2-N	0.05	0.007	0.007	0.005	0.05	0.01	0.01	0.035	0.035	0.035
Ammonia nitrogen	mg/l NH_3-N	n.d.	tr.	tr.	tr.	0.04	tr.	0.04	0.04	0.06	n.f.
Phenols	mg/l	tr.	0.02	0.02	tr.	0.02	0.01	—	tr.	tr.	tr.
Mercury	mg/lHg	0.0013	0.0010	0.0009	0.0005	0.0004	0.0005	0.0004	0.003	—	—
Selenium	mg/lSe	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	—	—

Note: tr. = traces
n.f. — not found

Table 4

Concentrations of pollutants contamination in the liquid content of the container for animal feces stated in June 10, 1974

Parameters	Units	Value
Turbidity	ppm	1300 — 2000
BOD_5	ppm	9300 — 9870
COD	ppm	1730 — 1800
Total hardness	m val	29.3 — 35.0
Alkalinity	m val	61.0 — 8.0
Dry residue	ppm	11500
Ammonia nitrogen	ppm	150 — 160
Chlorides	ppm	1278 — 1492
Magnesium	ppm	312 — 365
Calcium	ppm	240 — 440

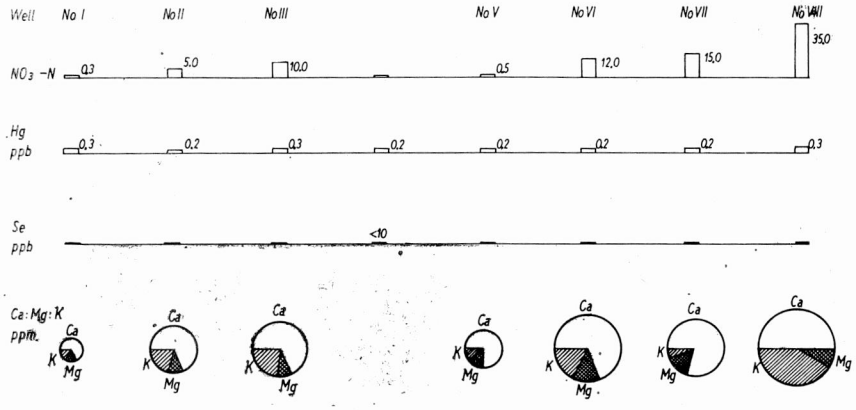

Fig. 2. The contents of nitrate nitrogen, mercury, selenium and relative abundance by weight of Ca, Mg, K in the water sampled from the wells on July 9, 1974

Rys. 2. Zawartość azotu azotanowego, rtęci i sodu w stosunku do zawartości wapnia, magnezu i potasu w próbkach wody pobieranych 9 lipca 1974

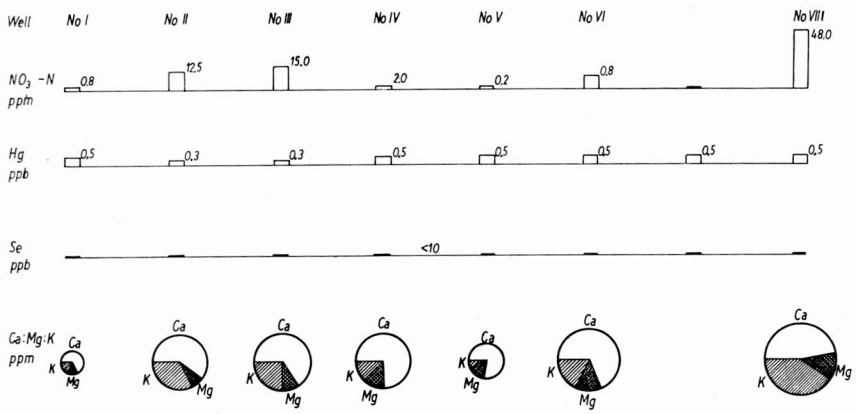

Fig. 3. The contents of nitrate nitrogen, mercury, selenium and relative abundance by weight of Ca, Mg, K in the water sampled from the wells on September 16, 1974

Rys. 3. Zawartość azotu azotanowego, rtęci i sodu w stosunku do zawartości wapnia, magnezu i potasu w próbkach wody pobieranych 16 września 1974

Numerical values by which the water quality can be determined are given in Tables 2 and 3. Table 2 presents a list of the parameters determined for all examined wells on May 27, 1974. Table 3 contains ten results of ten analyses of the water from well No. VIII, which along with wells No. VI and VII, is characteristic of the region within which cancer diseases are more frequent.

The diagram for water sampled on July 9 and September 16, 1974, are given in Figs. 2 and 3. In some wells a very high hardness of the water occurs, in majority being of transitory character. Calcium content is generally high (142 to 291 mg/dm^3) except for two cases where low contents of calcium has been established (24.0 and 54.4 mg/dm^3). Magnesium concentrations were remarkably lower ranging from 5.5 to 69.3 mg/dm^3. Great variations in potassium content as well as in dry residue have been stated. The examined water samples displayed excessive sulphate concentration while iron and manganese contents were within admissible limits. Agressive CO_2 was found in one case only. Suspended solids were present only in three wells. Dissolved oxygen amounted from 1 to 6 mg/dm^3, BOD_5 from 0.5 to 2.7 mg/dm^3 and COD — from 0.7 to 5.0 mg/dm^3. Nitrate nitrogen content ranged from 0.2 to 80 mg/dm^3; nitrite and ammonia nitrogen occured at concentrations 0.005 — 0.05 mg/dm^3. Bacteriological contaminations was fairly high. The contents of separate microelements determined are presented in Table 1 [11]. In all examined samples of water the significant concentrations of zinc, copper, iron, sodium, and traces of nickel and manganese were found. In the water samples from wells No. IV and VII zinc and lead contents were remarkably higher than in the other ones. No differences in Hg content were found among the samples of water taken from particular wells.

The performed analyses of the water samples from wells No. VI, VII, and VIII have showed surprising amounts of nitrates and a low selenium content. It seems worth noticing that the wells characterized by high concentrations of nitrites are situated at a small distance (8 to 15 m) from not sufficiently hermetic earth containers for animal feces. The concentrations of some pollutants present in the container situated in the vicinity of the well No. VI are given in Table 4 (according to analyses made on June 10, 1974 and November 14, 1974).

CONCLUSIONS

The investigations have shown that the water composition in the wells No. VI, VII, VIII representative of the regions where morbility on certain neoplastic diseases was observed differs from that found in other wells. This refers a specially to nitrate concentration and suspended solids. In the wells quantitative proportions of some elements (calcium, magnesium, potassium) differ at various degrees from values found in other wells. Large amounts of potassium were found.

The carried out investigations have shown that apart from the conventional analyses performed in order to establish the quality of potable water there exists a necessity of microelement qualitative and quantitative analysis, especially when an increased cancer morbidity is recorded.

The performed analytical investigations of well waters showed very low content of mercury (10^{-7} g/dm^3) and selenium (below 10^{-5} g/dm^3).

FIZYKOCHEMICZNA I BAKTERIOLOGICZNA CHARAKTERYSTYKA WODY STUDZIENNEJ W REJONIE O PODWYŻSZONEJ ZACHOROWALNOŚCI NA CHOROBY NOWOTWOROWE

Przeprowadzono badania wody pobranej ze studni zlokalizowanych w gospodarstwach, w których stwierdzono występowanie chorób nowotworowych. Wykazano odmienną charakterystykę jakości wody od innych analizowanych studni. Wodę ze studni, w gospodarstwach, w których stwierdzono choroby nowotworowe, cechowała większa zawartość azotanów oraz substancji rozpuszczalnych. Nie stwierdzono natomiast, mimo 500-krotnego zagęszczania próbek wody, obecności selenu.

PHYSIKALISCHE, CHEMISCHE UND BAKTERIOLOGISCHE KENNGRÖßEN DES BRUNNENWASSERS IN EINER DURCH HOHE ZUWACHSRATE VON KREBSKRANKHEIT BEZEICHNETEN GEGEND

Es wurde festgestellt, daß in gewissen Bauernfamilien die Krebserkrangsrate hoch war. In diesen Bauernhöfen wurde das Brunnenwasser geprüft. Es ergab sich aus den Untersuchungen, daß das Wasser durch gewisse Kenngrößen bezeichnet ist. Der Stickstoffinhalt sowie jener der wasserlöslichen Substanzen war höher als in allen anderen Brunnen. Nach 500mal durchgeführten Verdickungsprozedur wurde kein Vorkommen von Selen beobachtet.

ФИЗИКО-ХИМИЧЕСКАЯ И БАКТЕРИОЛОГИЧЕСКАЯ ХАРАКТЕРИСТИКИ КОЛОДЕЗНОЙ ВОДЫ В РАЙОНЕ ПОВЫШЕННОЙ ЗАБОЛЕВАЕМОСТИ ЗЛОКАЧЕСТВЕННОЙ ОПУХОЛЬЮ

Проведены исследования воды, взятой из колодцев тех хозяйств (дворов), в которых были отмечены случаи злокачественной опухоли. Показано, что качественные характеристики анализируемой воды отличаются от характеристик воды из других колодцев, подвергнутых исследованию. В воде из колодцев тех дворов, где была отмечена названная болезнь, содержалось больше азотнокислых солей и растворимых веществ.

Наличия селена в воде не обнаружено — несмотря на обогащение проб воды в 500 раз.

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