Water Quality Analysis and Countermeasure Research of Centralized Rural Drinking Water Project in Zhejiang Province

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Abstract: Objective: The water quality and sanitary conditions of centralized rural drinking water project in Zhejiang Province is analyzed, it can provide the scientific basis for rural water improvement and the government administrative department makes decision. **Method:** In 2013, 40 monitoring Counties in Zhejiang province were selected as the research objectives, in the high water period and in low water period, each sampling 1 time, 3973 copies of the centralized water samples were collected, and 20 indicators were detected. On each monitoring point, the selection of water source and the water purification process were investigated. **Results:** Most of the centralized rural drinking water projects in Zhejiang province take the surface water as water source, accounting for 71.25%, 7908 waterworks take the whole clean water processing, accounting for only 16.21%, 25.49% of the projects have not taken any measures. The centralized drinking water quality and health monitoring researched, and the total qualified rate is 46.72%. In the low water period and high water period, the qualified rates are respectively 58.57% and 35.03%, the main exceed the standard indicators are total coliforms and thermotolerant coliform bacteria and other microbial indicators, the turbidity and other sensory indicators are excess. **Conclusions:** The water quality monitoring qualified rate is low of Zhejiang province rural drinking water projects, and the hidden safety of drinking water is serious. We propose to strengthen the monitoring work and operation management, water facilities need to be improved, the construction of coordination mechanism among the departments needs to be enhanced, and the safety of rural drinking water should be ensured.

1. Introduction

Rural drinking water safety is directly related to the life and health of millions of farmers. Rural water supply project is the key work of balancing the urban and rural development, improving the quality of life of farmers, and promoting the rural economic and social development. The rural drinking water project is the important infrastructure in the country of China[1]. It is also the main part of rural public health system construction. The water quality and sanitary conditions of centralized rural drinking water project in Zhejiang Province is analyzed, it can provide the scientific basis for rural water improvement and the government administrative department makes decision[2]. In 2013, 40 monitoring Counties in Zhejiang province were selected as the research objectives, the comprehensive investigation and analysis of water quality monitoring were taken, and the analysis reports and results are expressed as follows.

2. Contents and methods

2.1 Selection of monitoring spots

According to the geographical environment, social and economic conditions, 40 monitoring Counties are selected as the monitoring spots, there are 7908 waterworks. According to water types, water treatment process, and water supply scale, layering random sampling is taken, 1000 centralized water supply spots in rural areas are determined[3-5].

2.2 Investigation and sampling method

According to the requirements of "Zhejiang province rural drinking water hygiene monitoring technology program", through the methods such as information access, on-site investigation, etc, the unified survey table is filled in. On each monitoring point, the selection of water source, water purification process is investigated. In the high water period and in low water period, waterworks are investigated on the spot, the water sanitary quality detection is taken, each monitoring point is provided with 2 sampling points (Outlet has 1 sampling point, and the terminal has 1 sampling point), there are total of 1000 sampling points. The water quality monitoring indicators include microbial indicators, toxicological indicators, sensory indicators and general chemical indicators, total of 20 indicators. There are total of 3973 centralized samples.

The collection, preservation and test of water samples are taken in accordance with GB /T5750-2006 "drinking water standard test method". According to GB5749-2006 "drinking water health standards", the evaluation is formed, all the test items are in accordance with GB5749-2006 "drinking water health standards", it is taken as the

standard for judging the sample is qualified, of which one and above indicators do not meet the standard, judging the sample is unqualified.

2.3 Data processing and analysis

After the data information is verified, the data are read to the MS Excel, SPSS 10. 0 and DUNCAN software are used for the statistical processing and analysis.

3. Results

3.1 Types of water source

Most of the centralized rural drinking water projects in Zhejiang province take the surface water as water source, accounting for 71.25%. There are 2273 waterworks take the groundwater as the water source, accounted for 28.75%, the source of water distributions of centralized water supply in Rural County Waterworks are shown in Table 1.

Table 1. Water source situation of rural county waterworks on monitoring points

Types of water source		Waterworks	Proportion (%)
Surface water	River water	134	1.69
	Lake water	13	0.16
	Reservoir water	1998	25.27
	Pond ditch water	170	2.15
	Stream water	2994	37.86
	Else	326	4.12
	Subtotal	5635	71.25
Groundwater	Deep well water	624	7.89
	Spring water	1122	14.19
	Shallow well water	527	6.67
	Subtotal	2273	28.75
Total		7908	100.00

3.2 Water purification process

In 7908 waterworks, 1282 waterworks take the complete clean water processing, accounting for only 16.21%. 3576 waterworks take sedimentation and filtration method for water clean processing, accounting for 45.22%.1034 waterworks only take disinfection method for clean water processing, 2016 waterworks have not taken any processing procedures, accounting for 25.49%. From the survey results, there are still part of the centralized water supply in rural areas do not have any water treatment process, using the direct water supply mode, it is not safe. The investigation results are shown in Table 2.

Table 2. Clean water processing investigation results of monitoring points

	Water processing methods	Complete processing	Sedimentation and filtration	Only disinfection	Without processing	Total
3.3	Number of Waterworks	1282	3576	1034	2016	7908
	Proportion (%)	16.21	45.22	13.08	25.49	100.00

Water quality status

The centralized drinking water quality and health monitoring researched, and the total qualified rate is 46.72%. In the low water period and high water period, the qualified rates are respectively 58.57% and 35.03%, the qualified rate of waterworks outlet is 44.60%, the qualified rate of water terminal is 48.82%. The results are shown in Table 3. Overall, the qualified rate in dry season is higher than the abundant water period, and the qualified rate of terminal water is higher than the outlet water. This result is mainly because that water treatment process is not perfect of the rural drinking water safety, disinfection equipment configuration has low rate, and the disinfection facilities do not use norms and so on. The broad masses of peasants need to improve the drinking water situation, improve the quality of life.

From the rural centralized water supply factory monitoring results, according to all the indicators, the lowest standard rate indicator is the total coliform, it is 57.44%. The rate of thermotolerant coliform bacteria is 61.92%, and the turbidity is 86.03%. From the above three indicators, the water quality is bad, and it affects the rural drinking water safety, it has close relationship to the configuration and usage of disinfection facilities.

The investigation and research results are described in Table 4 and Table 5.

Table 3. Overall evaluation of water quality and health monitoring of centralized water supply

Overall evaluation	Outlet water of waterworks			Terminal water			Total		
	Water samples	Qualified number	Qualified rate（%）	Water samples	Qualified number	Qualified rate（%）	Water samples	Qualified number	Qualified rate（%）
Low water period	984	531	53.96	988	624	63.16	1972	1155	58.57
High water period	998	353	35.37	1003	348	35.03	2001	701	35.03
Total	1982	884	44.60	1991	972	48.82	3973	1856	46.72

Table 4 Water single indicator evaluation in low water period

Indicators	Outlet water			Terminal water			Total		
	Water samples	Qualified number	Qualified rate（%）	Water samples	Qualified number	Qualified rate（%）	Water samples	Qualified number	Qualified rate（%）
Chroma	984	982	99.80	988	987	99.90	1972	1969	99.85
Turbidity	984	852	86.59	988	874	88.46	1972	1726	87.53
Smell taste	984	983	99.90	988	984	99.60	1972	1967	99.75
Visible	984	911	92.58	988	918	92.91	1972	1829	92.75
pH	984	949	96.44	988	951	96.26	1972	1900	96.35
Iron	984	977	99.29	988	979	99.09	1972	1956	99.19
Manganese	984	981	99.70	988	985	99.70	1972	1966	99.70
Chloride	984	984	100.00	988	988	100.00	1972	1972	100.00
Sulfate	984	980	99.59	988	984	99.60	1972	1964	99.59
Solubility	984	984	100.00	988	988	100.00	1972	1972	100.00
Hardness	984	983	99.90	988	988	100.00	1972	1971	99.95
Oxygen	984	983	99.90	988	987	99.90	1972	1970	99.90
Ammonia	984	980	99.59	988	985	99.70	1972	1965	99.65
Fluoride	984	981	99.70	988	985	99.70	1972	1966	99.70
Arsenic	984	984	100.00	988	988	100.00	1972	1972	100.00
Nitrate	984	981	99.70	988	985	99.70	1972	1966	99.70
Bacteria	984	928	94.31	988	937	94.84	1972	1865	94.57
Coliform	984	675	68.60	988	663	67.11	1972	1338	67.85
Thermotolera	984	723	73.48	988	714	72.27	1972	1437	72.87
Residual	268	142	53.38	260	162	62.31	528	304	57.58
Chlorine	177	121	68.36	181	121	66.85	358	242	67.60
Total	19141	18064	94.37	19213	18153	94.49	38354	36217	94.43

Table 5. Water single indicator evaluation in high water period

Indicators	Outlet water			Terminal water			Total		
	Water samples	Qualified number	Qualified rate（%）	Water samples	Qualified number	Qualified rate（%）	Water samples	Qualified number	Qualified rate（%）
Chroma	998	985	98.70	1003	993	99.00	2001	1978	98.85
Turbidity	998	838	83.97	1003	854	85.14	2001	1692	84.56
Smell taste	998	995	99.70	1003	1003	100.00	2001	1998	99.85
Visible	998	900	90.18	1003	918	91.53	2001	1818	90.85
pH	998	949	95.09	1003	960	95.71	2001	1909	95.40
Iron	998	984	98.60	1003	993	99.00	2001	1977	98.80

Manganese	998	969	97.09	1003	982	97.91	2001	1951	97.50
Chloride	998	998	100.00	1003	525	100.00	2001	1523	76.11
Sulfate	998	525	100.00	1003	1003	100.00	2001	1528	76.36
Solubility	998	998	100.00	1003	1003	100.00	2001	2001	100.00
Hardness	998	997	99.90	1003	1002	99.00	2001	1999	99.90
Oxygen	998	994	99.60	1003	1002	99.90	2001	1996	99.75
Ammonia	998	986	98.80	1003	995	99.20	2001	1981	99.00
Fluoride	998	996	99.80	1003	1001	99.80	2001	1997	99.80
Arsenic	998	998	100.00	1003	1003	100.00	2001	2001	100.00
Nitrate	998	993	99.50	1003	1001	99.80	2001	1994	99.65
Bacteria	998	804	80.56	1003	790	78.76	2001	1594	79.66
Coliform	998	473	47.39	1003	471	46.96	2001	944	47.18
Thermotoler	998	515	51.60	1003	508	50.60	2001	1023	51.12
Residual	299	119	39.80	326	148	50.34	625	267	42.72
Chlorine	193	95	49.22	197	96	48.73	390	191	48.97
Total	19454	17111	87.96	19580	17251	88.11	39034	34362	88.03

4. Discussions and conclusions

4.1 Existing problems

The survey results show that, the drinking water project in Zhejiang province has the water quality and safety problem, it is shown as the following aspects:

(1) The water quality monitoring qualified rate is low, for the 40 counties (cities, areas), the total qualified rate of water samples is 46.72%.

(2) The microbial indicators exceed the standard, it is the main factor affecting the water quality, the main exceed the standard indicators are total coliforms and thermotolerant coliform bacteria and other microbial indicators, the turbidity and other sensory indicators exceed the norm.

(3) The water purification process and operation management level should be further improved, according to this monitoring, the complete processing of water purification only accounts for 16.21%, and even 25.49% of the waterworks have not taken any measures, which is an important reason for water quality not up to standard.

4.2 Countermeasures and suggestions

(1) To strengthen the monitoring and management, monitoring funds should be abundant. The monitoring counties make the rural drinking water safety projects in the annual work plan. Actively strive for all levels of finance supporting funds, provide security monitoring with abundant funds, to ensure the completion of the task and the infrastructure construction.

(2) To strengthen the operation management of rural drinking water safety project. Strive to promote the rural drinking water safety project, increase the rural drinking water safety work funds and policy support. To strengthen the management of rural drinking water safety project technical guidance, staff training and supervision and management. Strengthen and improve the operation and management, build a number of water quality health management areas.

(3) To strengthen relevant contact and coordination of departments, strengthen the monitoring work and operation management, water facilities need to be improved, the construction of coordination mechanism among the departments needs to be enhanced. All the departments work together to ensure that the rural drinking water safety.

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