Research article

Chemical Characteristics of Natural Mineral Water from a Wellspring in the Ban Haubueng Community Forest, Nampong District, Khon Kaen Province, Thailand

NUTTIRA KLEAWKLAHAN
Office of Agricultural Research and Development Region 3,
Ministry of Agricultural and Cooperatives, Khon Kaen, Thailand

CHULEEMAS BOONTHAI IWAI*
Department of Soil Sciences and Environment, Faculty of Agriculture,
Khon Kean University, Khon Kean, Thailand
Email: chuleemas1@gmail.com

Received 21 February 2022 Accepted 22 April 2022 (*Corresponding Author)

Abstract This research aimed to analyze the chemical characteristics of natural mineral water from a wellspring in the Ban Haubueng Community Forest, Nampong District, Khon Kaen Province, Thailand. Physico-chemical properties and minerals status are important deciding factors in the assessment of water quality for water resource utilization. Therefore, the contamination of heavy metal and essential minerals from different locations within the Ban Haubueng community forest were evaluated. Water samples were collected in 2021 and then analyzed according to standard methods for heavy metal and the essential minerals; As, Pb, Cd, Zn, Cu, Hg, Ni, Mn, Zn, Fe, Se, Na, Si, and Ca through the use of Inductively Coupled Plasma Optical Emission Spectroscopy. In-house methods were also employed, based on EPA 3015 and microbial contamination; such as *Escherichia coli* via AFNOR Certificate Number 3 M 01/ 8-06/ 01 compared with ISO16649-2, and for *Salmonella* spp. by ISO 6579:2017. The results found that As, Pb, Cd, Zn, Cu, Hg and Ni as well as *E. coli* and *salmonella* were not detected in all water samples. Essential minerals including Si and Ca were detected in the mineral water samples at 7.61 ppm -7.64 ppm and 3.0 ppm-8.86 ppm, respectively. Therefore, we concluded that the mineral water has no heavy metal contamination and is safe from pathogenic microorganisms; *E. coli* and *Salmonella* spp. Moreover, other mineral elements present, like silicon may warrant further investigation for other purposes, such as agricultural production**.**

Keywords natural mineral waters, heavy metals, pathogenic microorganisms, water quality

INTRODUCTION

Water is very important for rural development and contributes significantly to people health. Water is an essential component of our food and contributes to many mineral nutrients. Its contribution to health is directly within households through food and nutrition, and indirectly as a means of maintaining a healthy, diverse environment. Fresh water is essential for agriculture, domestic use, and drinking purpose for human and animals. Water quality depends upon the chemical and biological characteristics of water. Therefore, human health as well as sustainable agricultural development will not be possible without availability of quality fresh water in adequate quantity (WHO, 1996).

The Ban Huabueng community forest has an area of 80 rai (1 rai= 1,600 square meters), and is represented by seven community forest committees. The area is characterized by sandy loam and characterized as a dry evergreen forest, most of the trees found are *Dipeterocapus alatus Roxb.* ex. G. Don, *Shorea obtusa Wall. Ex Blume, Shorea siamensis Miq. Hopea odorata* Roxb., *Ficus callose.* Community utilization of the forest has been for conducting ritual ceremonies and for the

benefits provided by the wellspring, at 100 and 91.2 percent, respectively (Phulawan, 2020). A wellspring in the Ban Huabueng community forest was found and used by villagers since 1899. Mineral water from wellspring is a natural water source, which farmers use for both consumption and agriculture. A quality assessment of the natural mineral water is, therefore, needed to ensure safe water consumption and for water resource management for villagers.

OBJECTIVE

The purpose of this research was to analyze the chemical and biological water characteristics of the natural mineral water from the wellspring in the Ban Haubueng community forest, Nampong District, Khon Kaen Province, Thailand.

METHODOLOGY.

The study area is Ban Huabueng which located at Moo 9, Sai Mun Sub-district, Nam Phong District, Khon Kaen Province, Thailand and founded in 1899, the village consists of a 62-rai residential area with a total of 157 households, an agricultural area of 883.24 rai, and a public area of 124 rai (1 rai= 1,600 square meters). The educational level was primarily at the elementary level, representing 46.0 percent. Agriculture was the primary occupation followed by various forms of general employment. The average number of household members was four people, with an average income of 44,734.51 baht per year, and the average life span in the Ban Huabueng community was 52.55 years.

The water samples were collected from different sites in plastic bottles, which were previously washed with detergents and HNO_3 acid and later rinsed with sampled water several times. Total 1.5mL of 2M HNO_3 was added to each 100mL samples (pH<3) for metallic ions determination to maintain the stability of the oxidation state of the various elements in solution and prevent precipitation (Singh et al, 2005).

Three samples from different sites consisting of a) mineral water from the community forest's wellspring, b) mineral water from paddy fields, c) irrigation water, were collected and tested. The water samples were collected in June 2021 and then analyzed according to standard methods for heavy metal and essential minerals; including As, Pb, Cd, Zn, Cu, Hg, Ni, Mn, Zn, Fe, Se, Na, Si, and Ca through the use of inductively coupled Plasma optical emission spectroscopy (ICP-OES). In-house methods were also employed, based on EPA 3015 and microbial contamination, such as *E. coli* via AFNOR Certificate Number 3 M 01/8-06/01 compared with ISO16649-2, and for *Salmonella* spp. by ISO 6579:2017.

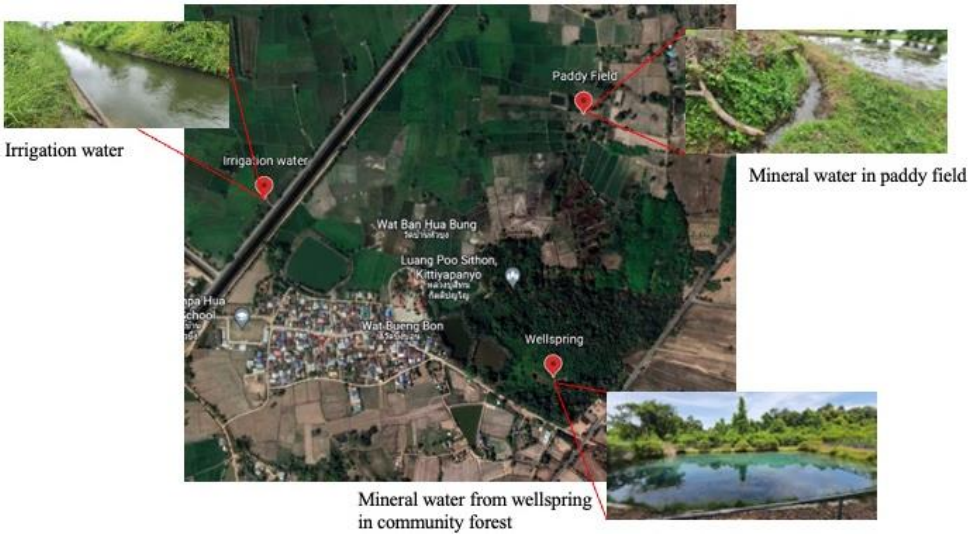

Fig. 1 The study area and water sampling sites

RESULTS

Heavy metal and other essential minerals from each sample location within the Ban Haubueng community forest were shown in Tables 1 and 2. The results found that As, Pb, Cd, Zn, Cu, Hg, Ni; as well *Escherichia coli* and *Salmonella* spp. were not detected in all water samples. Essential minerals, such as Si and Ca were detected in the mineral water at 7.61ppm-7.64 ppm and 3.0 ppm-8.86 ppm, respectively. Therefore, it can conclude that the natural mineral water from a wellspring in the Ban Haubueng Community Forest has no heavy metal contamination and safe from pathogenic microorganisms, like *Escherichia coli* and *salmonella* spp. (Tables 1, 2).

Table 1 Chemical characteristics (metal contents) of natural mineral water from the wellspring in Ban Haubueng Community Forest, Nampong District, Khon Kaen Province (unit:ppm)

Metal contents	Mineral water from wellspring in community forest	Mineral water in paddy field	Irrigation water	Standard[a]
Zn (ppm)	ND	ND	ND	1.00
Fe (ppm)	ND	0.84	0.03	1.00
Se (ppm)	ND	ND	ND	-
Na (ppm)	1.71	2.75	15.67	200[b]
Si (ppm)	7.61	7.64	6.36	-
Ca (ppm)	3.0	8.86	28.31	-
As (ppm)	ND	ND	ND	0.10
Pb (ppm)	ND	ND	ND	0.05
Cd (ppm)	ND	ND	ND	0.01
Cu (ppm)	ND	ND	ND	1.00
Ni (ppm)	ND	ND	ND	0.10
Mn (ppm)	0.01	0.02	0.02	0.05

[a] *Water quality standard for surface water sources, Pollution Control Department, Ministry of Natural Resources and Environment, Thailand*
[b] *The World Health Organization, a drinking water guideline of 200 mg of sodium/L*

Table 2 Analysis of pathogenic microorganisms (*Escherichia coli* and *Salmonella* spp.) in the water samples

	Pathogenic microorganisms	
	E. coli (cfu/g)	*Salmonella* spp. (in 25 grams)
Mineral Water from the wellspring	< 10	Not detected
Tap water in the village	< 10	Not detected
Irrigation water	< 10	Not detected

DISCUSSION

Heavy metals are known to be toxic, persistent within environmental settings, possibly bioaccumulated and concentrated in the biota and food chain, as well as containing carcinogenic metalloids (Hee et al., 2019). There are various sources, including natural and anthropogenic, of heavy metals in aquatic environments. Metals from anthropogenic sources such as industrial wastes, agricultural runoff, urban runoff, atmospheric deposition, and automobile emissions could be dispersed to the surface water via surface runoff or rain water. From this research, no toxic heavy metal contents were found in the natural mineral water from the wellspring in the Ban Haubueng community forest, Nampong District, Khon Kaen Province. But silicon and calcium, the mineral elements were found in the mineral water from community forest wellspring. This finding may be useful information for using this water resource in others purposes, such as agricultural production. The composition of the mineral water was analyzed and found several nutrients; for example, silicon, which is known for its role in alleviating the negative stress effects on numerous plant

species (Frew et al., 2018) and calcium that is good for plants. Silicon, as previously reported, applied with fertilizer increased grain and straw yield, plant height, number of tillers, number of panicles, and 1000-grain weight of rice (Pati et al., 2016; Cuong et al. 2017). The increased growth and yield of rice were influenced by its ability to reduce biological and physical stresses (Pati et al., 2016). The nutritional values of rice vary with different varieties, soil fertility, fertilizer application, and other environmental conditions (Verma, and Srivastav, 2017). Rice production has been done in this area. Therefore, rice grown with mineral water from wellspring in community forest could be a beneficial source of mineral supplements for people in the village.

CONCLUSION

We concluded that the natural mineral water from the wellspring in the Ban Haubueng community forest, Nampong District, Khon Kaen Province has no heavy metal contamination and is safe from pathogenic microorganisms (*Escherichia coli* and *salmonella* spp.). The water quality status of the natural mineral water from the wellspring in the Ban Haubueng community forest, Nampong District, Khon Kaen Province during the wet seasons is under Thailand Water Quality Standard in term of heavy metals and pathogen. This finding provides a scientific reference for protecting local aquatic ecosystem and managing water resources development in this community for the future.

ACKNOWLEDGEMENTS

The authors wish to express their gratitude to the Office of Agricultural Research and Development Region 3, Ministry of Agricultural and Cooperatives, Khon Kaen, Thailand, and the Integrated Land and Water Resource Management Research and Development Center in Northeastern Thailand, Khon Kean University, Khon Kaen, Thailand.

REFERENCES

Cuong, T.X., Ullah, H., Datta, A. and Hanh, T.C. 2017. Effects of silicon-based fertilizer on growth, yield and nutrient uptake of rice in tropical zone of Vietnam. Rice Science, 24 (5), 283-290, Retrieved from DOI https://doi.org/10.1016/j.rsci.2017.06.002

Frew, A., Weston, L.A., Reynolds, O.L. and Gurr, G.M. 2018. The role of silicon in plant biology, A paradigm shift in research approach. Annals of Botany, 121 (7), 1265-1273, Retrieved from DOI https://doi.org /10.1093/aob/mcy009

Hee, Y.Y., Suratman, S. and Aziz, A.A. 2019. Water quality and heavy metals distribution in surface water of the Kelantan River basin (Malaysia). Oriental Journal of Chemistry, 35 (4), Retrieved from DOI http:// dx.doi.org/ 10.13005/ojc/350402

Pati, S., Pal, B., Badole, S., Hazra, G.C. and Mandal, B. 2016. Effect of silicon fertilization on growth, yield, and nutrient uptake of rice. Communications in Soil Science and Plant Analysis, 47 (3), 284-290, Retrieved from DOI https://doi.org/10.1080/00103624.2015.1122797

Pollution Control Department. 2010. Water quality standard for surface water. PCD, Thailand, Retrieved from https://www.pcd.go.th

Singh, D., Chhonkar, P.K. and Dwivedi, D.S. 2005. Manual on soil, plant and water analysis. Westville Publishing House, ISBN 8185873267, New Delhi.

Verma, D.K. and Srivastav, P.P. 2017. Proximate composition, mineral content and fatty acids analyses of aromatic and non-aromatic indian rice. Rice Science, 24 (1), 21-31, Retrieved from DOI https://doi.org/ 10.1016/j.rsci.2016.05.005

World Health Organization. 2003. Health criteria and other supporting information. Guidelines for Drinking-Water Quality (Second Ed), Vol. 2, World Health Organization, Geneva.