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An Outfit for Improving Potability of Water in Snow-Bound Areas

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ABSTRACT

A water sterilising outfit has been developed for improving potability of water in snow-bound areas by coverting snow-melted water into safe drinking water. The outfit (wt. 50 g) contains a rectangular tin box and two types of tablets–white sterilising tablets and pink thio-mineral tablets–stored in pharmaceutical packings and provides 35 litres of wholesome drinking water as per World Health Organisation and Indian Council of Medical Research standards. The sterilised and mineralised water obtained from this outfit is not only free from turbidity, colour, odour and bad taste, but also supplements the deficiency of iodine which has been found as a primary cause of goiter in high altitude areas by health authorities. Mineralised water containing 0.04 mg/l of iodine provides a daily dose of about 0.08 to 0.12 mg of iodine to a person consuming 2 to 3 litres of water in snow-bound areas. The item has been introduced in Armed Forces for the regular use.

1. INTRODUCTION

The troops located in high altitude areas ranging upto a height of 6000 m are having almost no normal drinking water supply. The source for drinking water in these areas is snow or snow-melted water in the form of streams. The high altitude areas of Ladakh receive a scanty rain fall, as the central high Himalayas act as a barrier and block the rain bearing winds from the south. The high altitude areas beyond Leh generally remain covered with snow during most of the period of the year. Storms lasting for several days accompanied by heavy avalanche activity are

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quite common in Himalaya affecting security posts and movements, communications, villages and winter tourism. The drinking water to the troops are provided by melting the snow or from natural streams of snow-melted water, which has a flat taste due to very low mineral concentration (Table 1). This water does not satisfy the consumer. The necessity of an outfit to make users self-sufficient for their water requirement by converting snow-melted water into safe and wholesome drinking water, was therefore felt in these areas.

Table 1. Physico-chemical characteristics of snow-melted water of snow-bound areas

Constituents	Region		
	Ladakh	Satlej	Antarctica
p^H	6.9-7.0	-	6.7 to 6.8
TDS	67-180	318	12 to 25
Cations (*Ca* + *Mg*)	17-48	80	traces
Anions (*Cl*)	34-68	28	traces to 3
Heavy metals	Nil	Nil	Nil
Coliform (MPN/100 ml)	Nil*	Nil	Nil

* A few snow samples near deep trench latrines showed presence of coliforms

2. CHARACTERISTICS OF SNOW-MELTED WATER AND DRINKING WATER STANDARDS

In high altitude forward areas, no normal drinking water supply system exist. Physico-chemical studies undertaken by the authors on snow-melted waters of different areas indicate that the electrolytes are present in insignificant amounts (Table 1). The entire Himalayan belt which includes high altitude areas stretching from Jammu & Kashmir to Arunachal Pradesh in India has been declared as goiter affected areas[1-3]. This has been attributed to the deficiency of iodine in soil and food-stuffs. Minerals along with traces of iodine are an essential part of the diet. The normal daily requirement of iodine[4] is 0.15 to 0.2 mg. Both potassium iodide and potassium iodate have been found to be effective for iodisation of common salt[5] and consumption of only iodised salt is permitted in goitre-genic areas.

As per drinking water standards of World Health Organisation[6,7] (WHO) and Indian Council of Medical Research[8] (ICMR), the desirable limits of dissolved salts in water is 500 mg/l which could be extended to a maximum allowable level of 1500 mg/l. WHO guideline values for dissolved salts however is upto 1000 mg/l while ICMR has relaxed upto 3000 mg/l in case where alternate sources are not available within the reach. The respective element limits of major constituents in water are given in Table 2.

The presence of faecal coliform group of organisms are generally taken to be an indicator of potential public health hazard because of possible presence of pathogens responsible for water-borne diseases like typhoid, dysentry and cholera. The limits of coliform and faecal coliform (*E. coli*) in drinking water are also given in Table 2.

Table 2. Drinking water standards

Constituents	WHO		ICMR (1975)	
	Allowable (1971) (mg/l)	Guideline value (1984) (mg/l)	Highest desirable level (mg/l)	Maximum permissible level (mg/l)
Total dissolved solids			500	1500*
p^H			7.0–8.5	6.5–9.2
Calcium (Ca^{2+})			75	200
Magnesium (Mg^{2+})			50**	100
Sulphate (SO_4^{2-})		400	200	400
Chloride (Cl)		250	200	1000
Hardness (*as* $CaCo_3$)		500	300	600
Sodium (Na^+)		200		
Coliform (MPN/100 ml)		3	10	
E coli (MPN/100 ml)		Nil	Nil	

* Dissolved solids relaxable upto 3000 mg/l in case where alternate sources are not available within reach.

** Not more than 50 mg/l; if there are 200 mg/l sulphate. If there are less sulphate, magnesium upto 100 mg/l, magnesium may be allowed at the rate of 1 mg/l for every 4 mg/l decrease in sulphate.

The water-borne diseases are commonly transmitted through water supply contaminated by the causative agents present in the faeces of infected persons. Bad hygiene, open and deep trench latrines, improper disposal of human waste and food-stuffs thrown outside the habitats have been found to be other sources of contamination of water supply. It is concluded from the laboratory studies[9] undertaken on *E. coli* at –5 to +10°C, that the bacteria remains dorment and once it finds a way in the human systems, it gets multiplied rapidly at the body temperature, 37°C.

3. DEVELOPMENT OF OUTFIT

In order to make troops and survey parties self-sufficient under prevailing conditions of snow-bound areas, a water sterilising outfit has been developed[10] by modifying an existing one used in other than snow-bound areas. The developed outfit provides safe sterilised mineral water having required concentrations of essential minerals including iodine as per drinking water standards. The existing outfit contains a brown coloured rectangular box and two glass bottles—one colourless bottle containing sterilising tablets and the other amber coloured bottle containing blue taste-removing tablets. The purpose of the existing outfit is to provide potable water after sterilisation. However, it is not effective in snow-bound areas as the snow-melted water after treatment with this existing outfit is not wholesome due to deficiency of naturally occurring elements and iodine. The tablets packed in glass bottles are also subject to deterioration due to moisture and sunlight.

The outfit developed for snow-bound areas contains a rectangular tin container, sterilising and thio-mineral tablets.

3.1 Rectangular Tin Container

The rectangular white tin box with length 6.3 cm, breadth 6.3 cm, height 2.2 cm and locking arrangement is strong enough to meet stress and strain of field conditions.

The outer white painted lid is inscribed on top in blue letters as 'Sterilising Outfit for Snow-Bound Areas'. The operating instructions have been printed on inner side of the lid.

3.2 Sterilising Tablets

The sterilising tablet (100 mg) contains halogen benzoic acid *p-N*-dichloro-sulphono amide as an active ingredient releasing 3 to 4 mg/l (ppm) of free-chlorine. 32 tablets are stored in white coloured strips of aluminium foil lined with polythene.

3.3 Thio-Mineral Tablets

The thio-mineral tablet (250 mg) contains sodium thiosulphate, salts of sodium, potassium, magnesium as well as potassium iodide, along with amaranth dye, etc. 32 pink tablets are stored in thick pink coloured strips of aluminium foil lined with polythene.

3.4 Operation

In the water bottle (1.14 l capacity) provided to a soldier, one sterilising tablet is required to be dissolved in snow-melted water by shaking vigorously and standing for 30 minutes to ensure complete sterilisation. Second operation involves dissolution of a thio-mineral tablet which in addition to removing the bad taste due to excess of residual chlorine left after sterilisation, supplements deficiency of minerals and iodine.

3.5 Characteristics of Treated Snow-Melted Water

The sterilised, mineralised and iodised snow-melted water free from turbidity, colour, odour and bad taste, has been found aesthetically acceptable by the consumers after several field trials in snow-bound areas. Physico-chemical characteristics of the treated water vis-a-vis recommended limits of WHO and ICMR of respective constituents are given in Table 3, which clearly indicates that it is wholesome and

Table 3. Physico-chemical characteristics of treated snow-melted waters vis-a-vis WHO and ICMR standards

Constituents	Concentration of constituents in treated water (mg/l)	Recommended limits (mg/l)	
		WHO	ICMR
p^H	7.4*	6.5–8.5	6.5–9.2
Cations			
Sodium (Na^+)	63	200	
Potassium (K^+)	3		
Magnesium (Mg^{2+})	3.5	150	100
Anions			
Chloride (Cl^-)	63	600	100
Sulphate (as SO_4^{2-})	51		
Thio-sulphate ($S_2O_3^{2-}$)	11	400	400
Amaranth dye (pink)	0.09		-
Iodine	0.05	Nil	Nil
E coli (MPN/100 ml)	Nil/100 ml*	Nil/100 ml	Nil/100 ml

* Except p^H & *E coli* all values are in mg/l.

potable. Field and laboratory studies on water samples contaminated with faecal pollution (*E. coli*) have shown the absence of *E. coli* in treated waters indicating complete disinfection.

The outfit developed for troops may find usage in civil sectors by local habitants, survey parties, para-military forces and tourists. It is being marketed by enterpreneurs licensed through the National Research Development Corporation of India.

REFERENCES

1. Thorp's Dictionary of Applied Chemistry, Ed. 4, Vol. VIII, (Longman Green & Co., London), 1955, p. 2, 3.
2. Jayaraman, K.S., *Nature,* **304** (1983), 206.
3. Jain, Naresh, *Science Reporter,* **21** (3), (1984), 126-128.
4. International Commission on Radiological Protection, No-23, Report of the Task Group on Reference Man (Pergamon Press, New York), 1981, p. 386.
5. Aggarwal, S.C., The Salt Industry in India (The Manager of Publication, Delhi), 1956.
6. International Standards for Drinking Water, Ed. 3, (WHO, Geneva), 1971.
7. Guidelines for Drinking Water Quality, (WHO, Geneva), Vol. 1 and 2, 1984.
8. Indian Council of Medical Research, Manual of Standards of Quality of Drinking Water Supplies, Ed. 2, Special Report Series, No. 44, (ICMR, New Delhi), 1975.
9. Conversion of Snow-Melted Water into Potable Water, Report No. DLJ/TEC/CHEM/79/5, (Defence Laboratory, Jodhpur), 1975.
10. Conversion of Snow-Melted Water into Potable Water Report No. DLJ/TC/CHEM/85/10, (Defence Laboratory, Jodhpur), 1985.