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Nutritional and Microbial Quality Evaluation of Herbal Drinking Water

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ABSTRACT

About 80% of all illnesses in developing countries are related to water e.g., cholera, dysentery, diarrhea, etc. Herbal traditions throughout the world have used infusions and decoctions of herbs in drinking water. This study assessed the antibacterial activity, quality and consumer acceptability of drinking water on treatment with *Piper longum* and *Caesalpinia sappan* extracts. Among the various concentrations, 0.5 g *P. longum* root extract and 0.5 g *C. sappan* bark extract treated with drinking water recorded high quality, high antibacterial activity and better consumer acceptability.

Keywords: antibacterial activity, *Caesalpinia sappan*, consumer acceptability, *Piper longum*, total hardness

INTRODUCTION

Water is the elixir of life. It is a strong solvent and helps in easy disposal of wastes from our body. About one billion people lack safe drinking water and more than 6 million people (of which 2 million are children) die from diarrhoea every year (Postnote 2004). Herbal infusions are potent water-based preparations. An experiment was conducted at the Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore to study the nutritional quality and antibacterial activity of two herbal extracts in drinking water. *Caesalpinia sappan* (sappan wood or East Indian red wood) is a multipurpose tree of great economic importance in southern parts of India. Decoction of the wood is a powerful astringent and emmengogue. It is prescribed as a tonic for diarrhoea and dysentery (Badami *et al*. 2004). *Piper longum* (Indian long pepper or pippali) an indigenous medicinal plant of North-eastern and Southern India and Sri Lanka, is a powerful stimulant for both the digestive and the respiratory systems and has been shown to have a rejuvenating effect on the lungs. The root is used for bronchitis, stomachache, and diseases of spleen, tumors and improves appetite also. The infusion of root is prescribed after parturition to induce the expulsion of placenta (Badmaev *et al*. 1999). This paper describes the antimicrobial activity, quality and consumer acceptability of herbal drinking water.

MATERIALS AND METHODS

Collection of plant material

The heartwood of *C. sappan* and the root of *P. longum* were purchased from the Farming Trust of India (NGO), Palghat and Tharakar Agency, Coimbatore, respectively. The materials were pulverized into a powder using an electric crushing machine. The powdered samples were hermetically sealed in polythene bags and stored under room condition until extraction.

Preparation of various concentrations of herbal drinking water

Various concentrations of dried and powdered materials were dissolved in 1 l of ordinary drinking water (**Table 1**). The bottles used for storage were autoclaved at 15 psi at 120°C for 20 min and the samples were kept in sterilized bottles.

Testing the water quality on a regular basis is an important part of maintaining a safe and reliable source. The samples were subjected to various nutrient analyses (total soluble salts, chloride, nitrate, sulphate and total hardness), an oraganoleptic test (Senthil Kumar 2007) and a test for antibacterial activity (Nair *et al*. 2005).

Determination of antimicrobial activity of herbal drinking water

1. Test microorganisms

The Gram-positive bacteria *viz*., *Escherichia coli*, *Staphylococcus aureus*, *Streptococcus B* strain and Gram-negative bacteria namely *Salmonella typhi*, *Klebsiella pneumoniae* were used as test microorganisms.

The microorganisms were obtained from the Azolla Laboratory, Department of Agricultural Microbiology, TNAU, Coimbatore. The bacteria was cultured and maintained on nutrient agar (NA) medium. For the bioassay, a loopful of the organism was inoculated into 100 ml of NA broth as the medium. The conical flask was kept in a rotary shaker for 24 h.

Table 1 Concentrations of herbal powders used in herbal drinking water.

Treatment code	Treatment concentration
T_1	Control (water)
T_2	Water (1 L) + 0.1 g *C. sappan* powder+ 0.1 g *P .longum* powder
T_3	Water (1 L) + 0.2 g *C. sappan* powder + 0.2 g *P. longum* powder
T_4	Water (1 L) + 0.3 g *C. sappan* powder + 0.3 g *P. longum* powder
T_5	Water (1 L) + 0.4 g *C. sappan* powder + 0.4 g *P. longum* powder
T_6	Water (1 L) + 0.5 g *C. sappan* powder + 0.5 g *P. longum* powder

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Research Note

2. Preparation of test controls

Negative control: The pure water was used as the negative control. **Positive control:** 1 mg of chloramphenicol (Falcon Chemox Pvt. Ltd., India) as the positive control was dissolved in 1 ml of water.

For determination of antibacterial activity, the agar well diffusion assay method was used (Navarro *et al.* 1996).

Quality and consumer acceptability of herbal drinking water

The nutrients *viz*., total soluble salts, chloride, nitrate, sulphate and total hardness (calcium and magnesium) were analyzed (Browne 1926).

For consumer acceptability, a scoring sheet was given to the consumer for assessing the taste, colour and flavour of herbal drinking water.

Statistical analysis of data

The experiment was conducted in a complete randomized design with six treatments and five replications. All values were expressed as the mean of five replications for each treatment. Data were subjected to one multifactorial analysis of variance (ANOVA). The statistical parameters like mean, standard error and critical difference for all the observations were worked out by adopting standard methods of the analysis as suggested by Panse and Sukhatme (1978).

RESULTS AND DISCUSSION

The World Health Organization emphasized the guidelines for drinking water quality in **Table 2** (Yamamura 1984). The primary aim of the guidelines for drinking water quality is the protection of public health.

Colour is an aesthetic parameter and treatment is given to remove or reduce to produce water that will have an acceptable appearance to customers. The colour of herbal drinking water may vary considerably according to the chemical constituents of herbal (PFRA 2007). Among the various concentrations, T_6 treatment had recorded permissible as well as high levels of nutrients (**Table 3**). The nutrient levels slightly increased at increased concentrations. Normally drinking water contains certain limits of nutrients and the herbal plants have nutrients in smaller amounts (Bergner 1997). The accumulated levels of nutrients in water as well as herbal extracts have been the cause of increased nutrient level in herbal drinking water.

The data pertaining to the antibacterial potential of the herbal drinking water are presented in **Table 4**. It is obvious from the **Table 4** that higher concentrations of herbal drinking water had inhibitory action on *E. coli*, *S. typhi*, *S. aureus* and *Streptococcus* B strain, but no effect on *K. pneumoniae*. Both *S. aureus* and *Streptococcus* B showed equal susceptibility to the higher concentration. The findings were similar to that *S. aureus and Streptococcus* B strain susceptible to different plant extracts reported by Madamombe and Afolayan (2003).

The relative inhibition zone diameter was 97.38 and 84.44% in *S. aureus* and *Streptococcus* B strain, respectively (**Table 5**). For Gram negative bacteria, the RIZD was 71.91% for *S. typhi* but there was no activity against *K. pneumoniae*. Similar antimicrobial activity has been reported earlier in *C. sappan* by Kim *et al.* (2004) against methicillin-resistant *S. aureus* (Kim *et al*. 2004). Piperine, a *trans-trans* isomer of 1-piperoyl-piperidine found in *P. longum* markedly inhibited the growth of *S. aureus*, including methicillin-resistant *S. aureus* (Khan *et al*. 2006).

Twenty five consumers evaluated the acceptability of herbal drinking water using a hedonic scale. Sensory scores for color, flavor, taste and overall acceptability for herbal drinking water were acceptable (**Fig. 1**).

Table 2 WHO guidelines for drinking-water quality (GDWQ)

Nutrients	Permissible limit
Total soluble salts	0.050 – 0.200 ppm
Chloride	250.00 mg L^{-1}
Sulphate	250.00 mg L^{-1}
Nitrate	10.0 mg L^{-1}
Total hardness	18.00 mg L^{-1}

Table 5 Determination of antibacterial activity of herbal drinking water: Relative inhibition zone diameter (RIZD; %).

Microorganisms	RIZD (%)
Gram-positive bacteria	
Staphylococcus aureus	97.38 ± 1.83
Streptococcus B strain	84.44 ± 1.83
Escherichia coli	64.62 ± 1.83
Gram-negative bacteria	
Salmonella typhi	71.91 ± 1.83
Klebsiella pneumoniae	00.00

CONCLUDING REMARKS

Water is a strong solvent and helps in easy disposal of wastes from our body. Herbal drinking water is aimed to increase the nutrient contents and also to reduce the bacterial activity in water to control the water borne diseases. Hence the present investigation is of importance in demonstrating the quality and antibacterial activity and defining the disease curing ability of herbal drinking water. It seems important to recommend that, further studies using isolated constituents instead of whole extract must be done in this field. Health foundations have to increase their funding of these

Table 3 Nutritional quality of herbal drinking water

Treatments	Total soluble salts (ppm)	Chloride (mg L^{-1})	Nitrate (mg L^{-1})	Sulphate (mg L^{-1})	Total hardness[a]
T_1	0.007 ± 0.001	248.3 ± 0.11	9.4 ± 0.05	245.8 ± 0.14	15.7 ± 0.06
T_2	0.042 ± 0.001	249.0 ± 0.11	9.5 ± 0.05	249.7 ± 0.14	16.0 ± 0.06
T_3	0.055 ± 0.001	249.5 ± 0.11	9.5 ± 0.05	248.0 ± 0.14	16.2 ± 0.06
T_4	0.069 ± 0.001	246.0 ± 0.11	9.6 ± 0.05	248.9 ± 0.14	16.5 ± 0.06
T_5	0.076 ± 0.001	246.6 ± 0.11	9.7 ± 0.05	249.7 ± 0.14	16.7 ± 0.06
T_6	0.104 ± 0.001	250.5 ± 0.11	9.8 ± 0.05	250.0 ± 0.14	16.9 ± 0.06

[a] mg L^{-1} as Ca and Mg

Table 4 Determination of antibacterial activity of herbal drinking water

Treatment	*Staphylococcus aureus*	*Streptococcus* B strain	*Salmonella typhi*	*Klebsiella pneumoniae*	*Escherichia coli*
T_1	-	-	-	-	-
T_2	-	-	-	-	-
T_3	-	-	-	-	-
T_4	-	-	-	-	-
T_5	-	-	-	-	-
T_6	+	+	+	-	+

(+) susceptibility (inhibition zone ≥ 2 cm)
(-) absence of susceptibility

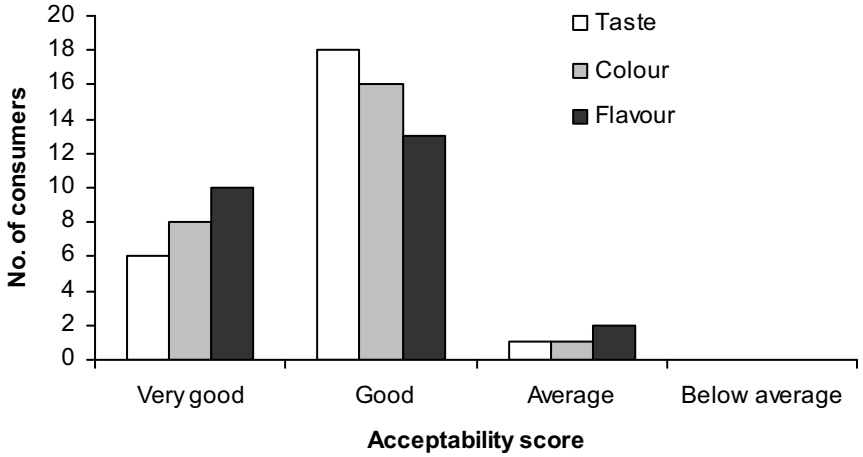

Fig. 1 Consumer acceptability of herbal drinking water.

studies and research to improve the quality of drinking water and to help saving the lives of many peoples.

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