

INVESTIGATE THE ABILITY OF *MORINGA*  
*OLEIFERA* SEEDS AND *NEEM* LEAVES AS  
ANTI-FUNGAL ACTIVITY IN URBAN  
DRINKING WATER

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We hereby declare that we have checked this thesis, and, in our opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Doctor of Philosophy.



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## STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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## ABSTRAK

Air minuman berkualiti tinggi yang datang dari loji rawatan adalah terdedah kepada pencemaran dan kemerosotan kualiti yang teruk akibat sistem penghantaran air minuman sebelum ianya kepada paip pengguna. Air seharusnya tulen dan bebas daripada sebarang bahan cemar untuk kegunaan manusia. Walau bagaimanapun, prosedur rawatan air sediaada adalah jauh lebih mahal, dan menggunakan banyak pembasmi kuman yang bersifat toksik, menjadikan pencarian alternatif organik yang lebih selamat menjadi lebih penting. Kajian terdahulu membuktikan keupayaan biji *Moringa oleifera* dan daun *Neem* untuk merawat air dengan cara menghadkan pertumbuhan bakteria dan mengurangkan kekeruhan air. Kajian terdahulu tidak mengesahkan keupayaannya untuk menghadkan pertumbuhan kulat dalam rangkaian air minuman. Oleh sebab ini, kajian ini dijalankan untuk mengesahkan keupayaan biji *Moringa oleifera* dan daun *Neem* dalam menghadkan pertumbuhan kulat yang terdapat dalam sistem pengagihan air minuman. Sampel diambil dari paip bangunan kediaman dan awam tempatan yang mengandungi air dibekalkan dari Loji Rawatan Air Semambu Kuantan. Parameter kualiti air diukur menggunakan kriteria kualiti air minuman Malaysia dan WHO. Didapati bahawa parameter seperti warna, kekeruhan, dan klorida berada dalam had yang boleh diterima dalam kebanyakan sampel air paip mengikut Piawaian Kualiti Air Minuman Kebangsaan (NDWQS) Kementerian Malaysia dan WHO. Baki klorin bebas dalam air paip di kawasan terpilih ini berbeza dari 0.05 hingga 1.97 mg/L, kekeruhan berubah dengan purata 3.8 NTU, dan ambang rasa untuk ion kalsium ialah 100 mg/l hingga 300 mg/l. Terdapat 2 jenis kulat yang tersebar luas dalam sampel air paip telah dikesan iaitu *Aspergillus sp.* (73%) dan *Rhodotorula mucilaginosa* (63%). Keputusan mengesahkan bahawa biji Moringa, ekstrak daun Neem dan klorin pada semua kepekatan mempunyai aktiviti antikulat didalam penyiasatan ini. Faktor yang paling penting, iaitu dos, masa, dan pergolakan, telah dipilih untuk penilaian lanjut tentang kesannya terhadap menghapuskan pertumbuhan komuniti kulat dalam air minuman menggunakan reka bentuk komposit pusat (CCD) dalam metodologi permukaan tindak balas (RSM). Keputusan pengesahan adalah diantara 0 % hingga 5.88 % dalam kadar kesilapan untuk *Rhodotorula mucilaginosa* dan *Aspergillus sp.* Penemuan ini juga menunjukkan bahawa model yang dibangunkan boleh dipercayai untuk menghadkan pertumbuhan kulat dalam selang keyakinan sebanyak 94%. Oleh kerana benih *Moringa oleifera* dan daun *Neem* boleh dihasilkan secara tempatan, penggunaannya dalam rawatan air harus digalakkan. Hasil kajian ini dapat mengurangkan perbelanjaan yang tinggi dan bahaya terhadap kesihatan yang berkaitan dengan rawatan air kimia yang kerap digunakan selama ini. Oleh kerana prosesnya adalah bersifat biologi, tiada sisa tidak boleh dirawat dicipta, penyelesaiannya juga adalah kos efektif, tradisional dan mudah dilaksanakan, menjadikannya sesuai untuk digunakan di kawasan luar bandar.

## ABSTRACT

High-quality drinking water coming from treatment plants is susceptible to pollution and severe deterioration due to the drinking water delivery system prior to access to consumers' faucets. Water must be pure and free of any contaminants for human consumption. However, promising water treatment procedures are considerably more expensive, and many of the disinfectants now in use are toxic, making the hunt for safer organic alternatives even more important. Previous studies proved the ability of *Moringa oleifera* seeds and *Neem* leaves to treat water in the area of limiting bacterial growth and reducing water turbidity. The previous studies have not verified the ability to limit the growth of fungi in the drinking water network. For this reason, this study was carried out to choose *Moringa oleifera* seeds and *Neem* leaves to verify their ability to limit the growth of fungi present in the drinking water distribution system. The samples were taken from a tap of local residential and public building that contains direct water from Kuantan's Semambu Water Treatment Plant. Water quality parameter were measured using Malaysian and WHO drinking water quality criteria. It was found that parameters such as colour, turbidity, and chloride were within acceptable limits in most tap water samples according to the National Drinking Water Quality Standards (NDWQS) of the Ministry of Malaysia and WHO. The residual free chlorine in the tap water of these selected areas varied from 0.05 to 1.97 mg/L, the turbidity was varied with an average of 3.8 NTU, and the taste threshold for calcium ions is 100 mg/l to 300 mg/l. The typical two fungi widespread in the tap water samples have detected which are *Aspergillus sp.* (73%) and *Rhodotorula mucilaginosa* (63%). The results confirmed that *Moringa* seeds, *Neem* leaves extract and chlorine at all concentrations had antifungal activity against the under this investigation. The most significant factors, which are dosage, time, and agitation, were selected for further evaluation of their impact on eliminating the fungi communities' growth in the drinking water using central composite design (CCD) in response surface methodology (RSM). The results for validation were between 0 % to 5.88 % in error for *Rhodotorula mucilaginosa* and *Aspergillus sp.* These findings also implied that the developed models were reliable for limit the growth of the fungi within the 94 % confidence interval. Because the seed of the *Moringa oleifera* and leaves of the *Neem* can be produced locally, its use in water treatment should be encouraged. The high expenses and health hazards connected with frequently used chemical water treatments would be reduced as a result of this. Because the process is biological, no non-treatable wastes are created, the solution is cost-effective, traditional, and easy to implement, making them ideal for rural regions.

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