

## **RURAL COMMUNITITES DOMESTIC ALTERNATIVE FOR TREATED WATER CONSUMPTION**

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### **Abstract:**

The rural population being most vulnerable, marginalized and poor in Colombia, has no access to potable water for human consumption due to lack of economic resources in order to obtain industrial chemicals used in water treatment, such as aluminum sulfate to the process of clarification and chlorine disinfection, whose high costs in the market fails to purchase, in addition, the construction of physical infrastructure to make the treatment process technology and materials involved are inaccessible to this population by their high costs. This forces millions of people consuming untreated water and whose consequences are high rates of morbidity and mortality, especially among children as the most vulnerable.

This research achieves the design and construction of a treatment plant for small water flows and focus for the rural population, whose process of clarification and disinfection is achieved by the replacement of industrial chemicals with natural products and biologically active substances which occur naturally in plants as bioactive compounds used by its qualities, called phytochemicals, are able to obtain the same efficiency, effectiveness, low cost and effective harmless to human health. This was achieved by physical, chemical and bacteriological laboratory showed that so. Treatment and application of natural products is given in small domestic treatment system constructed in lightweight materials, durable and economic such as PVC, wood and plastic, treating the water in a conventional free-flow and no power consumption, ensuring its applicability, benefit and sustainability over time.

### **Keywords**

Rural water, phytochemical

### **Introduction:**

To achieve the drinking water need to be tested at various elementary processes, which include clarification, disinfection and conditioning chemical and organoleptic (Arboleda, 2000). The water pollution and the economic impossibility of access to effective sanitation, the only means capable of providing protection against diarrheal diseases, cholera, typhus and other diseases transmitted through water, are the cause of millions of child deaths each year in the developing world, especially in the rural population.

The research group AQUA Civil Engineering program of the Cooperative University of Colombia Ibague branch, from 2006, is investigating the plight of raw water consumption in most of the rural population of the Department of Tolima, reflecting the country's health situation. The main cause is the economic and technological difficulties accessing water treatment systems, where the acquisition and use of industrial chemicals needed is an impediment, in addition, the physical infrastructure for its implementation is not feasible to build.

In Colombia, traditional use as a coagulant aluminum sulfate, ferric sulfate, and a whole range of chemicals that your first problem is the high cost for the production of sulfuric acid and aluminum oxide, the raw material to produce these sulfates. Disinfection is the chemical nature and is made using chlorine gas or in solution, in addition to its high cost is a product that causes irreversible damage the health of the social cluster, as their consumption on a large scale or over long periods time, generates catastrophic diseases.

This critical situation facing the rural population can be solved from the implementation of simple technologies that include the installation of physical infrastructure for water treatment, with the replacement of industrial chemicals with natural products that abound in the flora of Colombia, whose efficiency, effectiveness and safety in human health can be corroborated by laboratory tests, with practical applications in diverse communities. This simple solution involves teaching and replication of biotechnology to direct beneficiaries to take ownership of the solution to ensure its applicability, replica massive health and economic benefits and sustainability over time.

Have been obtained for the clarification of water with natural products, four coagulant with acceptable results (extracted from plants whose common names include: Moringa, Saman, Tuna Cactus Opuntia and Cereus), and

for disinfection, three (3) products natural (extracted from plants whose common names are: Lemon, Camu Camu and Marañon). All the above meet the requirements in the standard of Water Quality for Human Consumption in Colombia (Resolution No. 2115, 2007). Today biotechnology is spreading and teaching the beneficiary rural communities for adequate implementation, including management and maintenance of household treatment systems.

#### **Methods:**

Research shows the usefulness of nature in the treatment of drinking water, following the empirical experience of the culture of Colombia ancestors who used certain plants and fruits to improve water quality with visible results. This valuable experience was the basis for the investigation started from the year 2006 in the Tolima department of the Research Group for AQUA. All this cultural experience was investigated to form the database of potential phytochemicals for use in research. The project was developed through the use of various samples of natural products (phytochemicals), taken to the laboratory in order to subject them to prepare and apply raw water from the river that supplies the aqueduct Combeima the city of Ibagué, capital of the department of Tolima, Colombia. The tests were conducted in the laboratory quality control of the Company of Water and Sewer Ibagué IBAL, certified by the Ministry of Social Protection of Colombia and Quality Assurance System ISO-9001-2004. The experiment was performed with trial and error to determine the natural products capable of meeting the proposed target, in compliance with current regulations in Colombia regarding the quality of water fit for human consumption (Resolution No. 2115, 2007).

Coagulation of natural products: For replacement usually used chemical coagulant (aluminum sulfate) is used several types of plants that are presumed to possess the ability to clot suspended and colloidal particles, by removing the electrostatic forces that repel and prevent them from clumping. By trial and error experimentation, samples were prepared by drying, soaking and spraying to apply in the raw water and jar tests simulating clarifying the results of measuring turbidity, pH and color, determining the optimal dose (CEPIS , 1981). Of these samples, we chose those that met the clotting process and whose potential would allow the replacement of aluminum sulfate.

Image 1 - Test jars (if applied to the Tuna)



Source: Guevara; Ramírez; Ospina, 2007

Disinfection with natural products: Similar procedure was performed for the disinfection process, where the sample taken from the natural product was applied to the raw water in the presence of total coliform and *E. coli* (an indicator of the presence of fecal coliform), then the product was applied natural disinfectant, verify their effectiveness. We used various plants and fruits by trial and error to determine those with the ability to remove pathogens in the water and the optimal dose was determined to remove all total coliform and *E. coli*.

The treatment plant consists of a system built up of materials readily available, economical, durable, clean and some of them recycled, which together are capable of removing water pollution in the conventional manner, making it suitable for human consumption. It does not require any power and is manually manipulated to treat small amounts of water, equivalent to single-family household use.

**Results:**

Coagulation of natural products: For the coagulation of natural products were tested several plant species being able to obtain three (3) natural coagulants with acceptable results (extracted from plants whose common names include: Moringa, Saman and Opuntia Tuna (Guevara; Ramírez; Ospina, 2007) and later another species called Cactus Cereus (Peña; Ramirez; Ospina, 2008), whose efficiency is measured from the flocculation-sedimentation of raw water from the river that supplies the aqueduct Combeima city of Ibague in times of winter and average turbidity of 1200 Nephelometric Turbidity Units (NTU).

Picture 2 - The process of sample preparation (if applied to the Tuna)



Source: Guevara; Ramírez; Ospina, 2007

The equipment was calibrated jar to simulate the flocculation and settling times of the treatment plant, equivalent to 15 minutes for each process (Colombian Technical Standard NTC 3093, 1996). We used samples with different turbidity levels (ranges) to compare the results obtained between the chemical coagulant dosage (aluminum sulfate) and natural products, in order to obtain the optimum doses in each of them that it could achieve a turbidity lower end a 10 NTU. The required dosage of the chemical coagulant to remove turbidity to below 10 NTU is slightly lower than that of natural products, with the Moringa more efficient than others.

Results show the possibility of using natural products to replace chemical coagulants in the treatment of drinking water being a viable environmental, social, economic and technical, especially for marginalized communities.

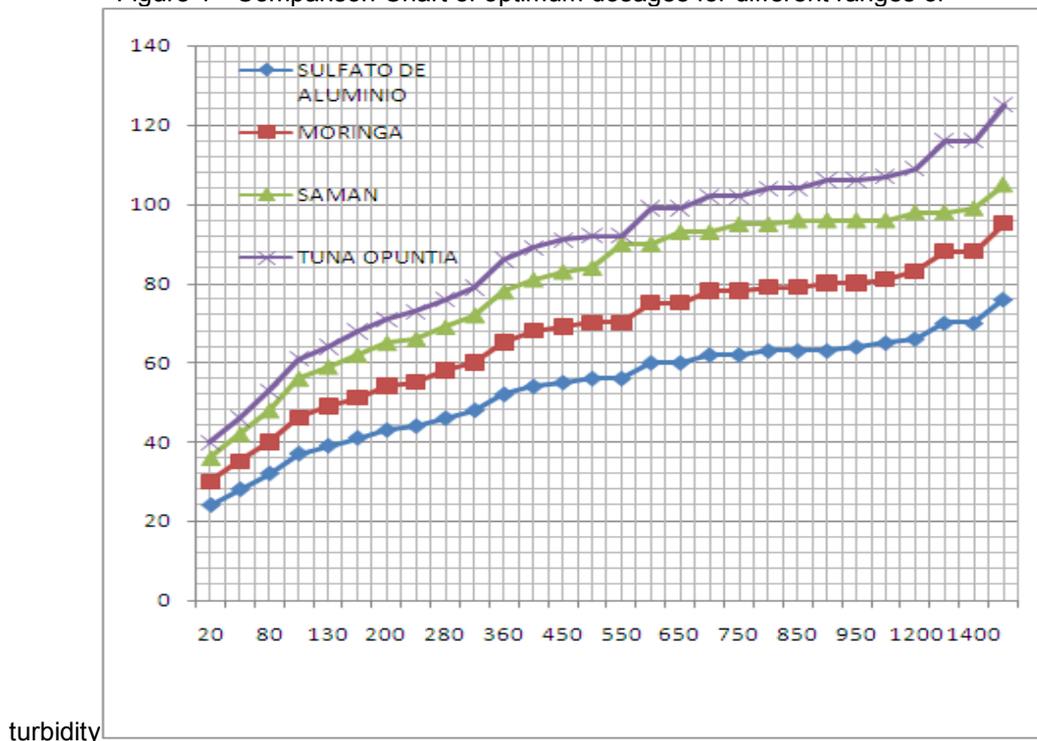
Table 1 - Results of optimal doses of coagulant chemicals and natural products, for different ranges of

RANGO (UNT)		SULFATO DE ALUMINIO (mg/l)	MORINGA (mg/l)	SAMAN (mg/l)	TUNA OPUNTIA (mg/l)
0	20	24	30	36	40
20	40	28	35	42	46
41	80	32	40	48	53
81	100	37	46	56	61
101	130	39	49	59	64
131	180	41	51	62	68
181	200	43	54	65	71
201	240	44	55	66	73
241	280	46	58	69	76
281	320	48	60	72	79
321	360	52	65	78	86
361	400	54	68	81	89
401	450	55	69	83	91
451	500	56	70	84	92
501	550	56	70	90	92
551	600	60	75	90	99
601	650	60	75	93	99
651	700	62	78	93	102
701	750	62	78	95	102
751	800	63	79	95	104
751	850	63	79	96	104
801	900	63	80	96	106
851	950	64	80	96	106
901	1100	65	81	96	107
951	1200	66	83	98	109
1101	1300	70	88	98	116
1201	1400	70	88	99	116
1301	1500	76	95	105	125

turbidity

Source: Guevara; Ramírez; Ospina, 2007

Figure 1 - Comparison Chart of optimum dosages for different ranges of



turbidity

Source: Guevara; Ramírez; Ospina, 2007

Disinfection with natural products: When testing various plants and fruits were obtained three of them successfully to disinfect drinking water (extracted from plants whose common names are: Lemon, Camu Camu and Maranon) meeting the requirements standard established in the Colombian water quality for human consumption, removing entirely the total coliforms and faecal samples (Arias; Ramirez; Ospina, 2008).

The inherent properties of natural disinfectants cause the synergistic effect of ascorbic acid and citric Fumal present in them, mainly attacking the cell wall and cytoplasm to interfere with bacterial respiration. Are not volatile, are biodegradable, broad spectrum of action, toxicity and have almost no residual activity.

### **Conclusions:**

Natural products are for plants and fruits that abound in the wild in the flora of Colombia, with no part of the diet. The research project identified the natural products capable of treating water for human consumption in the processes related to the clarification and disinfection.

Culture is implanted clean production for water treatment products for consumption. For the very conditions of technology, the impact on local and national level will allow transmute the problem of impaired quality of life in all areas, water consumption by contaminated. Mitigate the effects of morbidity and mortality produced by the residual chemicals on human health, saving resources in the treatment of gastric and diarrheal diseases, especially in children by consumption of raw sewage. It helps solve one of the most critical issues currently facing the human being, with respect to water unfit for consumption, without risk to their health outcomes and low-cost side. The direct benefit occurs in Colombia and most underdeveloped countries and the developing world, limiting their access to the high current costs of industrial chemicals. The use of natural products (phytochemicals) in the treatment of drinking water, can carry out fully the provisions of Resolution No. 2115 of 2007 and Decree 1575 of 2007 (current regulations of water quality for human consumption in Colombia).

### **References**

- GROVE, J. (2000). Theory and practice of water purification systems - Volume 1 Third Edition. Bogota: Nomos S.A.
- ARIAS, A., RAMIREZ, H., OSPINA, O.E. (2008). Disinfection of water with natural products [undergraduate thesis]. Ibagué: Universidad Cooperativa de Colombia Ibagué sectional CEPIS (Pan American Center for Sanitary Engineering and Environmental Sciences) (1981). Theory, design and control of water clarification processes - Technical Series 13.
- GUEVARA, D.O., RAMIREZ, H., OSPINA, O.E. (2007). Coagulation and flocculation water for consumption, with natural products [undergraduate thesis]. Ibagué: Universidad Cooperativa de Colombia Ibagué sectional Colombian Technical Standard NTC 3093 (1996). Procedure for the method of pitchers in the coagulation-flocculation water. Bogota: Colombian Institute of Standards and Certification ICONTEC.
- PEÑA, E.F.; RAMIREZ, H., OSPINA, O.E. (2008). Coagulation and flocculation water for consumption, with natural phase II [undergraduate thesis]. Ibagué: Universidad Cooperativa de Colombia Ibagué sectional RESOLUTION 2115 (2007). Characteristics, basic instruments and control system frequencies and monitoring for water quality for human consumption. Ministry of Social Protection of the Republic of Colombia.