OPTIMIZATION OF THE WATER SUPPLY SYSTEM IN THE COMMUNITY OF JARAQUIEL, MONTERÍA-COLOMBIA, USING MORINGA OLEIFERA AS COAGULANT AND ENDOCARPIO OF COCO NUCIFERA TO OBTAIN ACTIVATED CARBON

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SUMMARY: Cordoba is one of the most productive departments of Colombia, generating a population growth towards urban areas, increasing the demand in the services of potable water and basic sanitation, however, the efforts and the public investments at national, departmental and municipal level, There is a great inequality in the provision of public services, between urban and rural areas of the department, such as the district of Jaraquiel in which water is sought to be purified with natural products such as Moringa Oleifera and Cocos nucifera, Project will benefit approximately 1,253 community members.

Key words: Moringa, Cocos nucifera endocarp.

1. INTRODUCTION

The raw water contains a number of suspended solids and dissolved particles which must be removed in the potabilization, since they are responsible for the turbidity and color of the water (AMIRTHARAJAH, 1989). The removal of each of these particles is carried out by conventional agents used in coagulation, are metal salts such as aluminum sulfate, ferric chloride and ferrous sulfate. However, the use of aluminum salts should be controlled as they could leave some residual aluminum in the treated water, and this can lead to health problems, such as severely affecting the central nervous system and adverse neurological effects, mainly manifested in Alzheimer's disease (ROMERO, 1989), (Miller et al., 1984). Other studies have reported that their residues may be carcinogenic (SANGHI et al, 2006). However, this can be avoided with the use of a natural coagulant, such as the Moringa Oleífera (M. Oleífera), which avoids the use of these products and is more environmentally friendly (POUMAYE et al, 2012), (PRITCHARD Et al, 2009), is active, safe, economical (GHEBREMICHAEL et al, 2005), And its wide use is possible in the treatment of water, which brings economic benefits to those who use the M. Oleifera tree.

For the purification of water, it is necessary to use activated carbon because it is a very versatile adsorbent. It has the virtue of adhering or retaining on its surface one or more

components (atoms, molecules, ions) that are dissolved in the liquid that is in contact with it, by means of adsorption the water or other liquids or gases that come in contact with the adsorbent element are purified, deodorized and discolored, considering the environmental benefits of the use of natural products, the coconut endocarp Nucifera as activated charcoal for water purification, these processes of obtaining products will be made in a craft way by the community of the benefited community.

The chemical properties of the seed of the Moringa Oleifera make it one of the main alternatives of natural coagulant, studies carried out in recent years have reported reliable results (NDABIGENGESERE, 1998), in Colombia this plant is found naturally, because its adaptability characteristics allows it to survive in different kinds of climate, plants have been found at heights between 0 and 1800 meters above sea level and temperatures that approximate between 6 and 38ºC (REYES et al, 2010).

The community of Jaraquiel is located 15 minutes from the town of Montería, Córdoba department, to date has not had a supply of drinking water for approximately 20 years, despite having a water supply infrastructure It is not suitable for the treatment of it. The source of water abstraction that consumes the community comes from the Rio Sinu, on whose slope is the settlement of the population; The consumption of raw water has negative consequences on the health of the population, an activity that is common in the population, ignoring health risks and generating consumption expenditures in families.

The seed of Environmental Quality Research "SICAM", The group of Investigation of Environmental Sciences Applied "GICAP", the National Learning Service SENA, have joined efforts to meet the needs of the population of Jaraquiel, So in conjunction with COLCIENCIAS funding under the call IDEAS FOR THE BIO CHANGE 2016, it is intended to carry out a series of activities that end in the supply of drinking water to the members of the community of Jaraquiel, with an added value, the use of natural alternatives to replace the use of chemical agents.

2. THEORETICAL FRAMEWORK

Cordoba is classified as one of the most productive departments in the country for its agro-industrial, livestock and mining development, this last mining-energy activity is also of great relevance for the economy. Also noteworthy is the extraction of nickel and coal, from this increase in productivity has seen a population growth towards urban areas, this has increased the demand in the services of drinking water and basic sanitation, it is important to point out that the development that has been achieved in the sector of drinking water and basic sanitation in the department of Cordoba, is largely due to public investments at the national, departmental and municipal levels, however, despite these efforts there is a great inequality in the provision of water, sewage and sanitation services between urban and rural areas Of the department, which is confirmed by the lag in the indicators of coverage, quality and departmental continuity with respect to the national indicators.

This is why the National Government established in the National Development Plan 2016 - 2019 a series of strategies aimed at reducing the number of inhabitants who do not have access to potable water and basic sanitation services with the required quality

and opportunity, especially in rural areas. Currently the department of Cordoba has an Aqueduct, with coverage of 87%. Also, the national government devised the Departmental Waters Plan (PDA) to ensure the use of all populations, the PDA has been directed to achieve urban coverage in aqueducts close to 96% in municipal headwaters, in order to ensure continuous improvements in the quality of service and its long-term sustainability, such is the case of municipalities such as Montería, which has a coverage close to 78% for the urban area, however, this progress is not as significant in rural areas, where coverage and continuity of service is precarious, resulting in great social inequality.

POTABLE WATER: It is one that, because it meets the organoleptic, physical, chemical and microbiological requirements, under the conditions indicated in the present decree, can be consumed by the human population without producing adverse effects on their health (MINISTRY OF SOCIAL PROTECTION, 1998).

RAW WATER: It is one that has not been subjected to treatment process (MINISTRY OF SOCIAL PROTECTION, 1998).

TURBIDITY: "Turbidity has a great sanitary importance, since it reflects an approximation of the content of colloidal, mineral or organic matter, so it can be an indication of contamination" (GARCÍA, 1999).

COLOMBIAN NORMATIVITY

Decree 1575 resolution 2115/2007: Normativity for drinking water (MINISTRY OF SOCIAL PROTECTION, 2007)

Table 1. Physical and chemical characteristics of water for human consumption (MINISTRY OF SOCIAL PROTECTION, 2007)

Physical Characteristics	**Expressed as**	**Maximum Acceptable Value**
Apparent color	Cobalt Platinum Units (UPC)	15
Odor and taste	Acceptable or not acceptable	Acceptable
Turbidity	Turbidity Nephelometry Units (UNT)	2
pH	pH Units	6,5 – 9,0

Decree 1594 of 1984: Establishes the parameters for the various water treatments according to their use and disposal (MINISTRY OF SOCIAL PROTECTION, 1984).

Table 2. Physico-chemical characteristics of natural water for human consumption (MINISTRY OF SOCIAL PROTECTION, 1984).

Physical Characteristics	Expressed as	Maximum Acceptable Value
Apparent color	Cobalt Platinum Units (UPC)	75 unidades,
Odor and taste	Acceptable or not acceptable	Acceptable
Chlorides	Cl^-	250
pH	pH Units	6,5 – 9,0
Sulfates	$S0_4^=$	400.0
Total coliforms	NMP	20.000 microorganisms /100 ml.
Fecal coliforms	NMP	2.000 microorganisms /100 ml.

Technical regulation of the drinking water and basic sanitation sector RAS-2000: This document relates the requirements of raw water for its subsequent treatment, as well as the procedures for operation and operation of the treatment plant, design of process steps , The choice of coagulants and coagulants, as well as alternative technologies for drinking water treatment (RAS, 2000).

3. MATERIALS AND METHOD

3.1. Initial conditions

Rio Sinu: It is located in the northeast region of Colombia, between 8º and 9º north latitude and 75º and 76º west longitude, covering an area of about 14,000 km2 with a total length of the channel of 438 km until its mouth in the Caribbean Sea (DIANA et al, 2013).

A visit to the ACUEDEJAR aqueduct, located in the district of Jaraquiel, is carried out. A qualitative analysis carried out by the members of GICAP, with the help of the Community Action Board, shows the water consumption conditions of the population.

The water catchment point is located downstream of the population settlement, the storage tank does not store the water for more than two hours, due to its low storage capacity, in addition to the lack of water treatment process.

The physical conditions of the water at the end of the distribution networks are similar to those found in the source of supply, which is why it is necessary to make a rapprochement with the community in search of the generation of alternatives for improvement.

3.2. Phase of social appropriation

This phase is carried out a series of activities in which it seeks to make a link of the community of Jaraquiel in the execution of this project. Consisting of meetings with members of the indigenous chapter of Zenu Xaraquiel and Community Action Board on the needs of implementation of water treatment alternatives, as well as the needs for expansion of water storage to meet the needs of the community.

Implementation of an activity schedule in which commitments are strengthened between

the members of the community and the investigation group GICAP for the successful completion of the ongoing project.

One of the activities to be carried out is the planting of moringa oleifera in community areas stipulated and sown by the community, in this process the owners of the houses receive a number of plants taking into account the physical space that they have; Perform the sowing and are responsible for the maintenance of the plants until their use.

The collection of coconut husk, a by-product of feeding activities within the community, is carried out by the communal action board in each of the dwellings of the population, this product was considered a residue that was not available; The objective of this product is to generate activated carbon for the process of potabilization of water, but the production of which is done in a handmade manner.

Environmental education campaigns involving active members of the community (community action council, indigenous chapter, community in general) related to the conservation of the water source (Rio Sinu), adequate disposal of wast e generated, adequate management of the water.

3.3. Phase of Optimization of the system of purification

In the optimization phase, the activities are aimed at the upgrading and improvement of the water quality process, among which the expansion of the storage capacity (expansion of the water storage tank), Improvements in the treatment system (flocculation, sedimentation, filtration, uptake), seeks to implement an alternative treatment of water from the use of natural products, whose chemical characteristics do not affect health and reduce the costs of water treatment.

Moringa oleifera as a natural coagulant is an alternative for water treatability, a series of small scale trials are carried out in order to obtain the optimum dose of moringa to reduce water turbidity taking into account Colombian regulations and the use of coal Activated from the endocarp of Cocos nucifera.

At the end of the processes, the community of Jaraquiel will have a physical water treatment system in accordance with the needs of the community, in turn will have the trained personnel, members of the same community in the execution of the activities inherent to the operation of the Processing facilities.

It will have the necessary documentation for the correct operation of the plant (operating instructions), water treatment with the use of alternative products of natural origin.

4. . ANALYSIS AND RESULTS

The partial results obtained to date are related to the execution schedule of the project.

4.1. Phase of social appropriation

In this phase, the community is approached in order to socialize the progress of the ongoing project. (Image 1)

Image 1. Socialization of the project.

Moringa Oleífera seed collection activities are coordinated for planting andlaboratory tests.

Image 2. Dissertation of activities schedule.

Image 3. Seed collection.

The first planting of plants of Moringa Oleífera is carried out in zones established by the community of Jaraquiel

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Image 4. Planting of Moringa Oleifera plants.

Talks have been made to the community of environmental conservation, related to management, conservation of the water source (Río Sinú), proper management of waste and management of water resources

Image 5. Socialization of knowledge.

4.2. Phase of Optimization of the system of purification

Location of the catchment point of the drinking water treatment plant Coordinates: 8°41'58.1"N 75°56'04.9"W

Image 3. Capture point

The pre-characterization of the water quality at the point of reference is performed.

4.3. Result of physical-chemical analysis of natural water at the catchment point.

In order to carry out the physicochemical analyzes, it was necessary to make three samples of water at the aqueduct collection point (ACUEDEJAR), the results are evidenced in table 3.

Table 3. Result of physico-chemical analysis of water at the catchment point.

SETTINGS	M1 RESULT	M2 RESULT	M3 RESULT	UNITS	MAXIMUM PERMISSIBLE NATURAL WATER VALUE - DECREE 1594 OF 1984	MAXIMUM MAXIMUM VALUE PERMISSIBLE DRINKING WATER- RESOLUTION 2115 OF 2007.

pH	7,56	7,12	7,19	pH Units	5,0-9,0	6,5 y 9,0.
Conductivity	112	112	111	µS/cm	…	1000
Total hardness	50,47	55,6	54,6	mgCaCO3/L	…	300
Chlorides	5,57	6	4,6	mgCl/L	250.0	250
Alkalinity	39,6	38,8	41,4	mgCaCO3/L	…	200
Temperature	26,9	26,9	26,9	°C	…	…
Nitrates	<0,2	<0,2	<0,2	mgN- NO3/L	10	10
Color	50	48	50	UPC	75	15
Turbidity	113	87,1	88,6	NTU	10	2
Sulfates	28,41	24,65	19,85	mgSO4/L	400	250
Phosphates	0,05	0,07	0,09	mgP-PO4/L	…	0,5
Total match	0,88	0,1	0,13	mgP/L	…	…
Total Dissolved Solids, SDT	62,72	62,72	62,16	mgSDT/L	…	…
Total Suspended Solids, SST	73,6	99,2	81	mgSST/L	…	…
Sedimentary Solids	0,5	0,5	0,6	mgSS/L	…	…
Biochemical Oxygen Demand, BOD5	<2,0	<2,0	<2,0	mgO2/L	…	…
Chemical Oxygen Demand, COD	29,78	23,16	23,16	mgO2/L	…	…
Dissolved Oxygen, OD	5,79	5,95	5,8	mgO2/L	…	…
Total Coliforms	283	299	295	UFC/100 mL	20000	…
Fecal coliforms	125	128	127	UFC/100 mL	2000	…

Table 3 relates the values obtained from the collection of samples at the point of abstraction of water for human consumption in the village of Jaraquiel. The result M1 and M2 correspond to the sampling on different days at the set point, and the result M3, corresponds to a sample taken in the water distribution system.

He three results are compared to the maximum permissible values of natural water (DECREE 1594 OF 1984) and the maximum allowable values for drinking water (RESOLUTION 2115 OF 2007).

The results of the physicochemical parameters for M1 and M2 yield reliable results around the water quality of the Sinú River, however the values of the analyzes for the sample M3 do not meet the maximum values for drinking water.
Due to the above, similarities are observed in the results of the samples M1, M2 and M3, stating that they comply with that established in Decree 1594 of 1984, and the water distribution system of Jaraquiel does not perform water treatment, sample M3 Does not comply with the provisions of Resolution 2115 of 2007.

4.4. Seed collection for natural water treatment.

Moringa Oleífera seed harvesting days were held for later water treatment as a coagulant agent.

Image 4. Moringa pods and seeds.

Collection of Cocos nucifera for later use
The inner shell of the coconut is collected, and tests are performed

Image 5. Process of coconut activated carbon.

5. DISCUSSION

Phase of social appropriation.

It shows the acceptance and active linkage to the project by the entire beneficiary community, in turn has understood the need for the operation of a treatment plant, which will benefit them with the provision of water suitable for human consumption at a low cost, Using natural raw materials supplied by the previous crops of the natural product.

The Research Group on Applied Environmental Sciences "GICAP" and the community of the district of Jaraquiel intend to disseminate this project can be replicated in other

communities.

The implementation of the project with community support is one of the policies established by IDEAS FOR CHANGE BIO 2016, whose purpose is "To support innovative solutions from science and technology that carry out processes of social appropriation of knowledge, starting from The challenges proposed in the theme of biodiversity, which will be developed among the scientific community in partnership with communities that are willing to work in a participatory and collaborative way for the preservation, sustainable use of natural resources and improvement of the quality of life ", Active involvement of the population has generated social commitment, and acceptance of new knowledge, as well as the creation of ties of cooperation among the population.

Phase of optimization of the system of potabilization.

The results of physicochemical analyzes have yielded results corresponding to the acceptable quality of the natural source.

The application of Decree 1594 of 1984, corresponding to maximum values permissible for natural water yield results where the water quality of the Sinu River is acceptable.

The water quality assessment of the Sinú River, under RESOLUTION 2115, for drinking water, qualifies water conditions as not acceptable for human consumption.

The expansion of the water supply system is fundamental to meet the expectations of the community.

The treatment of the oil moringa seed for the extraction of the coagulant protein varies depending on the tests carried out by different authors, so a bibliographic review is performed in order to evaluate the seed yield and the removal power in the Water to be treated.

6. CONCLUSION

The participation of the staff of the community of Jaraquiel integrated by the community, indigenous chapter Zenu Xaraquiel, Communal Action Board is active in the execution of the project.

The process of adaptation of the physical space to date has not been carried out.

Planting of Moringa Oleífera plants was done with the help of the community of Jaraquiel in designated communal areas.

The physical-chemical analysis of natural water at the point of abstraction (Table 1),

relates the quality of the natural water taking into account Colombian regulations (DECREE 1594 OF 1984), where the values are below the allowable range, concluding that water Of the Río Sinú, is of acceptable quality, but not suitable for human consumption, therefore it is necessary to treat it.

In relation to the current regulations (RESOLUTION 2115 OF 2007 FOR DRINKING WATER), the physico-chemical analyzes carried out on the water distributed by the community aqueduct show that it is not suitable for human consumption, which leads to the immediate adaptation of the water supply system, The results are shown in Table 1.

For the laboratory phase where the treatment and transformation of the seed of the Moringa Oleífera and the coconut endocarp for activated carbon is involved, it can be said that there are bibliographical reviews of the process and trials are being done for the optimal doses of Each natural product.

7. BIBLIOGRAPHY

- AMIRTHARAJAH A., O'MELIA C. 1989. *Coagulación Process: destabilization, mixing y flocculation, Chapter* 6. 269-365.
- ROMERO R. 1989 *Transferencia de metales en pacientes sometidos a hemodiálisis en hospitales de Maracaibo, Universidad del Zulia, Facultad Experimental de Ciencias*, Maracaibo (Venezuela), 98.
- MILLER R.G.; KOPFLER F.C., STROBER J.A. J Am Wat Wks Assoc. 1984. 76:54-91.
- SANGHI, R.; BHATTACHARYA, B.; DIXIT, A. & SINGH, V (2006). *Ipomoea dasysperma seed gum: an effective natural coagulant for the decolorization of textile dye solutions. Journal of Environmental Management,* 81(1), 36-41.
- POUMAYE, N.; MABINGUI, J.; LUTGEN, P. & BIGAN, M. (2012). *Contribution to the clarification of Surface water from the Moringa Oleifera: Case M'Poko River to Bangui, Central African Republic. Chemical Engineering Research and Design,* 90, 2346-2352.
- PRITCHARD, M.; KULULANGA G.; MKANDAWIRE, T.; EDMONDSON, A. S. & O'NEILL, J. G. (2009). *Potential of using plant extracts for purification of shallow well water in Malawi. Physics and Chemistry of the Earth,* 34, 799-805.
- GHEBREMICHAEL, K. A.; GUNARATNA, K. R.; HENRIKSSON H.; BRUMER, H.; DALHAMMAR, G. (2005). *A simple purification and activity assay of the coagulant protein from Moringa oleifera seed. Water Research,* 39, 2338-2344.
- NDABIGENGESERE, A., AND NARASIAH, K.S. (1998). Quality of water treated by coagulation using Moringa oleifera seeds. Wat. Res., Vol. 32, No. 3, pp. 781-

791.

- REYES, F., PÉREZ, A., SÁNCHEZ, T. Y ARMENGOL, N. (2010). *Características y potencialidades de Moringa oleifera, Lamark. Una alternativa para la alimentación animal*. Scielo, 33(4), 1–16.

- MINISTERIO DE PROTECCIÓN SOCIAL. Ministerio del Medio Ambiente, Vivienda y Desarrollo Territorial. Decreto 475 de 1998.

- ESPIGARES GARCÍA M. AND MORENO ABRIL O. 1999. Caracteres microbiológicos, aguas envasadas, usos recreativos del agua. In Estudio sanitario del agua. Pérez López J. A. and Espigares García M. (eds). Editorial Universidad de Granada, Granada (España).

- *DIANA M. ARROYAVE G. ET. ALL. Revista Ingenierías Universidad de Medellín, vol. 12, No. 22 pp. 33-44 - ISSN 1692-3324 - enero-junio de 2013/204 p. Medellín, Colombia.*

- MINISTERIO DE PROTECCIÓN SOCIAL. Ministerio del Medio Ambiente, Vivienda y Desarrollo Territorial. Resolución Número 2115, 22 de Junio de 2007.

- MINISTERIO DE PROTECCIÓN SOCIAL. Ministerio de Medio Ambiente, Vivienda y Desarrollo Territorial. Decreto 1594 de 1984.

- SISTEMAS DE POTABILIZACIÓN*, Sección II Título C. Reglamento Técnico del Sector del Agua Potable y Saneamiento Básico RAS 2000.* Ministerio de Desarrollo Económico. Bogotá DC, Noviembre 2000.