IARJSET
ISSN (Online) 2393-8021
ISSN (Print) 2394-1588
International Advanced Research Journal in Science, Engineering and Technology
ISO 3297:2007 Certified
Vol. 3, Issue 8, August 2016

Use of Activated Carbon of Coconut Shell (Cocos nucifera) for Reduction of Chloride and Hardness of Water

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Abstract: Water purification is indeed a challenging issue for all sections of the society especially the poor and deprived people, who mostly rely on groundwater sources as their source of drinking water. Cocos nucifera fruit can be used as a source of activated carbon which is relatively cheap and easily available. It improves the taste of drinking water and also makes water safe to drink by removing most toxic organic compounds in water like pesticides and heavy metal organic compounds. Cocos nucifera Shell Activated Carbon or Coconut Shell Activated Carbon (CSAC) also removes smells in water and makes cloudy water clear by removing colour causing compounds in the water. Coconut Shell Activated Carbon (CSAC) can be used as a natural way of removing contaminations from the water source .The present study aims to reduce hardness and chloride present in water .CSAC is used at varying concentrations and time intervals to decrease hardness and chloride present in the water sample .CSAC also reduces the colour and odour of the water sample. So, CSAC can be categorized as a very efficient purifier of water.

Keywords: Cocos nucifera, Coconut Shell Activated Carbon (CSAC), Total Hardness, Chloride, Odour, Water purification.

I. INTRODUCTION

The coconut tree (Cocos nucifera) is a member of the family Arecaceae (palm family) and the only accepted species in the genus Cocos.[1] The term coconut can refer to the entire coconut palm, the seed, or the fruit, which, botanically, is a drupe, not a nut. Coconuts are distinct from other fruits for their large quantity of "water", and when immature, they are known as tender-nuts or jelly-nuts and may be harvested for their potable coconut water. When coconuts are mature, they contain some water and which can be used as seed-nuts or can be processed to give oil from the kernel, activated carbon or charcoal from the hard shell, and coir from the fibrous husk. Coconuts are known for their great versatility, as evidenced by many traditional uses, ranging from food to cosmetics.[2] They form a regular part of the diets of many people leaving in the tropics and subtropics regions. The coconut also has cultural and religious significance in certain societies, particularly in India, where it is used in Hindu rituals.[3]

Activated carbon is extensively used in water purification due to its high porosity and large surface area, which makes it a highly valued adsorbent material. The most common natural substances used as base material to make activated carbon are lignite, bituminous and anthracite coal and peat, wood and coconut shell. Activated carbon is a form of carbon species that is processed and prepared to have high porosity and very large surface area available for adsorption[4]. Coconut shell is very suitable for preparing micro-porous activated carbon due to its excellent natural structure and low ash content. Coconut shell carbons have several advantages like high density, high purity and they are virtually dust-free, since they are harder and more resistant to attrition [5].There is a uniform pore structure distribution, with the majority of pores having size in the micro-porous range. Coconut-shell based activated carbons are predominantly micro-porous and are the least dusty, thus, they are very efficient when it comes to organic chemical adsorption. Compared to other types of activated carbon, coconut-shell based activated carbon filters have the highest hardness, which makes them ideal for water purification. Apart from these unique properties, coconut shells are also an eco-friendly and a renewable resource for water purification. Coconut fruits are harvested three times per year and their harvest has no negative impact on the coconut trees and will continue to grow throughout the year. Further advantages of the coconut-shell based activated carbon lie in the following: coconut shell carbon filters adsorb volatile organic chemicals, pesticides and herbicides, remove halogens from water and improve appearance and taste of drinking water.[6]There are also many evidences which tell us that water purification in ancient India was done by the usage of Coconut shell activated carbon (CSAC) .The coconut shells were burnt and disposed off in rivers, wells and ponds to purify water in it.

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Nowadays, water quality has become the popular global issue. People are increasingly concerned about contaminants in their drinking water that cannot be removed by water softeners or physical filtration[7]. Therefore, it needs treatment to make it safe for human and all living things in this world. There are many types of treatment that can improve water quality. One of the treatments is by using Coconut shell activated carbon(CSAC) for water treatment. In the present investigation, Total Hardness(Permanent Hardness) and Chloride of water is reduced by treating it with CSAC . Hard drinking water may have moderate health benefits, but can pose serious problems in industrial settings, where water hardness is monitored to avoid costly breakdowns in boilers, cooling towers, and other equipment that handles water and thereafter when hard water is disposed off in the open areas , it affects plants growth and soil fertility. In domestic settings, hard water is often indicated by a lack of suds formation when soap is agitated in water, and by the formation of lime-scale in kettles and water heaters.[8] Total or Permanent hardness is hardness (mineral content) that cannot be removed by boiling. When this is the case, it is usually caused by the presence of calcium sulphate and/or magnesium sulphates in the water, which do not precipitate out as the temperature increases.

Chlorides are widely distributed as salts of Sodium, Potassium, and Calcium in water, groundwater and wastewater .The salt taste produced by Chloride ions is highly variable and dependent on chemical composition of water of that respective area .Chloride in surface and groundwater from both natural and anthropogenic sources, such as run-off containing road de-icing salts, the use of inorganic fertilizers, landfill leachates, septic 2 tank effluents, animal feeds, industrial effluents, irrigation drainage, and seawater intrusion in coastal areas[9].

II. STUDY AREA

Study area compromises of Gwalior district of Madhya Pradesh. Gwalior is situated at Latitude : 26.2183° Nand Longitude :78.1828° E. Gwalior is a historic and major city in the Indian state of Madhya Pradesh. Located 319 kilometres (198 miles) south of Delhi the capital city of India, Gwalior occupies a strategic location in the Gird region of India. In this research, the groundwater sample is taken from New Prem Nagar, Near Saibaba Mandir, and Gwalior-474002 (M.P.) India.

III. EXPERIMENTAL

A. Material

Cocos nucifera fruit was bought from the local fruit market. Like other fruits, it has three layers: the exocarp, mesocarp, and endocarp. The exocarp and mesocarp make up the "husk" of the coconut. The shell of the Cocos nucifera fruit (i.e. the solid layer around the fibrous fruit)is undertaken as raw material for production of activated carbon . For the determination of Total Hardness and Chlorides, specified methods were used.[10]

B. Methods

First, Coconut Shell Activated Carbon (CSAC) was made from the Coconut shell. The initial weight of the coconut shell was 92.8101gm. It was heated in Muffle furnace at 150^0C for 300 seconds .Further, the collected coconut shell from muffle furnace was weighted and the weight was found out to be 18.9071gm. The product was again heated in Oven for 3600 seconds at 120^0C to remove any amount of moisture present in it. Thereafter, it was crushed and taken in powdered form with the help of Grinder . The charcoal was then grinded to get granular activated carbon that was finally sieved at perforated plate of mesh size 2.0 mm .The final weight of the Coconut shell activated carbon (CSAC) was found out to be 2.9357gm .

Fig 1 : Coconut Shell undertaken

Fig 2 : Activated Coconut Shell

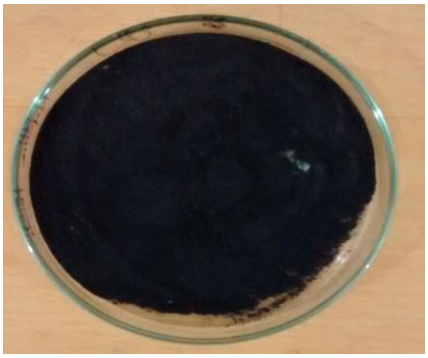

Fig 3: Coconut Shell Activated Carbon (CSAC)

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The experiment of determination of total hardness was conducted [8] and the hardness of the water sample was found out to be 840 ppm. The Chloride of water sample was found out to be 240.925ppm. This water sample was treated with CSAC to reduce total hardness and chloride by varying its concentration and contact time.

IV. RESULT AND DISCUSSION

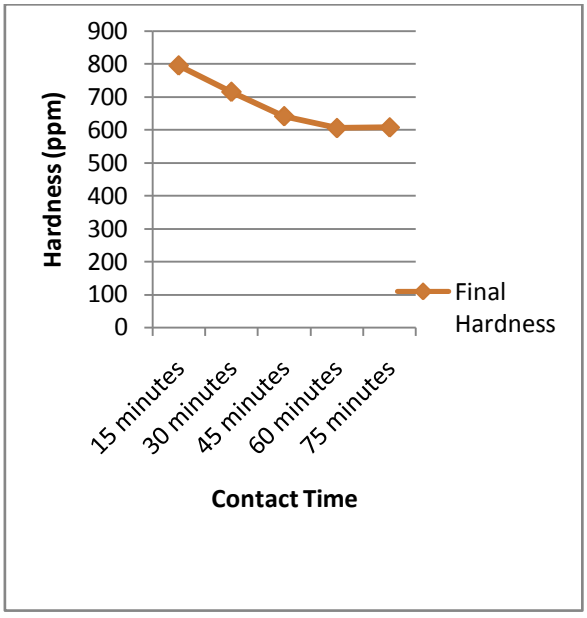
A. Total Hardness Reduction

1. 100 ppm Coconut Shell Activated Carbon(CSAC):
100 ppm CSAC (i.e. 5 mg CSAC in 50 ml water sample)in water sample was dissolved and had a contact time for time intervals of 15, 30, 45, 60 and 75 minutes by using rotary shaker (at a speed of 1000rpm) and then filtered by using Whatman filter paper no.40 . And the end point is when color changes from red -pink to blue.

Table 1: Total Hardness of the water sample

Serial Number	Contact Time (minutes)	Initial Total Hardness (ppm)	Final Hardness (ppm)	% Reduction
1.	15	840	796	5.24
2.	30	840	716	14.77
3.	45	840	642	23.57
4.	60	840	606	27.86
5.	75	840	608	27.62

Graph 1: Final Hardness Vs Contact Time

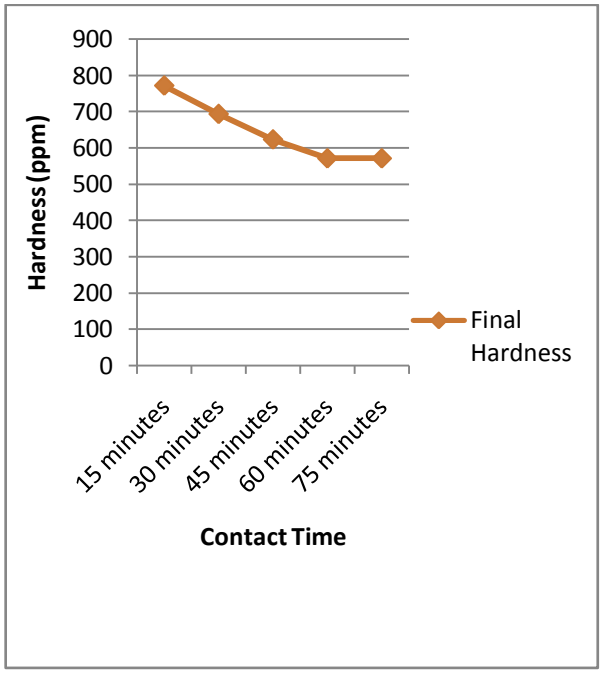


2. 200 ppm Coconut Shell Activated Carbon (CSAC):
200 ppm CSAC(i.e. 10mg CSAC in 50 ml water sample) in water sample was dissolved and had a contact time for time intervals of 15, 30, 45, 60 and 75 minutes by using rotary shaker (at a speed of 1000rpm) and then filtered by using Whatman filter paper no.40 . And the end point is when color changes from red -pink to blue.

Table 2: Total Hardness of the water sample

Serial Number	Contact Time (minutes)	Initial Total Hardness (ppm)	Final Hardness (ppm)	% Reduction
1.	15	840	772	8.09
2.	30	840	694	17.38
3.	45	840	624	25.71
4.	60	840	572	31.90
5.	75	840	572	31.90

Graph 2: Final Hardness Vs Contact Time



3. 300 ppm Coconut Shell Activated Carbon (CSAC):
300 ppm CSAC (i.e. 15mg CSAC in 50 ml water sample) in water sample was dissolved and had a contact time for time intervals of 15, 30, 45, 60 and 75 minutes by using rotary shaker (at a speed of 1000rpm) and then filtered by using Whatman filter paper no.40.

And the end point is when color changes from red -pink to blue.

Table 3: Total Hardness of the water sample

Serial Number	Contact Time (minutes)	Initial Total Hardness (ppm)	Final Hardness (ppm)	% Reduction
1.	15	840	684	18.57
2.	30	840	578	31.19
3.	45	840	462	45.00
4.	60	840	408	51.43
5.	75	840	406	51.67

DOI 10.17148/IARJSET.2016.3815

IARJSET
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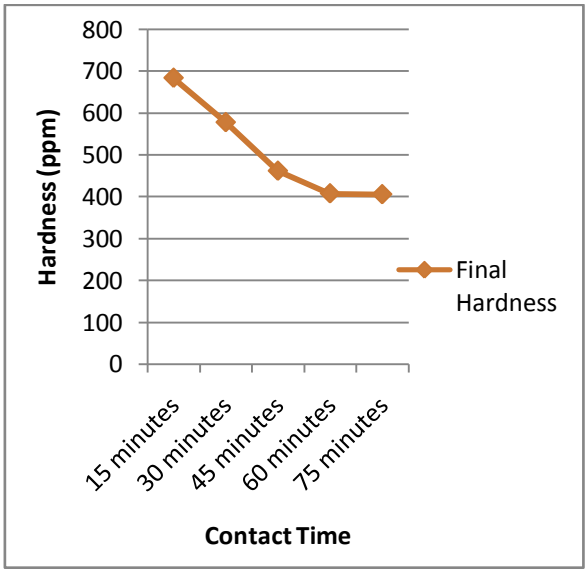
Graph 3: Final Hardness Vs Contact Time

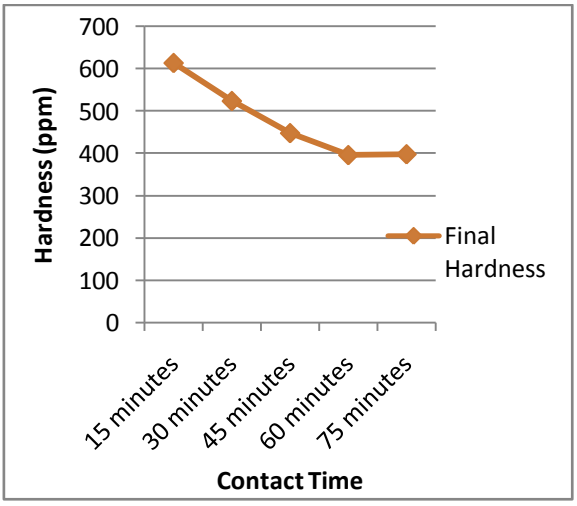


4. 400 ppm Coconut Shell Activated Carbon(CSAC) :
400 ppm CSAC (i.e. 20mg CSAC in 50 ml water sample) in water sample was dissolved and had a contact time for time intervals of 15, 30, 45, 60 and 75 minutes by using rotary shaker (at a speed of 1000rpm) and then filtered by using Whatman filter paper no.40. And the end point is when color changes from pink to blue.

Table 4: Total Hardness of the water sample

Serial Number	Contact Time (minutes)	Initial Total Hardness (ppm)	Final Hardness (ppm)	% Reduction
1.	15	840	614	26.90
2.	30	840	524	37.62
3.	45	840	448	46.67
4.	60	840	396	52.86
5.	75	840	398	52.62

Graph 4: Final Hardness Vs Contact Time

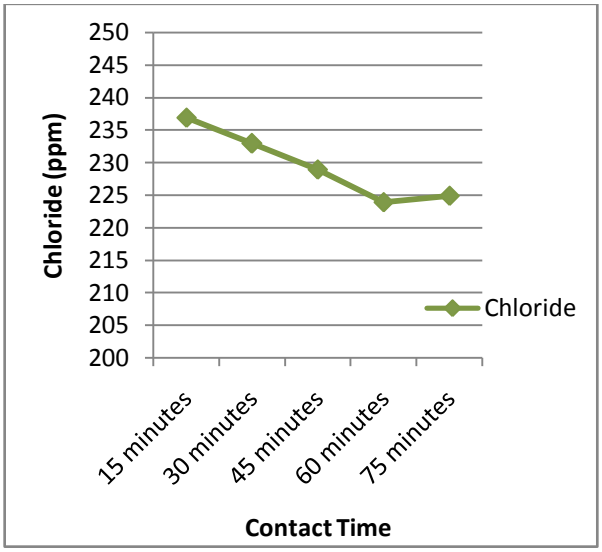


B. Chloride Reduction
1. 100 ppm Coconut Shell Activated Carbon (CSAC):
100 ppm CSAC (i.e. 5mg CSAC in 50 ml water sample) in water sample was dissolved and had a contact time for time intervals of 15, 30, 45, 60 and 75 minutes by using rotary shaker (at a speed of 1000rpm) and then filtered by using Whatman filter paper no.40 . And the end point is when color changes from yellow (light yellow) to brick red.

Table 5: Chloride of the water sample

Serial Number	Contact Time (minutes)	Initial Chloride (ppm)	Final Chloride (ppm)	% Reduction
1.	15	240.925	236.926	1.66
2.	30	240.925	232.927	3.32
3.	45	240.925	228.929	4.98
4.	60	240.925	224.930	6.63
5.	75	240.925	223.930	7.05

Graph 5: Chloride Vs Contact Time



2. 200 ppm Coconut Shell Activated Carbon(CSAC) :
200 ppm CSAC (i.e. 10mg CSAC in 50 ml water sample) in water sample was dissolved and had a contact time for time intervals of 15, 30, 45, 60 and 75 minutes by using rotary shaker (at a speed of 1000rpm) and then filtered by using Whatman filter paper no.40 . And the end point is when color changes from yellow (light yellow) to brick red.

Table 6: Chloride of the water sample

Serial Number	Contact Time (minutes)	Initial Chloride (ppm)	Final Chloride (ppm)	% Reduction
1.	15	240.925	229.928	4.56
2.	30	240.925	226.929	5.81
3.	45	240.925	221.931	7.88
4.	60	240.925	216.932	9.96
5.	75	240.925	216.932	9.96

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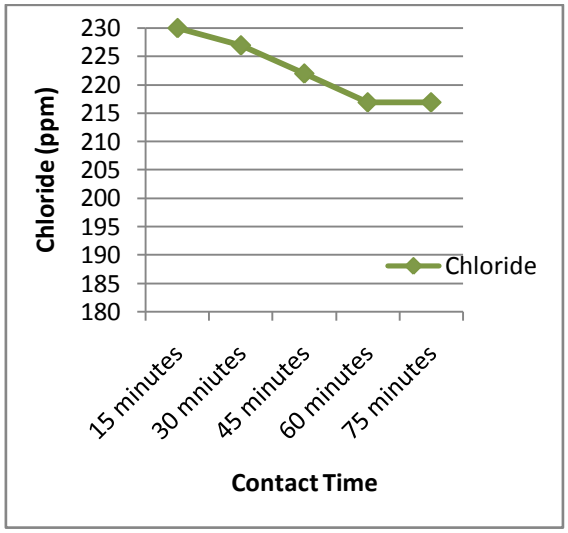
Graph 6: Chloride Vs Contact Time

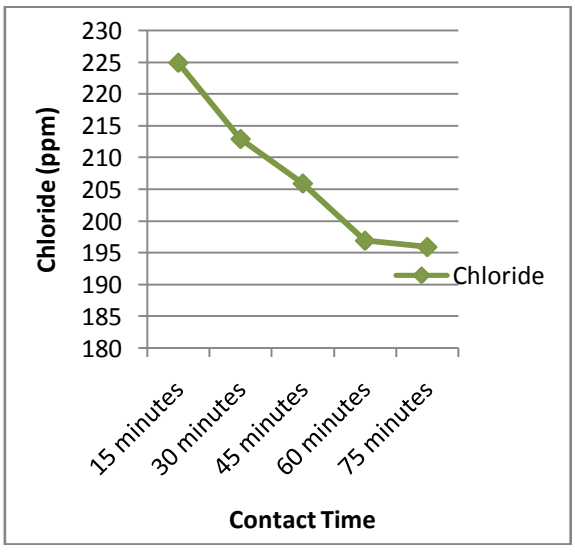


3. 300 ppm Coconut Shell Activated Carbon (CSAC):
300 ppm CSAC (i.e. 15mg CSAC in 50 ml water sample) in water sample was dissolved and had a contact time for time intervals of 15, 30, 45, 60 and 75 minutes by using rotary shaker (at a speed of 1000rpm) and then filtered by using Whatman filter paper no.40 . And the end point is when color changes from yellow (light yellow) to brick red.

Table 7: Chloride of the water sample

Serial Number	Contact Time (minutes)	Initial Chloride (ppm)	Final Chloride (ppm)	% Reduction
1.	15	240.925	224.930	6.64
2.	30	240.925	212.933	11.62
3.	45	240.925	205.936	14.52
4.	60	240.925	196.938	18.26
5.	75	240.925	195.939	18.67

Graph 7: Chloride Vs Contact Time

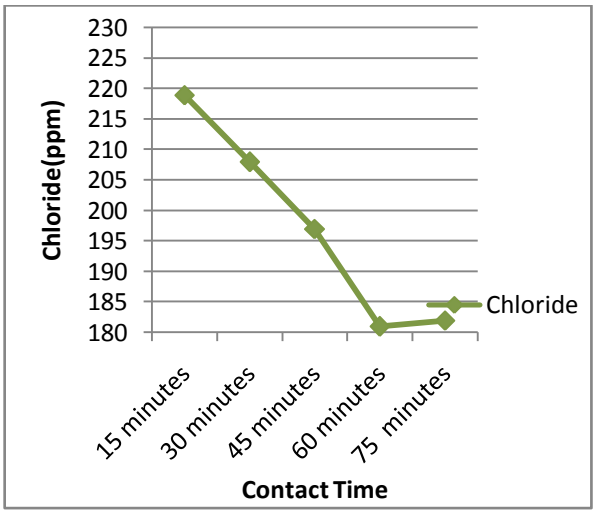


4. 400 ppm Coconut Shell Activated Carbon(CSAC) :
400 ppm CSAC (i.e. 20mg CSAC in 50 ml water sample) in water sample was dissolved and had a contact time for time intervals of 900, 1800, 2700, 3600 and 4500 seconds by using rotary shaker (at a speed of 1000rpm) and then filtered by using Whatman filter paper no.40 . And the end point is when color changes from yellow (light yellow) to brick red.

Table 8: Chloride of the water sample

Serial Number	Contact Time (minutes)	Initial Chloride (ppm)	Final Chloride (ppm)	% Redu-ction
1.	15	240.925	218.932	9.13
2.	30	240.925	207.935	13.69
3.	45	240.925	196.938	18.26
4.	60	240.925	181.943	24.48
5.	75	240.925	180.943	24.89

Graph 8: Chloride Vs Contact Time



V. CONCLUSION

It is found out that due to presence ofCoconut Shell Activated Carbon (CSAC),the hardness of water sample is reduced .The best results were found when the 400 ppm of CSAC was dissolved and treated with 50 ml water sample and the contact time was 3600 seconds .It caused a % reduction of 52.8571 %. Another important observation was that if the contact time is increased beyond 60 minutes then there is no considerable reduction in total hardness of the water sample.

The total hardness reduces with the increase in concentration of CSAC and also with increase in contact time .But when experiments were tried by further increasing the concentration of CSAC and treating it with 50 ml water sample , no substantial changes in results were observed .Similarly, Chlorides present in water sample were reduced by CSAC .The best results were found when 400ppm of CSAC was dissolved and treated

DOI 10.17148/IARJSET.2016.3815

IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology
ISO 3297:2007 Certified
Vol. 3, Issue 8, August 2016

with 50 ml water sample having a contact time of 4500 seconds .The best Chlorides reduction result accounted for a 24.4814% decrease. Further, when we tried to increase contact time and concentration of CSAC, no considerable changes were observed with 50ml water sample. The CSAC thus obtained has the ability to absorb the color, odor and suspended particles that is present in water and reduces pollution. Although, the present investigation is essentially a primary work and needs to be further investigated to arrive at specified conclusion with respect to other implications.

ACKNOWLEDGMENT

We are highly thankful to **Mr. Arvind Sharma**, Head of Microbiological Section and Quality Manager, Analitika Ecolab Pvt. Ltd., Gwalior, India .We are also grateful to **Mr. Govind Vajpayee**, and all the staff of Analitika Ecolab Pvt .Ltd., Gwalior, India for their cooperation and guidance.

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