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Chitosan from Gonggong Snail Shells to Reduce Iron (Fe) Levels in Dug Well Water in Andana Residence Housing, Batu IX Village, Riau Islands

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ABSTRACT

Dug well water often contains organic and inorganic components, including various dangerous metals that are commonly found in it, such as iron (Fe). Therefore, this research aimed to determine the combination of aeration and filtration methods using chitosan from gonggong shells to reduce Fe levels in dug well water in the Andana Housing Complex, Tanjungpinang City. This research implemented a pre-experimental design. Water samples were obtained from 10 dug wells in the Andana Housing Complex, Tanjungpinang City. The samples were treated with a combination of aeration and filtration methods using chitosan from gonggong shells. Before and after treatment, physical conditions of the water were observed and laboratory tests were carried out to measure Fe levels. After treatment, it was discovered that the smell, color and taste disappeared. Meanwhile, there was also a decrease in Fe levels of 80.95% for gonggong snail shell chitosan with a thickness of 1 cm, 84.93% for a thickness of 3 cm, and 98.33% for a thickness of 5 cm. It was concluded that the combination of aeration and filtration methods using chitosan from gonggong shells was effective in improving the physical conditions of water and reducing Fe levels in water. Suggestions for further research include: improving this research by adding other media to reduce Fe levels or combining it with filtering media and other methods. Suggestions for the community to process chitosan from gonggong snail shells in water treatment containing Fe and offer the government to socialize the use of chitosan filtration from gonggong snail shells.
Keywords: dug well; Fe; gonggong snail shell; chitosan

INTRODUCTION

Water is a chemical substance with the chemical formula H_2O. One water molecule consists of two atoms, namely a hydrogen atom covalently bonded to an oxygen atom.(1-5) Almost all human activities require water for cleaning themselves, eating and drinking for other activities, and the human body consists of 60%-70% water. In Indonesia, water comes from ground water, surface water and rain water.(6-10) However, the availability of water sources in each region varies, depending on human activities and natural conditions in each region. Human water needs must be balanced with increasing population and industrial development. If the increase in water is not balanced with adequate water sources, this will result in a clean water crisis that will be caused by humans. Water is physically clean and has healthy quality standards (fit for use), including clear, colorless, odorless and tasteless.(11-15)

One source of water used to meet needs is ground water using dug wells. Because, making and using a dug well does not require large costs. However, the mineral content exceeds the maximum permitted limit, which can cause problems. Healthy water conditions are not suitable for use; it needs to be processed to clear the water.

Most people use dug well water as a source of clean water, based on data from the Tanjungpinang City Health Service, namely 56% or around 146,976 people use dug wells. Meanwhile, the number of dug well users in the Mekar Baru Community Health Center working area is 77%. However, the proportion of water used per person per day in households is still very minimal; for the very minimal category in Indonesia it is still 2.2%, while in the Riau Islands it is still 1.1%.(16)

In a preliminary survey carried out at the Andana Residence Housing Complex, Batu IX Village, East Tanjungpinang, researchers observed that the condition of the dug well water was yellow-brown in color, forming an oil-like layer and smelling of rust. From well water samples, Fe levels were obtained at 3.90 mg/l. Apart from that, based on the results of observations and interviews with one of the residents of the housing complex, information was obtained that the residents had experienced health problems due to these problems, including dry and itchy skin.

Efforts to improve the quality of dug well water can be carried out using a gradual approach to clean water technology, namely processing technology to minimize pollution and reduce negative impacts due to physical, chemical and biological pollutant elements entering or entering water that can harm the surrounding environment. Absorption is one method that can be used to improve the quality of dug well water. Previous researchers used egg shells as an adsorbent to reduce Fe levels in water because they contain the CaCO3 compound which can adsorb 99.82% Fe.(17)

One of the natural resource waste materials from Tanjungpinang City, Riau Islands, which can be used to reduce Fe levels in water is gongong snails. Gonggong snails (*Strombus Sp*) are a typical food of Tanjungpinang City, Riau Islands. Gonggong snails can often be found in seafood restaurants in Tanjungpinang City. Due to the high level of public consumption of gonggong snails, an impact arises, namely the accumulation of gonggong snail shell waste. This waste has only been used for handicraft materials such as key chains and decorations on souvenirs, but it is not uncommon for gonggong snail shells to be thrown away and left to rot so that in the end it has a bad impact on the environment, such as causing an unpleasant odor, thus damaging the aesthetics of the environment and becoming rubbish that accumulates in the area. beach or under a seafood restaurant.

One alternative effort is to utilize gonggong snail shell waste so that it has value and benefits. Gonggong snail shell waste is processed into products of high economic value, namely chitin and chitosan. Chitosan is a polysaccharide obtained from the deacetylation of chitin which generally comes from skin waste from crustaceans and mollusks. Chitosan has relatively more reactive properties than chitin and is quickly produced in the form of powder, paste, film and fiber. Chitosan produced from gongong snails has a degree of deacetylation of 70.27%.(18) Based on Lubena's research (2020)(19), chitosan from ranjungan shells is able to reduce Fe levels, where the highest Fe reduction was obtained at a stirring time of 15 minutes, with the addition of 5% chitosan in the sample water where the Fe content was 10.67 mg/l to 2.01mg/l with a % reduction in Fe content of 81.13%. Karelius' research (2012)(20) states that the optimum dose of chitosan from shrimp shells as an adsorbent for Fe metal ions in peat water, namely 1.5 grams, is capable of adsorbing Fe metal ions in peat water samples of 0.668 mg/L or with an effectiveness of 92.65%.

Based on the background above, research is needed which aims to analyze the effectiveness of gonggong shells as an adsorbent to improve the water quality of dug wells in Tanjungpinang City, especially Andana Residential Housing.

METHODS

This study was a pre-experimental research that applies a treatment, namely a combination of aeration and filtration methods using chitosan from gonggong shells. The expected result was an increase in the physical quality of water; and a decrease in Fe levels in dug well water. The research was conducted in 2023 at Andana Housing in Tanjungpinang City. The water samples in this study were taken from 10 dug well points, taking into consideration cost and time efficiency. The water samples were treated in the form of aeration and filtration using chitosan thicknesses of 1 cm, 3 cm and 5 cm. Thus, the total samples were 40.

The manufacture of gonggong snail shell chitosan adsorbent was carried out at the Tanjungpinang Ministry of Health Polytechnic Laboratory, while the measurement of Fe levels was carried out at the Sucofindo Batam Laboratory.

In the pre-treatment phase, the physical quality of the water (color, taste and smell) and the Fe content in the water are checked. Next, treatment was given in the form of a combination of aeration and filtration methods using chitosan from gonggong shells. Next, another inspection is carried out regarding the physical quality of the water (color, taste and smell) and the Fe content in the water.

Making chitosan from gonggong shell snails is carried out in the following stages:

1) The initial stage of making chitosan
   a) Prepare gonggong shells obtained from seafood waste.
   b) Clean the gonggong shell from dirt, then dry it in the sun.
   c) Crush the gonggong shell or grind it into flakes,
   d) Carry out demineralization, deproteination and deacetylation which aims to remove minerals, proteins and acetyl groups in the gonggong shell to produce chitosan (Romalina et al, 2022).

2) Mineral removal (demineralization)
   a) Put 500 grams of gonggong snail shell powder into a beaker and add 1.5 M HCl with a ratio of 1:5 (w/v) while stirring for 4 hours at 65°C.
   b) Leave for a moment, then filter.
   c) Wash until neutral with distilled water, then test the remaining Cl ions with AgNO3.
   d) Dry the solid in an oven at 80oC for 24 hours to get mineral-free gonggong powder.

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3) Protein removal (deproteination)
   a) Put the gonggong snail shell powder that has passed the demineralization stage into a glass beaker and add 3.5% NaOH in a ratio of 1:10 (w/v) for 4 hours at a temperature of 65-70oC.
   b) Leave for a moment and filter.
   c) Wash until neutral with distilled water.
   d) Dry the solid in an oven at 80°C for 24 hours to obtain chitin.
4) Removal of acetyl groups (Deacetylation)
   a) Place the chitin obtained from deproteination in a beaker then add 50% NaOH and 50% distilled water in a ratio of 1:20 (w/v) for 4 hours at 120oC while stirring.
   b) Leave for a moment and filter.
   c) Wash until neutral with distilled water and test for remaining Cl ions with $AgNO_3$.
   d) Dry the solid in an oven at 80oC for 24 hours to get chitosan.

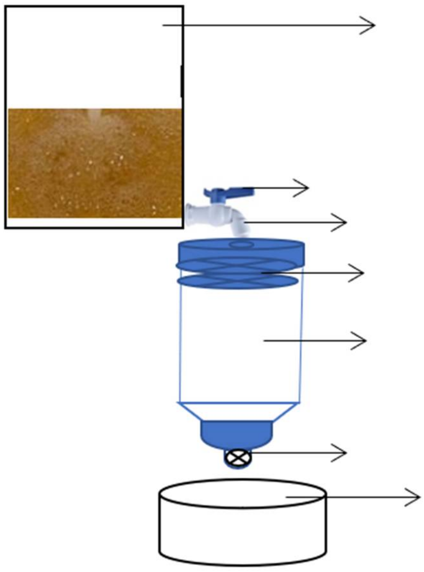

Figure 1. Aeration and filtration circuit

Sampling in this study followed the SNI 6989.59, 2008 procedure, with the following steps:
1) Prepare sampling tools (jerry cans, ropes, bucket bottles, dug well water, label paper, stationery
2) Wash tools such as jerry cans, ropes and bucket bottles until clean
3) Take samples from dug wells using the container provided with a depth of 20 cm (SNI 06-2412-1991)
4) Test physical parameters, such as color, smell and taste
5) Record the results of testing physical parameters, such as color, smell and taste, as well as Fe levels which have been carried out three times.

RESULTS

Andana Residence Housing, RT 003, RW 001 is included in Batu IX Village, East Tanjungpinang District, Tanjungpinang City, Riau Islands Province, Indonesia. The boundaries of the Andana Residence RT 003 RW 001 housing area are as follows: north: CK Hotel and BASARNAS office, west: Jalan Raja Haji Fisabilillah, east: Jalan Sri Andana, and south: Tanjungpinang City Center Mall and STISIPOL Campus.

This research was carried out in several stages. The first stage was a preliminary survey by physically observing and measuring Fe levels at the PDAM Tirta Riau Islands Laboratory on six samples of dug well water in the Andana Housing Complex, Tanjungpinang City, Riau Islands. The second stage is making chitosan filtration media from Gonggong snail shells and activated charcoal from coconut shells. This research obtained gonggong snail shell waste from seafood restaurants and coconut shell charcoal from a charcoal processing factory in Dompak. Making chitosan from gonggong shells goes through 3 stages, namely: demineralization, deproteination and deacetylation). Making activated charcoal from coconut shells is done by washing the coconut shell charcoal

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until clean, then activating it using the chemical KMNO4 for 24 hours, then washing it using distilled water until the pH is neutral, then drying it using an oven and putting it in a container. filtration tool according to the specified thickness. The third stage is taking samples of dug well water using a random sampling method located in the Andana Housing Complex, Tanjungpinang City, Riau Islands. The fourth stage is to use a filtration device with gonggong snail shell chitosan absorption filtration media with varying thicknesses, namely 1 cm, 3 cm and 5 cm. A 5 liter sample of dug well water was processed using a filtration device with gonggong snail shell chitosan as a medium which was first separated using teabag paper at a thickness of 1 cm, 3 cm, 5 cm so that the media did not spill over. The treated water sample is put into a sample bottle and given a sample label. The samples are ready to have Fe levels measured at the PT Sucofindo Batam Branch laboratory. Next, data analysis was carried out.

Descriptive analysis was carried out to explain each parameter studied, namely the Fe content and physical parameters (smell, taste and color) of the water before and after processing using a combination of gonggong snail shell chitosan filtration media with a thickness of 1 cm, 3 cm, 5 cm.

The results of measuring Fe levels in dug well water before and after processing using Gonggong Snail Shell chitosan filtration media are shown in Table 1.

Table 1. Results of measuring Fe levels in well water samples before and after treatment

Dug well sample	Fe levels before treatment (mg/L)	Fe levels after treatment (mg/L)		
		1 cm	3 cm	5 cm
A12a	51.46	8.93	21.99	0.18
A12b	31.26	1.65	0.23	<0.07
I20	45.54	19.55	<0.07	<0.07
H02	45.27	19.3	0.29	1.23
F10	37.28	0.4	<0.07	0.15
H11	97.86	1.13	35.84	0.37
H12b	32.55	13.04	6.26	5.17
H07	37.73	8.15	<0.07	<0.07
H10	31.85	0.35	0.16	0.15
H12	33.12	12.07	2.15	0.18
Mean (mg/L)	44.392	8.457	6.692	0.743
Percentage of Fe reduction (%)		80.95	84.93	98.33

Table 1 shows that the average score for Fe levels in dug well water before using chitosan filtration media was 44.392 mg/L. The average score for Fe levels after processing using 1 cm thick chitosan was 8.457 mg/L, with a percentage reduction in Fe levels reaching 80.95%. The average score for Fe levels after being treated using 3 cm thick chitosan was 6.692 mg/L with a reduction percentage of 84.93%. Meanwhile, the average Fe content after treatment using 5 cm thick chitosan was 0.743 mg/L with a reduction percentage of 98.33%.

DISCUSSION

There were differences in Fe levels before and after treatment using chitosan media from gonggong snail shells in dug well water in Andana Housing Complex, Batu IX Village, East Tanjungpinang District, Tanjungpinang City. This research proves that the thicker the chitosan media, the higher the percentage reduction in Fe levels in dug well water. The pore size and surface area of the adsorbent are important characteristics of the adsorbent. Pore size is related to surface area. The smaller the pore size of the adsorbent, the greater the surface area so that the number of adsorbed molecules will be greater.(21) This study proves that a thickness of 1 cm shows a very high reduction compared to a thickness of 3 cm and 5 cm. There is an anomalous phenomenon where a thickness of 5 cm produces a higher reduction than a thickness of 3 cm. Several factors can cause this problem, such as human error or mistakes in taking samples or when carrying out examinations, making it possible that the results do not match the calculations in the testing process in the laboratory.(22)

This research is in line with that carried out by Ramadhani (2020)(21) who absorbed Mn ions using chitosan from tiger prawn shells with a variation of 0.5 gram chitosan, resulting in a reduction in Mn levels reaching 0.06045 mg/g. In the 1.5 gram variation, the Mn level decreased to 0.01983 mg/g. 2.5 gram variation with a decrease in Mn levels reaching 0.01154 mg/g. It can be concluded that the highest reduction of chitosan from tiger prawn shells with a mass of 0.5 grams is capable of absorbing manganese metal ions reaching 0.06045 mg/g.

This research is also in line with research by Wibowo, et al.[23] regarding increasing the use of chitosan absorbent which was used to reduce Fe levels in water by 92% within a contact time of 20 minutes to 160 minutes. Fe absorption using chitosan absorbent has weaknesses which can be influenced by several factors, including low strength and stability of the mechanical structure. In its pure state, chitosan can dissolve in liquids that have a low pH. Therefore, by using a neutral pH, it is best to use chitosan absorbent in water treatment.

This research is in line with research by Valentine, et al. (2020),[24] where a decrease in Fe levels occurred in the first repetition. Crab shell chitosan is able to absorb 64% of heavy metals with a residual metal content of 0.4307 mg/l. In the second repetition, crab shell chitosan was able to absorb 42% of heavy metals with a residual metal content of 0.682 mg/l. In the third repetition, crab shell chitosan was able to absorb 28% of heavy metals with a residual metal content of 0.8441 mg/l.

The compounds contained in chitosan are amine polysaccharides resulting from the chitin deacetylation process. This has an important role in reducing iron metal levels in dug wells. This compound is an essential natural polycationic biopolymer, so it can be applied in various fields, such as metal adsorbents and textile dye absorbents. The biocompatible, biodegradable and non-toxic nature of chitosan makes this compound environmentally friendly.[22]

CONCLUSION

Based on the research results, it can be concluded that the use of chitosan from gonggong snail shells improves the physical quality of water and reduces Fe levels in dug well water at Andana Residential Housing, Tanjungpinang City, Indonesia.

REFERENCES

1. Abudouwaili Z, Yang Y, Feng X. Characteristics of Hydrogen–Oxygen Isotopes and Water Vapor Sources of Different Waters in the Ili Kashi River Basin. Water. 2023; 15(17):3127. DOI: https://doi.org/10.3390/w15173127
2. Polanyi M. Heavy water in chemistry. Nature. 1935;135:19–26. DOI: https://doi.org/10.1038/135019a0
3. Santilli RM. A new gaseous and combustible form of water. International Journal of Hydrogen Energy. 2006;31(9):1113-1128.
4. Wu X, Chen F, Liu X, Wang S, Zhang M, Zhu G, Zhou X, Chen J. The significance of hydrogen and oxygen stable isotopes in the water vapor source in Dingxi Area. Water. 2021;13(17):2374. DOI: https://doi.org/10.3390/w13172374
5. Keane TP, Veroneau SS, Hartnett AC, Nocera DG. Journal of the American Chemical Society. 2023;145(9): 4989-4993. DOI: 10.1021/jacs.3c00176
6. Ulfah M. Pemanfaatan air permukaan dan air tanah. Seminar Nasional Hari Air Sedunia. 2018;1(1).
7. Djuwansah M, Rachman, et al. Pencemaran air permukaan dan airtanah dangkal di hilir Kota Cianjur. Riset Geologi dan Pertambangan. 2009;19(2):109-121.
8. Triadi, Thomas, Kristi I. Permasalahan airtanah pada daerah urban. Teknik. 2009;30(1):48-57.
9. Soedireja HR. Potensi dan upaya pemanfaatan air tanah untuk irigasi lahan kering di Nusa Tenggara. Jurnal Irigasi. 2016;11(2):67-80.
10. Aisyah AN. Analisis dan identifikasi status mutu air tanah di Kota Singkawang studi kasus Kecamatan Singkawang Utara. Jurnal Teknologi Lingkungan Lahan Basah. 2017;5(1).
11. Gafur A, Kartini AD, Rahman R. Studi kualitas fisik kimia dan biologis pada air minum dalam kemasan berbagai merek yang beredar di Kota Makassar tahun 2016. HIGIENE: Jurnal Kesehatan Lingkungan. 2017;3(1):37-46.
12. Sampulawa I, Tumanan D. Analisis kualitas air minum isi ulang yang dijual di Kecamatan Teluk Ambon. Arika. 2016;10(1):41-56.
13. Kurniawati RD et al. Peningkatan akses air bersih melalui sosialisasi dan penyaringan air sederhana desa Haurpugur. Jurnal Pengabdian dan Peningkatan Mutu Masyarakat (JANAYU). 2020;1(2).
14. Surati, Qomariah N. Tingkat keamanan minuman infused water dengan diversifikasi penyimpanan yang berbeda. Jurnal Riset Kesehatan. 2017;6(1):13-19.
15. Elystia S, et al. Teknologi pengolahan air bersih sebagai upaya peningkatan kesehatan masyarakat di Desa Bunga Raya, Kabupaten Siak. Jurnal Abdi Masyarakat Indonesia. 2023;3(3):973-982.
16. Kemenkes RI. Riset kesehatan dasar tahun 2018. Jakarta: Kemenkes RI; 2018.
17. Asip F, Mardhiah R, Husna. Uji efektifitas cangkang telur dalam mengadsorbsi ion Fe dengan proses batch. Jurnal Teknik Kimia. 2008;15(2):22-26.

18. Sammulia, Fitriani S, Suhaera, Ardhini M. Identifikasi kandungan kimia kalsium karbonat dari limbah cangkang siput gong-gong (*Strombus turturella*) dengan metode Wd-Xrf Fussion. Jurnal Katalisator. 2020;5(2):161-168.
19. Lubena, Naidir F, Andrian B. Penurunan turbidity, pH, kadar Fe menggunakan biokoagulan kitosan dari cangkang rajungan (*Portunus pelagicus*). 2020;9(1):7–16.
20. Karelius. Pemanfaatan kitosan sebagai adsorben ion logam Fe pada air gambut yang akan digunakan sebagai air minum. Jurnal Ilmiah Kanderang Tingang. 2012;3(907):33–39.
21. Ramadhani SZ. Penyerapan ion logam mangan menggunakan kitosan dari kulit udang windu (*Penaeus monodon*) dengan penambahan TiO_2-Resin. Diss. UIN Ar-Raniry. 2020.
22. Ismiyati M, Diah R, Setyowati N. Pembuatan bioadsorben dari sabut dan tempurung kelapa untuk menurunkan kadar besi (Fe). 2021;7(1):33–45.
23. Wibowo ER, Rosariawari F, Lingkungan T, Teknik F. Efektivitas adsorben kitosan - natrium tripolifosfat dalam menurunkan konsentrasi Fe dan Mn pada air sumur. 2023;2(1):67–79. DOI: https://doi.org/10.55123/insologi.v2i1.1323
24. Valentine DA. Efektivitas pemanfaatan kitosan dari limbah cangkang kepiting sebagai adsorben logam berat tembaga (Cu) menggunakan metode filtrasi di Desa Kuala Langsa. Jurnal EDUKES: Jurnal Penelitian Edukasi Kesehatan. 2020;3:56-62.