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Original Research Article

The Effectiveness of Using Coral Stone and Shell Powder as Natural Coagulants in Reducing Mn, Fe and Turbidity Levels in Water Using the Backwash Method

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Abstract: Turbidity poses a big problem in water treatment. One of the processing stages in the water treatment unit is the coagulation/flocculation process to remove turbidity. This study uses coral stone and oyster shell powder as locally available natural coagulants to reduce water turbidity. Coral stone and shell powder have now been widely used as a natural coagulant in reducing Mn, Fe levels. However, using coral stone and shell powder as a natural coagulant is still debated. To determine the effectiveness of using coral stone and shellfish powder as natural coagulants in reducing Mn, Fe, and water turbidity levels using the backwashing method. This research is an experimental study with a pretest and post-test design. The population in this study was all water in community dug wells that were cloudy and contained high levels of Mn, Fe, and a sample of 100 liters was taken for filtering experiments and samples for checking levels of Mn, iron (Fe), and water turbidity. This research was conducted at the Health Polytechnic of the Aceh Ministry of Health from July to November 2021. The water analysis was carried out at the Health Laboratory of the Aceh Environmental Health Department. The laboratory tests were analyzed using the paired t-test and the ANOVA test. The results showed an effect of the treatment of coral stone and clamshells on the decrease in Fe content with a P-value of 0.012 ($\alpha < 0.05$). Likewise, the Mn content affects the treatment of coral stone and shell powder with a thickness of 40 cm, 30 cm, and 20 cm, which affects the decrease in Mn content with a P-value of 0.001 ($\alpha < 0.05$). The results showed that Fe levels before entering the shelter had a significant difference with the processing of coral and shell powder with a thickness of 40 cm, 30 cm, and 20 cm. Coral and shells with a thickness of 40 cm, 30 cm, and 20 cm with 15 repetitions can reduce Fe content from 5.2476 ppm to the lowest at 2.4747 ppm. Coral Rock and Shell Powder Effective as a natural coagulant in reducing the levels of Mn and Fe. Coral and oyster shell powder are effective as natural coagulants in reducing water turbidity at 40cm thickness of coral and shells media. Coral and shells media with thicknesses of 40 cm, 30 cm, and 20 cm, respectively, decreased turbidity from 45.8889 NTU to the lowest at 18.50 NTU, with the lowest average being 19.12 NTU. The effectiveness of the thickness of the combination of coral and shells on the levels of Mn, Fe, and water turbidity at a thickness of 40 cm. Coral Stone And Shell Powder are Effective As Natural Coagulant In Lowering Mn. Levels with a P-value of 0.012 (< 0.05) and a decrease in Mn content with a P-value of 0.001 (< 0.05). Coral and oyster shell powder are effective as natural coagulants in reducing water turbidity at 40cm thickness of coral and shells media.

Keywords: Media, Stunting, Adolescents, Coral Stone and Shell Powder.

INTRODUCTION

Water is the most vital element among natural resources.Human activities and global industrialization increasingly affect the natural environment, resulting in increased pollution of natural water sources. Groundwater and surface water can be contaminated with suspended solids, colloidal particles, and solutes. Access to clean and safe water is essential in many developing countries. More than six million people die from diarrhea caused by polluted water [1]. The United Nations (UN) 2019 noted that 2.2 billion people, or a quarter of the world's population, still lack safe drinking water [2].

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Meanwhile, 4.2 billion people do not have safe sanitation services, and 3 billion do not have basic handwashing facilities [3]. Water quality problems occur in almost all developing countries, including Indonesia. More than 80% of people in Indonesia lack clean and safe water [4]. As the fourth most populous country globally, the unequal availability of clean water is an essential issue because it affects all aspects of life, from health to public welfare [5]. The body absorbs the water people drink and the compounds and elements. Generally, drinking water treatment comes from river water which is generally still in a cloudy state, and some particles can come from various rocks. To get potable water, further management is needed. The techniques used in water treatment must be specific, economical, and efficient [6-8]. One of the processing steps in the water treatment unit is the coagulation/flocculation process to remove turbidity in the form of suspended and colloidal matter [9-11]. Coagulants have several advantages because they are non-toxic, readily biodegradable, polyelectronic, and easily interact with other organic substances such as proteins. Coagulant using natural and environmentally friendly materials is an alternative that needs to be done. Using locally available natural coagulants is suitable, accessible, and environmentally friendly for water treatment [12].

Natural coagulants often found in the community are coral stone and shell powder. Shellfish is an environmentally friendly material and has a high added value. Shellfish shells and coral stones can also be used in the water purification process, both for turbidity and Fe content. The use of coral, when combined with shells, is expected to improve the physical and chemical quality of water, especially water turbidity and Fe content.

In addition, coral can be obtained quickly, and the price is also relatively low. Likewise, clamshells can be obtained easily both on the shores and lakes and from clam shells whose meat/contents have been taken. Based on this, researchers are interested in researching "Effectiveness of Using Coral Stone and Shell Powder as Natural Coagulant in Reducing Levels of Mn, Fe, and Turbidity of Water with Backwash Method

METHOD

This research is an experimental study with a pretest and post-test design. The pretest and post-test design was to conduct an experiment bypassing the sample water through the filter media with shell powder as a natural coagulant and coral with different thicknesses. Then look at the differences in Mn, Iron (Fe), and water turbidity at different thicknesses. This research was conducted at the Environmental Health Department of the Health Polytechnic of the Ministry of Health Aceh from July to November 2021. The filter was made using shells and coral stone as a medium in a workshop or workshop of the Environmental Health Department of the Health Polytechnic of the Ministry of Health of Aceh, and the water analysis was carried out at the Health Laboratory of the Health Department. Aceh Environment. The population in this study was all water in community dug wells that were cloudy and contained high levels of Mn, Fe, and a sample of 100 liters was taken for filtering experiments and samples for checking levels of Mn, iron (Fe), and water turbidity. The object of this research is the resident dug well water with a sample of 20 liters before and after passing through a filter using mussel shell powder and coral stone as the media. Water samples were included in 3 (three) treatments, namely, in treatment one, the thickness of coral stone was 40 cm, and shell powder was 40 cm, and in treatment 2 (two), the thickness of coral was 30 cm, and shell powder was 30 cm, while for the third treatment the thickness of the stone was 20 cm of coral and 20 cm of shellfish powder, and the repetition in the treatment refers to the formula (Federer, 1977): (n-1) (t.-1) > 15, so n = 6.

Data collection from the laboratory examination results of Manganese levels Iron (Fe) and turbidity levels before and after filtering. The laboratory tests show the levels of Mn, Iron (Fe), and water turbidity. It is known that the thickness of the shellfish powder media reduces the levels of Mn, Iron (Fe), and turbidity and compares with the levels of iron (Fe) and turbidity based on Minister of Health Regulation No. 492 2010 concerning Clean Water Quality Requirements. Meanwhile, statistical tests were carried out with 0f variance (ANOVA) analysis to see the effectiveness of coral stone filter media and shellfish powder. The results of the sieves were checked in the laboratory to see their physical quality, and then the data from the laboratory examinations were analyzed using the paired t-test and ANOVA. A paired t-test was used to determine the effect of each treatment, while the effectiveness of using clamshell powder and coral stone for filter media was tested with Anova.

RESULTS

The results of the examination of Fe and Mn levels with a thickness of coral stone and shell powder were 40 cm, 30 cm, and 20 cm.

From the data processing of the research that has been done with the thickness of coral stone 40 cm, 30 cm, and 20 cm, the results obtained as in Table 1 below:

Table 1: Results of Examination of Fe and Mn Levels with Thickness of Coral Stone and Shell Powder 40 cm, 30 cm, and 20 cm

		N	mean	95% Confidence Interval for Mean	
				Lower Bound	Upper Bound
Fe check	Water before going to the shelter	15	.2476	3.6377	6.8574
	Water from the reservoir	15	4.9338	3.3823	6.4852
	Water after storage and coral	15	4.7573	3.4014	6,1133
	Water after storage, coral and shell powder40 cm	15	2.4747	1.1612	3.7881
	Water after storage, coral and shell powder30 cm	15	3.4693	2.2751	4.6636
	Water after storage, coral and shell powder20 cm	15	3.1876	2.1535	4.2216
	Total	90	4.0117	3.4684	4,5550
Mn examination	Water before going to the shelter	15	1.8622	,3152	3.4092
	Water from the reservoir	15	1.4804	,0655	2.8954
	Water after storage and coral	15	-1.6404	-4.0486	,7677
	Water after storage, coral and shell powder 40 cm	15	-1.7151	-3.1737	-,2565
	Water after storage, coral and shell powder 30 cm	5	-,5173	-1.8072	,7725
	Water after storage, coral and shell powder 20 cm	15	-1.9947	-3.8746	-,1148
	Total	90	-,4208	-1.1288	,2872

Based on the table above, it can be explained that coral and shells with a thickness of 40 cm, 30 cm, and 20 cm with 15 repetitions can reduce Fe content from 5.2476 ppm to the lowest at 2.4747 ppm. The results of this study, when compared with the standards set by the Ministry of Health, are not following Permenkes no. 492 in 2010, still above the standard of 0.3 ppm. The results of the examination of Fe and Mn levels, after an analysis of variance, has been carried out, can be seen in the table below:

Table 2: ANOVA Test Results for Fe and Mn Levels with Thickness of Coral and Shells 40 cm, 30 cm, and 20 cm

		Sum of Squares	f	Mean Square	F	Sig.
Fe check	Between Groups	94,041	5	18,808	3,130	0.012
	Within Groups	504.794	4	6,009		
	Total	598,835	9			
Mn examination	Between Groups	217.141	5	43,428	4,561	,001
	Within Groups	799,804	4	9,521		
	Total	1016,945	9			

Based on the table above, it can be explained that there is an effect of treatment of Krueng Baro coral stone and shellfish on the decrease in Fe content with a P-value of 0.012 ($\alpha < 0.05$). Likewise, the Mn content has the effect of treating coral stone and shell powder with a thickness of 40 cm, 30 cm, and 20 cm on the decrease in Mn content with a P-value of 0.001 (< 0.05).

The Effectiveness of Thickness of Coral Rock and Shell Powder to Decrease Fe and Mn. Levels

To see the effectiveness of the thickness of Krueng Baro coral and Shells to reduce Fe and Mn levels, it can be seen in the following table post hoc tests.

Table 3: Test results significant different list (lsd)

	(I) Fe and Mn. examination codes	(J) Fe and Mn. examination codes	Mean Difference (IJ)	Std. Error	Sig.
LSD	Water before going to the shelter	Water from the reservoir	,31378	,89513	,727
		Water after storage and coral	,49022	,89513	,585
		Water after storage, coral and shell powder 40 cm	2.77289 *	,89513	,003
		Water after storage, coral and shell powder 30 cm	1.77822	,89513	0.050
		Water after storage, coral and shell powder 20 cm	2.06000 *	,89513	,024
	ater from the reservoir	Water before going to the shelter	-,31378	,89513	,727
		Water after storage and coral	,17644	,89513	,844
		Water after storage, coral and shell powder 40 cm	2,45911 *	,89513	,007
		Water after storage, coral and shell powder 30 cm	1.46444	,89513	,106
		Water after storage, coral and shell powder 20 cm	1.74622	,89513	0.054
	Water after storage and coral	Water before going to the shelter	-,49022	,89513	,585
		Water from the reservoir	-,17644	,89513	,844
		Water after storage, coral and shell powder 40 cm	2,28267 *	,89513	0.013
		Water after storage, coral and shell powder 30 cm	1.28800	,89513	,154
		Water after storage, coral and shell powder 20 cm	1.56978	,89513	,083

	(I) Fe and Mn. examination codes	(J) Fe and Mn. examination codes	Mean Difference (IJ)	Std. Error	Sig.
	Water after storage, coral and shell powder 40 cm	Water before going to the shelter	-2.77289 *	,89513	,003
		Water from the reservoir	-2,45911 *	,89513	,007
		Water after storage and coral	-2,28267 *	,89513	0.013
		Water after storage, coral and shell powder 30 cm	-,99467	,89513	,270
		Water after storage, coral and shell powder 20 cm	-,71289	,89513	,428
	Water after storage, coral and shell powder 30 cm	Water before going to the shelte	-1.77822	,89513	0.050
		Water from the reservoir	-1.46444	,89513	,106
		Water after storage and coral	-1.28800	,89513	,154
		Water after storage, coral and shell powder 40 cm	,99467	,89513	,270
		Water after storage, coral and shell powder 20 cm	,28178	,89513	,754
	Water after storage, coral and shell powder 20 cm	Water before going to the shelter	-2.06000 *	,89513	,024
		Water from the reservoir	-1.74622	,89513	0.054
		Water after storage and coral	-1,56978	,89513	,083
		Water after storage, coral and shell powder 40 cm	,71289	,89513	,428
		Water after storage, coral and shell powder 30 cm	-,28178	,89513	,754
Tamhane	Water before going to the shelter	Water from the reservoir	,31378	1.04240	1,000
		Water after storage and coral	,49022	,98134	1,000
		Water after storage, coral and shell powder 40 cm	2.77289	,96870	,114
		Water after storage, coral and shell powder 30 cm	1.77822	,93456	,654
		Water after storage, coral and shell powder 20 cm	2.06000	,89209	,366
	Water from the reservoir	Water before going to the shelter	-,31378	1.04240	1,000
		Water after storage and coral	,17644	,96068	1,000
		Water after storage, coral and shell powder 40 cm	2,45911	,94776	,204
		Water after storage, coral and shell powder 30 cm	1.46444	,91284	,855
		Water after storage, coral and shell powder 20 cm	1.74622	,86931	,577
	Water after storage and coral	Water before going to the shelter	-,49022	,98134	1,000
		Water from the reservoir	-,17644	,96068	1,000
		Water after storage, coral and shell powder 40 cm	2,28267	,88017	,202
		Water after storage, coral and shell powder 30 cm	1.28800	,84244	,892
		Water after storage, coral and shell powder 20 cm	1.56978	,79507	,598
	Water after storage, coral and shell powder 40 cm	Water before going to the shelter	-2.77289	,96870	,114
		Water from the reservoir	-2,45911	,94776	,204
		Water after storage and coral	-2,28267	,88017	,202
		Water after storage, coral and shell powder 30 cm	-,99467	,82768	,984
		Water after storage, coral and shell powder 20 cm	-,71289	,77941	,999
	Water after storage, coral and shell powder 30 cm	Water before going to the shelter	-1.77822	,93456	,654
		Water from the reservoir	-1.46444	,91284	,855
		Water after storage and coral	-1.28800	,84244	,892
		Water after storage, coral and shell powder 40 cm	,99467	,82768	,984
		Water after storage, coral and shell powder 20 cm	,28178	,73654	1,000
	Water after storage, coral and shell powder 20 cm	Water before going to the shelter	-2.06000	,89209	,366
		Water from the reservoir	-1.74622	,86931	,577
		Water after storage and coral	-1,56978	,79507	,598
		Water after storage, coral and shell powder 40 cm	,71289	,77941	,999
		Water after storage, coral and shell powder 30 cm	-,28178	,73654	1,000
SD	before going to the shelter	Water from the reservoir	,38178	1.12673	,736
		Water after storage and coral	3,50267 *	1.12673	,003
		Water after storage, coral and shellpowder 40 cm	3,57733 *	1.12673	,002
		Water after storage, coral and shellpowder 30 cm	2.37956 *	1.12673	,038
		Water after storage, coral and shell powder 20 cm	3.85689 *	1.12673	,001
	Water from the reservoir	Water before going to the shelter	-,38178	1.12673	,736
		Water after storage and coral	3.12089 *	1.12673	,007
		Water after storage, coral and shell powder 40 cm	3.19556 *	1.12673	,006
		Water after storage, coral and shell powder 30 cm	1.99778	1.12673	0.080
		Water after storage, coral and shell powder 20 cm	3,47511 *	1.12673	,003
	Water after storage and coral	Water before going to the shelter	-3,50267 *	1.12673	,003
		Water from the reservoir	-3.12089 *	1.12673	,007
		Water after storage, coral and shell powder 40 cm	,07467	1.12673	,947
		Water after storage, coral and shell powder 30 cm	-1.12311	1.12673	,322
		Water after storage, coral and shell powder 20 cm	,35422	1.12673	,754

	(I) Fe and Mn. examination codes	(J) Fe and Mn. examination codes	Mean Difference (IJ)	Std. Error	Sig.
	Water after storage, coral and shell powder 40 cm	Water before going to the shelter	-3.57733 *	1.12673	,002
		Water from the reservoir	-3,19556 *	1.12673	,006
		Water after storage and coral	-,07467	1.12673	,947
		Water after storage, coral and shell powder 30 cm	-1.19778	1.12673	,291
		Water after storage, coral and shell powder 20 cm	,27956	1.12673	,805
	Water after storage, coral and shell powder 30 cm	Water before going to the shelter	-2.37956 *	1.12673	,038
		Water from the reservoir	-1.99778	1.12673	0.080
		Water after storage and coral	1.12311	1.12673	,322
		Water after storage, coral and shell powder 40 cm	1.19778	1.12673	,291
		Water after storage, coral and shell powder 20 cm	1.47733	1.12673	,193
	Water after storage, coral and shell powder 20 cm	Water before going to the shelter	-3.85689 *	1.12673	,001
		Water from the reservoir	-3,47511 *	1.12673	,003
		Water after storage and coral	-,35422	1.12673	,75
		Water after storage, coral and shell powder 40 cm	-,27956	1.12673	,805
		Water after storage, coral and shell powder 30 cm	-1,47733	1.12673	,193
Tamhane	Water before going to the shelter	Water from the reservoir	,38178	,97749	1,000
		Water after storage and coral	3,50267	1.33452	,201
		Water after storage, coral and shell powder 40 cm	3,57733 *	,99133	0.018
		Water after storage, coral and shell powder 30 cm	2.37956	,93911	,231
		Water after storage, coral and shell powder 20 cm	3.85689 *	1.13513	,031
	Water from the reservoir	Water before going to the shelter	-,38178	,97749	1,000
		Water after storage and coral	3.12089	1.30228	,318
		Water after storage, coral and shell powder 40 cm	3.19556 *	,94748	,032
		Water after storage, coral and shell powder 30 cm	1.99778	,89270	,400
		Water after storage, coral and shell powder 20 cm	3,47511	.09704	0.057
	Water after storage and coral	Water before going to the shelter	-3,50267	1.33452	,201
		Water from the reservoir	-3.12089	1.30228	,318
		Water after storage, coral and shell powder 40 cm	,07467	1.31270	1,000
		Water after storage, coral and shell powder 30 cm	-1.12311	1.27372	,999
		Water after storage, coral and shell powder 20 cm	,35422	1.42441	1,000
	Water after storage, coral and shell powder 40 cm	Water before going to the shelter	-3.57733 *	,99133	0.018
		Water from the reservoir	-3,19556 *	,94748	,032
		Water after storage and coral	-,07467	1.31270	1,000
		Water after storage, coral and shell powder 30 cm	-1.19778	,90783	,963
		Water after storage, coral and shell powder 20 cm	,27956	1.10939	1,000
	Water after storage, coral and shell powder 30 cm	Water before going to the shelter	-2.37956	,93911	,231
		Water from the reservoir	-1.99778	,89270	,400
		Water after storage and coral	1.12311	1.27372	,999
		Water after storage, coral and shell powder 40 cm	1.19778	,90783	,963
		Water after storage, coral and shell powder 20 cm	1.47733	1.06298	,946
	Water after storage, coral and shell powder 20 cm	Water before going to the shelter	-3.85689 *	1.13513	,031
		Water from the reservoir	-3,47511	1.09704	0.057
		Water after storage and coral	-,35422	1.42441	1,000
		Water after storage, coral and shell powder 40 cm	-,27956	1.10939	1,000
		Water after storage, coral and shell powder 30 cm	-1,47733	1.06298	,946

*. The mean difference is significant at the 0.05 level.

Based on the LSD table above, it can be explained that for Fe processing, it is known that Fe levels before entering the shelter have significant differences with the processing of coral and shell powder with a thickness of 40 cm, 30 cm, and 20 cm. This shows the effect of processing coral with shell powder with various thicknesses. When viewed from the processing of coral and shell powder with a thickness of 40 cm before storage, after storage, and after storage, coral shows a significant difference. Processing coral and shells with a thickness of 40 cm affect decreasing Fe levels from before storage, after holding and holding coral. Compared to the processing of shelters, coral and coral powder thicknesses of 30 cm and 20 cm did not show any difference.

Content from the inspection of storage processing, coral and clamshell powder was at a thickness of 40cm, meaning this thickness was the most effective. Processing of Mn is known that the levels of Mn before entering the shelter have a significant difference with the processing of coral and shell powder with a thickness of 40 cm, 30 cm, and 20 cm. meaning that there is an effect of processing coral with shell powder with various thicknesses. Processing of coral and shell powder with a thickness of 40 cm before storage, after storage, and after storage and coral, which shows a significant difference, means that the processing of coral and shells with a thickness of 40 cm affects decreasing Mn levels from the start before storage, after storage and storage with coral.

When compared to storage processing, coral and coral powder with a thickness of 30 cm and 20 cm did not show any difference, but when viewed from the Mn content, the results of the examination showed that the lowest processing of shelter, coral, and clamshell powder was at a thickness of 40 cm, meaning this thickness was the most effective. In addition, in several other studies, it is also known that several other ingredients can be used in water management, such as eggshells, chitosan, rice flour, banana peels, moringa seeds, etc [13, 14]. This process is considered very attractive because of its high efficiency, capacity to reduce sludge volume, fast sedimentation, and low cost [15, 16]. Eggshells are cost-effective, readily available as a biomaterial, and are widely used as bone substitutes, catalysts, and supports. They are efficient bio-templates due to their high catalytic activity, ease of handling, reusability, and docile nature [18-20].

Turbidity of Water Before and After Treatment of Krueng Baro Coral and Shells Powder as Natural Coagulant in Reducing Water Turbidity

Based on the results of the laboratory examination of turbidity of water before and after healthy water filtration treatment with Krueng Baro coral and shells with a thickness of 40 cm, 30 cm, and 20 cm, respectively, which was carried out five times, it can be seen in Fig. the following table:

Table 4: Turbidity of Water Before and After Filtration Process with Coral Rock and Shellfish Media

Turbidity Check	N	mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Min	Max
					Lower Bound	Upper Bound		
Water before going to the shelter	9	45,8889	2.47964	82655	43.9829	47.7949	43.10	50,10
Water after passing through the reservoir	9	41.5111	2.23072	,74357	39.7964	43,2258	38,70	44.00
Water after passing through reservoirs and coral	9	36.5667	1.18216	,39405	35,6580	37.4754	35,40	38,20
After passing water, reservoir ,coral, and shell powder, 40 cm	9	19.1667	,62728	,20909	18.6845	19.6488	18.72	20,10
After passing water, reservoirs, coral, and shell powder, 30 cm	9	25.7444	,56372	,18791	25,3111	26.1778	24.90	26,2
Water after passing through the reservoir, coral, and shell powder 20 cm	9	19.7333	1.29711	,43237	18.7363	20.7304	18,50	21.50
Total	54	31.4352	10,66535	1.45137	28,5241	34.3463	18,50	50,10

Based on the table above, before and after the filtering process using coral stone and shells with a thickness of 40 cm, 30 cm, and 20 cm, respectively, there was a decrease in turbidity from 45.8889 NTU to the lowest 18.50 NTU with the lowest average being 19. 12 NTU. The results of this study, when compared with Permenkes no.492 of 2010, are not appropriate, namely turbidity for drinking water 5 NTU. Turbidity in well water can be caused by suspended and dissolved organic and inorganic materials (e.g., mud and fine sand) and inorganic and organic materials in the form of plankton and other microorganisms (Effendi, 2003). Pekan Billy well water has a turbidity of 45.8889 NTU; physically, the water looks cloudy with a yellowish color. Based on the Regulation of the Minister of Health no. 416 of 1990, the maximum level of turbidity of clean water is 25 NTU. This still meets the established standards for clean water for household needs, and it is still allowed; however, it needs to be reprocessed for drinking water sources

CONCLUSION

Effectively Krueng Baro Coral Stone and Shellfish Powder as natural coagulants in reducing Mn and Fe levels. Krueng Baro Coral and oyster shell powder as natural coagulants in reducing water turbidity at 40cm thickness of coral stone and shells media. The effectiveness of the thickness level of the combination of coral and shells on the levels of Mn, Fe, and water turbidity at a thickness of 40 cm.

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