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Experiment on Filamentous Fungi in Shower Filters

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Abstract
There were news about shower filter products which got fungi in April 2019. The mugwort shower filter began to produce since February 2019. The product in the issue was unable to check the fact about the generation of fungi as it was discarded by the user. Thereby, it was necessary to carry out the fungi generating experiment and the experiment to check out the possibility of infected shower filter. In this paper, fungi generating experiment was carried out using shower filter which contains mugwort, reported in the case, maintaining the humidity and temperature of the shower room. Set mugwort filter as the experimental group and common filter as control group. With six randomly selected samples, the experimental period was 1st week, 2nd week, 3rd week, 1st month, 2nd month, 3rd month, 6th month, 8th month. In consideration of the possibility that fungi may exist inside the unused shower filter, commissioned the test to the Korea Chemical Research Institute (KTR), a third trust organization. As a result, aerobacter (bacteria, fungus), staphylococcus aureus, pseudomonas aeruginosa and colon bacillus were not detected. The results of the test for fungi generation by used shower filter showed that all 6 experimental groups (mugwort shower filter) and 6 control groups (general shower filter) did not produced fungi inside the filter. January 2020, products with similar case were reported. Korea Standard Test Researcher (KSTR) conducted additional fungi generating tests with the product. As a result, fungi did not grow. Comprehensively review the results, this confirmed that the report about mugwort shower filter was not true. To improve the misrecognizing situation, in the process of manufacture of shower filters, the percentage of mugwort extract shall be reduced from the previous. 4% to less than 2%, which is half the level. This paper will be used as a basic data for the people's health..

Keywords: *Shower filter, Vitamin filter, Mugwort, Fungi, Bacteria, Residual Chlorine*.

1. Introduction

On April 13, 2019, as shown in figure 1, a case of a fungi occured inside shower filter product was reported [http://www.newspim.com/news/view/20190413000067].

The product in the issue did not adopted as evidence and discarded without being checked. If fungi generate in the shower filter, it can adversely affect the health of humans taking a shower.

As shown in figure 3, existing shower filters were tested for safety and function, and their safety was confirmed through experiments on the removal of residual chlorine and rust from water which purified by shower filter.

So far, no cases of fungi in the shower filter have been reported. However, after the report of the case about fungi generation in the shower filter product, it is necessary to investigate the occurrence of fungi as the shower filter can cause adverse effect on the health of people.

Therefore, two kind of experiment were needed. First, the fungi generating experiment of shower filter in experimental group (mugwort shower filter) and control group (common shower filter) under conditions similar to actual shower scene.

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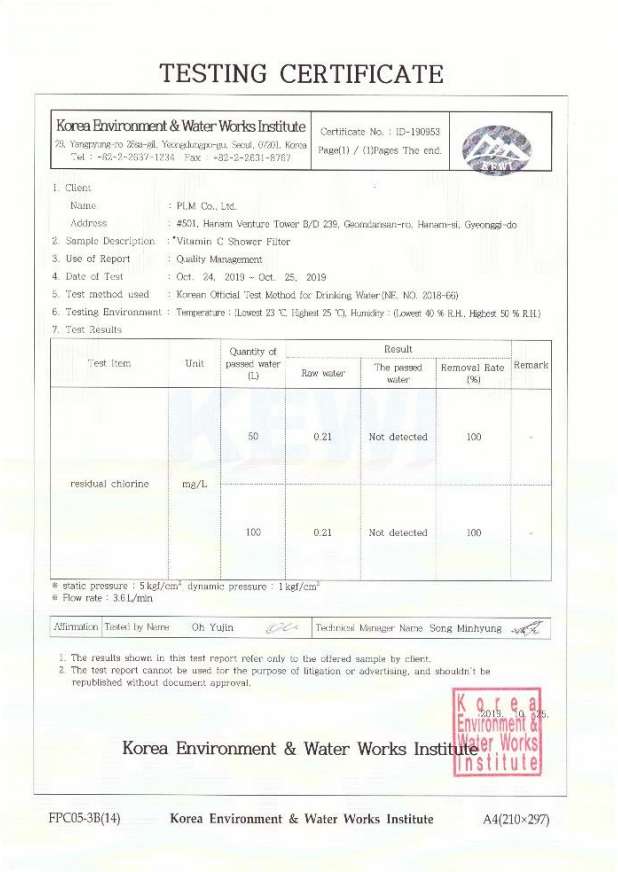
Figure 1. Shower Filters in the Case

Figure 2. Unused Shower Filter

Second, the experimental research about fungi generation of unused mugwort shower filter.

In this paper, a shower filter containing mugwort is tested for fungal fungus expression in an environment similar to a shower room. The experiment is carried out with the experimental group (mugwort shower filter) and the control group (common shower filter). These group was selected random and the experiment was conducted in 1st week, 2nd week, 3rd week, 1st month, 2nd month, 3rd month, 6th month, 8th month. In other words, the experiment was conducted in the actual shower room during the period when the mugwort shower filter was used.

In addition, through the middle report of the experiment and the results of the experiment, analyze generation of fungi and check the degree of fungi.



TESTING CERTIFICATE

Korea Environment & Water Works Institute
29, Yangpyong-ro 28sa-gil, Yeongdeungpo-gu, Seoul, 07201, Korea
Tel : +82-2-2637-1234 Fax : +82-2-2631-8787

Certificate No. : ID-190953
Page(1) / (1)Pages The end.

1. Client
Name : PLM Co., Ltd.
Address : #501, Hanam Venture Tower B/D 239, Geomdaesan-ro, Hanam-si, Gyeonggi-do
2. Sample Description : "Vitamin C Shower Filter
3. Use of Report : Quality Management
4. Date of Test : Oct. 24, 2019 ~ Oct. 25, 2019
5. Test method used : Korean Official Test Method for Drinking Water(NE. NO. 2018-66)
6. Testing Environment : Temperature : (Lowest 23 ℃, Highest 25 ℃), Humidity : (Lowest 40 % R.H., Highest 50 % R.H.)
7. Test Results

Test Item	Unit	Quantity of passed water (L)	Result: Raw water	Result: The passed water	Removal Rate (%)	Remark
residual chlorine	mg/L	50	0.21	Not detected	100	-
		100	0.21	Not detected	100	-

※ static pressure : 5 kgf/cm² dynamic pressure : 1 kgf/cm²
※ Flow rate : 3.6 L/min

Affirmation | Tested by Name : Oh Yujin | Technical Manager Name: Song Minhyung

1. The results shown in this test report refer only to the offered sample by client.
2. The test report cannot be used for the purpose of litigation or advertising, and shouldn't be republished without document approval.

2019. 10. 28.
Korea Environment & Water Works Institute

FPC05-3B(14) Korea Environment & Water Works Institute A4(210×297)

Figure 3. Test Certificate about Residual Chlorine Elimination

The paper's experiment with the mugwort shower filter will be used as a basic material contributing to public health

2. Environment and assumption of shower filter fungi experiment

2.1 Experiment environment

Specification of vitamin filter: Size 50 x 140mm, Weight 154g, Vitamin Gall Capacity 70g

Vitamin Gall Ingredients : Ascorbic acid, Dextrin, Glycerin, Xanthan Gum, Perennial artemisia

Case Material: polypropylene

Experiment environment: Environment similar to typical home 's shower room.

Experimental Observation Cycle after Shower Filter Installation :1st week, 2nd week, 3rd week, 1st month, 2nd month, 3rd month, 6th month, 8th month.

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2.2 Experiment Assumptions

The experiment assumes the following statements.

1) The shower filter did not use preservatives or preservatives, so the mixtures that escaped from the shower filter were expected to produce bacteria and fungi when exposed to air for long-term. Therefore, based on this expectation, check the time when fungi generate.
2) If the timing and degree of fungus occurring in the experimental group (mugwort shower filter) and the control group (common shower filter) are similar, this infer that the mugwort shower filter is normal because there were no similar cases in the common shower filter.
3) If the timing and degree of fungus occurring in the experimental group are faster and worse than the control group, this infer that the substance suspected as fungi was actual fungi.

2.3 Experiment Conditions

In an environment similar to a household shower room, the shower filter is operated for 20 minutes, and kept in a plastic container by soak 90 percent of it in water. Replenish the water every week.

The experimental product is mugwort Shower Filter produced on March 8, 2019. Randomly select six mugwort shower filters as the experimental group and six common shower filters as the control group.

The fungi generating experiments are conducted on period of 1st week, 2nd week, 3rd week, 1st month, 2nd month, 3rd month, 6th month, 8th month. The temperature of 25°C to 30°C and humidity above 25% to 35% are maintained of the time so that the experimental environment is similar to the shower room.

3. Experiment and Evaluation of Fungi Generation in a Shower Filter

3.1 The Function of Shower Filter

When chlorine is injected into the water, it is hydrolyzed rapidly and divided into HOCl (hypochlorious Acid) and HCl (Hydrochloric Acid).

$$H_2O + Cl_2 \rightleftarrows HCl \text{ (Hydrochloric Acid)} + HOCl^-$$

HOCl (Hypochlorous Acid) has the sterilizing power to exterminate aquatic microorganisms and it prevent waterborne diseases.

However, it is not recommended to be exposed directly to the body because it damages the protein in the skin and adversely affects the respiratory system.

Vitamin C, the main ingredient of shower filter, removes HOCl. The response formula for vitamin C and HOCl is as follows.

$$C_6H_8O_6 \text{ (Vitamin-C)} + HOCl \text{ (Hypochlorous Acid)} \rightleftarrows C_6H_6O_6\text{-}H_2O + HCl$$

The shower filter is manufactured by injecting 4% of the total weight of mugwort powder consisting of mugwort extract (40%) and dextrin (60%).

3.2 The Fungi Test of Unused Shower Filter

The possibility of infection in the manufacturing process should be considered. In order to determine whether the shower filter is infected or not, commissioned to the Korea Chemical Research Institute (KTR), an authorized agency , Aerobacter (bacteria, fungus), staphylococcus aureus, pseudomonas aeruginosa and colon bacillus test experiments to check the presence of fungi and harmful bacteria in the filter. Officially commissioned KTR, fungi experiment of same product with figure 1 which was reported on social media. In figure 4 is the official document of the results of experiments by the KTR. The results of the experiment show that the contents of the unused mugwort shower filter are free of fungus.

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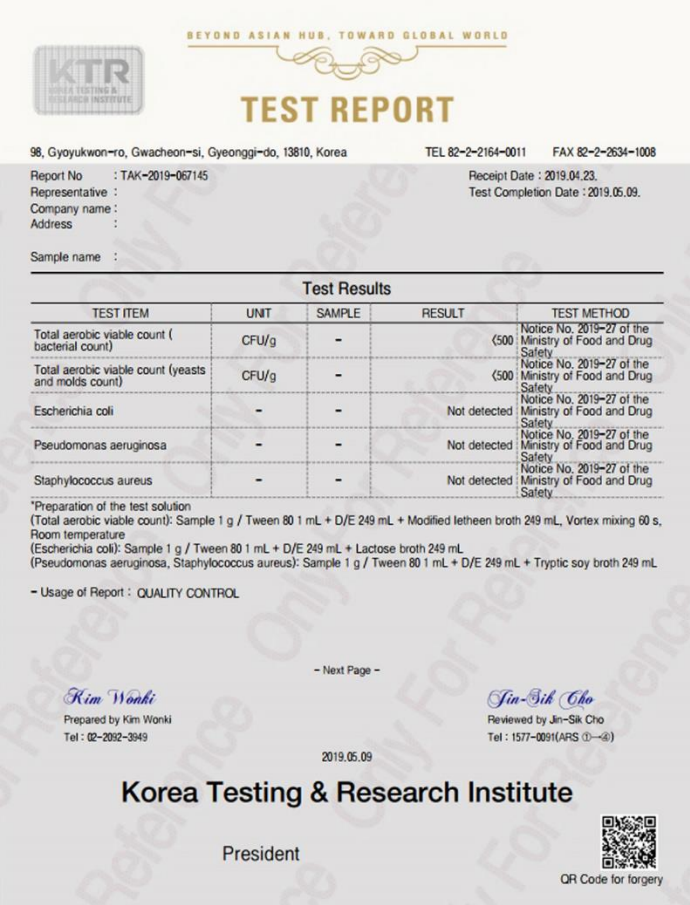

BEYOND ASIAN HUB, TOWARD GLOBAL WORLD

KTR KOREA TESTING & RESEARCH INSTITUTE

TEST REPORT

98, Gyoyukwon-ro, Gwacheon-si, Gyeonggi-do, 13810, Korea TEL 82-2-2164-0011 FAX 82-2-2634-1008

Report No : TAK-2019-067145
Representative :
Company name :
Address :

Receipt Date : 2019.04.23.
Test Completion Date : 2019.05.09.

Sample name :

Test Results

TEST ITEM	UNIT	SAMPLE	RESULT	TEST METHOD
Total aerobic viable count (bacterial count)	CFU/g	-	<500	Notice No. 2019-27 of the Ministry of Food and Drug Safety
Total aerobic viable count (yeasts and molds count)	CFU/g	-	<500	Notice No. 2019-27 of the Ministry of Food and Drug Safety
Escherichia coli	-	-	Not detected	Notice No. 2019-27 of the Ministry of Food and Drug Safety
Pseudomonas aeruginosa	-	-	Not detected	Notice No. 2019-27 of the Ministry of Food and Drug Safety
Staphylococcus aureus	-	-	Not detected	Notice No. 2019-27 of the Ministry of Food and Drug Safety

*Preparation of the test solution
(Total aerobic viable count): Sample 1 g / Tween 80 1 mL + D/E 249 mL + Modified letheen broth 249 mL, Vortex mixing 60 s, Room temperature
(Escherichia coli): Sample 1 g / Tween 80 1 mL + D/E 249 mL + Lactose broth 249 mL
(Pseudomonas aeruginosa, Staphylococcus aureus): Sample 1 g / Tween 80 1 mL + D/E 249 mL + Tryptic soy broth 249 mL

- Usage of Report : QUALITY CONTROL

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2019.05.09

Korea Testing & Research Institute

President

QR Code for forgery

Figure 4. Confirmation from KTR

3.3 The Fungi Test of Unused Shower Filter

In this paper, fungi generating experiments are conducted during the use period :1st week, 2nd week, 3rd week, 1st month, 2nd month, 3rd month, 6th month, 8th month in an experimental environment similar to the shower room of a general house.

The results of the experiment on whether fungi ware produced from the mugwort shower filter are shown as the figure 4.

Starting the experiment on April 8, and each experiment result of 15 April, 22 April 2019, 29 April, 14 May, 14 June, 15 August, 16 September appeared as a [Table 1].

A floating matter was found in the water in the experimental plastic container. Inside the plastic container, the contents of the filter were flowed out, causing brown stains, but after taking out the shower filter, the inside of the shower filter was clean.

On January 28, 2020, two shower filters (produced on February 28, 2019) which looks similar with the case were get additionally. In figure 5 is a picture of two shower filters.

Experiment period	April 15, 2019	April 22	April 29	May 14
Experiment Shower Filter				
Experiment period	**June 14**	**July 15**	**August 15**	**September 16**
Experiment Shower Filter				

Table 1. Observation state of Experiment

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Commissioned Korea Standard Test Researcher (KSTR) on 29 January to conduct incubation experiment with the two sample of matter which appear fungi inside mugwort shower filter. The week-long incubation experiment showed that fungi did not grow. In figures 6, 7, and 8 are the results of the experiment. This proves that the report of fungi generation in mugwort shower filter was misrecognition.

Figure 5. Shower Filters look similar with the case

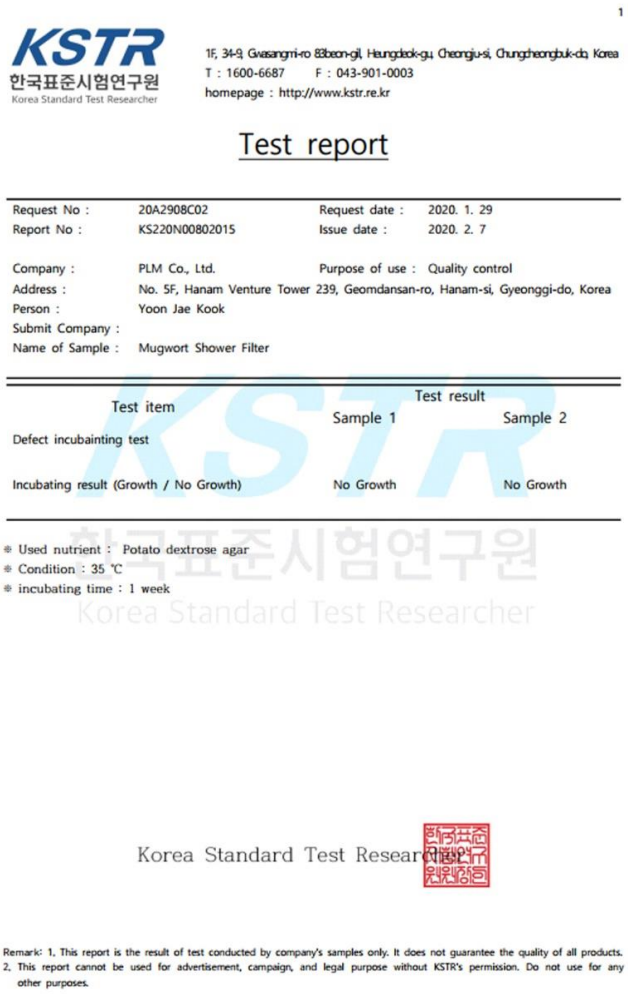
- Result picture -

< Sample 1 >

< Sample 2 >

Remark: 1. This report is the result of test conducted by company's samples only. It does not guarantee the quality of all products.
2. This report cannot be used for advertisement, campaign, and legal purpose without KSTR's permission. Do not use for any other purposes.

Figure 7. Laboratory Dish used on Incubating Fungi



KSTR
한국표준시험연구원
Korea Standard Test Researcher

1F, 34-9, Gwasangmi-ro 83beon-gil, Heungdeok-gu, Cheongju-si, Chungcheongbuk-do, Korea
T : 1600-6687 F : 043-901-0003
homepage : http://www.kstr.re.kr

Test report

Request No :	20A2908C02	Request date :	2020. 1. 29
Report No :	KS220N00802015	Issue date :	2020. 2. 7
Company :	PLM Co., Ltd.	Purpose of use :	Quality control
Address :	No. 5F, Hanam Venture Tower 239, Geomdansan-ro, Hanam-si, Gyeonggi-do, Korea		
Person :	Yoon Jae Kook		
Submit Company :			
Name of Sample :	Mugwort Shower Filter		

Test item	Test result	
	Sample 1	Sample 2
Defect incubainting test		
Incubating result (Growth / No Growth)	No Growth	No Growth

※ Used nutrient : Potato dextrose agar
※ Condition : 35 ℃
※ incubating time : 1 week

Korea Standard Test Researcher

Remark: 1. This report is the result of test conducted by company's samples only. It does not guarantee the quality of all products.
2. This report cannot be used for advertisement, campaign, and legal purpose without KSTR's permission. Do not use for any other purposes.

Figure 6. Test Result of Fungi Incubating experiment

To check similarity between wet mugwort powder and reported picture, sprayed water inside beaker and sprinkled the powder on the wet surface. In figure 9 is that appearance, and it looks similar with figure 1, the picture of the case.

In conclusion, the diluted mugwort by elution seems as fungi appeared. In other words, it was confirmed that the fungus did not appear as reported in the case of mugwort shower filter, and it was misrecognition by similar appearance between the diluted mugwort and fungi.

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Figure 8. Commissioned Sample photo

As the contents of the shower filter, including mugwort, were eluted, the water passing through the shower filter decreased the transparency of the water in the container containing the shower filter over time.

However, as shown in figure 3, fungi not detected in contents of mugwort shower filter. And as shown in figure 6, 7, and 8, confirmed that fungi did not grow by fungi incubating experiment with the samples suspected of fungi appears. Therefore, this paper proved that the case reported about mugwort shower filter was not true through officially approved experiment

4. Result

The mugwort shower filter began to produce since February 2019. The product in the issue was unable to check the fact about the generation of fungi as it was discarded by the user. Considering

Figure 9. Wet Mugwort Powder

the service life of shower filter is 2~3 months, conducted the fungi generating experiment for 8 months. Also check the infection of unused shower filter.

The fungi generating experiment was carried out with a shower filter containing mugwort under the condition similar to actual shower room's by maintaining the humidity and temperature. The experimental group (mugwort shower filter) and the control group (common shower filter) were randomly selected 6 each. The experimental period was set to 1st week, 2nd week, 3rd week, 1st month, 2nd month, 3rd month, 6th month, 8th month. As the result, fungi did not generate inside all 12 filters. The fungi formed only around the container containing the shower filter.

Considering the possibility that fungi may exist inside the shower filter, to determine whether unused shower filter products are infected, commissioned the experiment to the Korea Chemical Research Institute (KTR), a third trust agency. As a result, aerobacter (bacteria, fungus), staphylococcus aureus, pseudomonas aeruginosa and colon bacillus were not detected.

January 28, 2020, two products with similar case were reported. Commissioned Korea Standard Test Researcher (KSTR) to conduct additional fungi generating tests with the product. As a result, confirmed that fungi did not grow.

5. Conclusion

The results of three experiments, fungi generation over 8 months, checking infection of unused

shower filter and fungi generation with the reported products which are similar case with the issue, show that fungi not generate in shower filter. This appears to be due to the strong acidity (pH 2.6) inside the filter.

Figure 9 is the figure of beaker which sprayed water inside beaker and sprinkled the powder on the wet surface. the appearance looks similar with the reported photo, figure 1. A review of the preceding facts shows that the report of fungus in the mugwort shower filter reported in April 2019 is not true. This appears to be a misrecognition due to similar appearance. To improve the misrecognizing situation, in the process of manufacture of shower filters, the percentage of mugwort extract shall be reduced from the previous 4% to less than 2%, which is half the level. This paper will be used as a basic data for the people's health.

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