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Research Article

STUDY THE EFFECT OF HAIR STYLE PRODUCTS ON THE QUALITY OF DOMESTIC WASTEWATER- WAX AS CASE STUDY

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ABSTRACT

People have used personal care products throughout history. Hair cosmetics are among the most common and widely used products. In this study, the effect of WAX and shampoo, which are hair cosmetics, on domestic wastewater pollution were investigated separately and together. The study consists of two stages. In the first stage, Chemical Oxygen Demand (COD) and hydrogen concentration (pH) of WAX, shampoo and WAX + shampoo were analyzed. COD results were 1096 mg / L, 584 mg / L and 1896 mg / L, respectively. In the second stage, these products (0.1 g WAX and 0.1 g shampoo) were added separately and jointly to 2g of human raw hair. In this stage, wastewater was prepared by shaking sample of hair in 100 mL water for 30 minutes. The concentrations of COD were 1296 mg / L, 592 mg / L and 1328 mg / L, respectively. The PH increased from 7.3 to about 8 after adding cosmetics. The experiments showed that the added WAX to the hair is reduced by 40% by weight in 25 °C and 30 minutes. In order to quantify and realize the human habits of using such hair cosmetics during the day, a questionnaire was prepared and distributed to 385 of people. It was found that 43% of the people used WAX and 45% of them used this product every day. Accordingly, this study have been investigated only WAX and shampoo, keeping in mind that chemicals used for cosmetic purposes have been found enormous effects on domestic wastewater.

Keywords: Domestic Wastewater; Hair-style Products; Shampoo; Human Hair.

1. INTRODUCTION

Wastewater can be defined as any used liquid discharged into the environment and can harm it. It can be divided by mass to water which forms (99.9%). The residue part (0.1%) can be normal and industrial compounds which can be called as contaminants (Templeton & Butler, 2011).

Hair is very important to the human, it covers the human skin. Also, it protects the human body from the environmental factors and the injuries (Bouillon & Wilkinson, 2005). Follicles producing keratinized cells which form the hair shaft (Robbins, 2012). Hair elasticity caused by the presence of keratin (Marsh, et al., 2015). The hair shapes differ from individual to another but in general, it has a shape of an elongated cylinder. The hair diameter can vary between 45-110µm (Yin, et al., 1977).

In order to preserve hair shape, chemical products such as (WAX, Sprayetc.) were used by the human. When applying and drying these materials it causes a film on the hair surface which causes a stable shape (Bouillon & Wilkinson, 2005). Many factors affecting this process such as human habits, environmental conditions, etc. but the main factor is the time needed to conserve the shape of hair (hairstyle) (Bouillon & Wilkinson, 2005).

According to Schueller and Romanowski (2000), the main agent of hair styling product is the polymer (Schueller & Romanowski, 2000). The polymers can be one of these major categories: Non- ionic Polymers, Anionic Polymers, Cation Polymers, and Amphoteric Polymers (Frosch, et al., 1994).

WAX as one of the popular conditioner products which helps in maintaining the shape of the hair. It has an anhydrous base which can be formed from fat or emulsions. In both cases, WAX behaves as thickeners and hardeners because of the effect of fatty phases (Bouillon & Wilkinson, 2005). The problem is in removing the fats from hair, in order to deal with that, there are many products were used. The shampoo is a preferred product for human hair washing. The effect of these components (WAX and shampoo) on the domestic wastewater should be studied.

This paper aims to find the effect of using hairstyle products (especially WAX) on the quality of the domestic wastewater. Also, the effect of the shampoo on domestic wastewater was taken into the scope of this study.

2. MATERIAL AND METHOD

2.1. Material

In this study the effect of hair cosmetics (WAX and Shampoo) on the domestic wastewater was assessed. The main materials (WAX, shampoo and raw- clean human hair) were used in this research. WAX is the product used for men hair style while the shampoos are the preferred product for human hair washing. The above three component were collected from barber salon. Raw-clean hair (RC-Hair) was collected from people who have never used cosmetics, bleach or dies before, while WAX and shampoo were randomly selected with no brand discrimination was made.

2.2. Method

To study the effect of hair cosmetics on domestic wastewater, the following procedure had been followed:

2.2.1. People habits of using WAX and shampoo exploration

To explore people habits of using WAX and shampoo in Yenişehir –Mersin, field surveys were conducted to collect required information from barber salon and community. In order to facilitate this mission two simple and definite questionnaires were prepared for barber saloon and the community.

In this research, 95% confidence level and 5 confidence interval were achieved by distributing 385 questioners to the community Eq.(1). The collected data were used for analyzing and estimating the percent of WAX users in the sample area.

$$SS = \frac{Z^2 \times P \times (1 - P)}{C^2} \quad (1)$$

Whereas: SS: sample size, Z: Z-Value, P: Percentage of population picking a choice, C: Confidence interval.

2.2.2. Sample Preparation

Four samples were prepared as control groups (only WAX, only shampoo, only hair, shampoo, and WAX). Other three samples were prepared in the presence of human hair (Table 1). The hair samples were washed with distilled water and then dried for 24 h at the room temperature. All the work had been done in a tap water medium to simulate the real situation.

Table 1: Experimental design

No.	Experiment	Constituents (g/ 100 mL water)	Method of application (shaken for 30 min at 150 rpm)
1	WAX	0.1	WAX was dissolved in water.
2	Shampoo	0.1	Shampoo was dissolved in water.
3	WAX	0.1	A mix of shampoo and WAX were dissolved in water.
	Shampoo	0.1	
4	Raw-Clean Hair	2.0	Human hair was washed in water.
5	Shampoo	0.1	Human hair was washed with shampoo and water.
	Raw-Clean Hair	2.0	

6	WAX	0.1	Human hair was treated with WAX, waited to dry for 30min in room temperature, and then washed in water.
	Raw-Clean Hair	2.0	
7	WAX	0.1	Clean human hair was treated with WAX, waited to dry for 30 min in room temperature, and then treated with shampoo and then washed in water.
	Shampoo	0.1	
	Raw-Clean Hair	2.0	

2.2.3. Analysis

Closed Reflux, Titrimetric Method (5220 C) was used in order to find Chemical Oxygen Demand (COD) (AWWA, WEF, APHA, 1998). pH was measured before and after shaking. The volatile value of WAX (vvWAX) was calculated Eq. (2).

$$vvWAX = [aWAX] - [rWAX] \quad (2)$$

Whereas:

[vvWAX]: Volatile value of WAX;

[aWAX]: Amount of WAX applied to the hair;

[rWAX]: Amount of remaining WAX after 30 min.

3. RESULT AND DISCUSSION

3.1. Questionnaire's results

The used WAX in Yenişehir –Mersin data was collected from questionnaires (community and barber). For the community questioners, it showed that 61% of the sample were washing their hair every day which is 1.6 higher than the percentage obtained by (Ficheux, et.al, 2016) for French people for the same washing time. While 30% were cleaning it one time every two days, 8% one time every three days and just 1% are washing it one time every week (Figure 1).

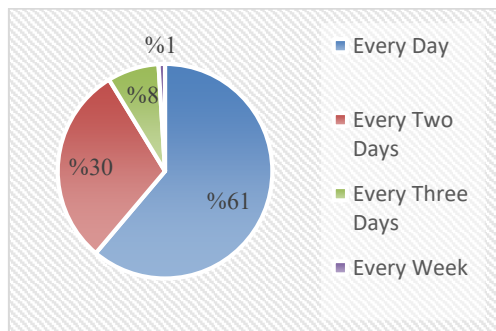


Fig. 1. Shows the hair washing rate.

The hairstyle users' percentage was 43% while the nonuser's percentage was 57% (Figure 2).

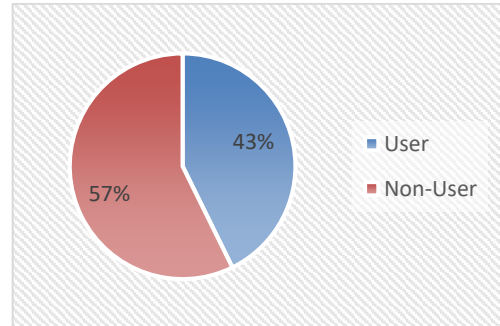


Fig. 2. Shows the hair style products user percentage.

It also showed that 45% of hairstyle users were using it every day, while 27%, 21%, 7% are using it every two days, three days, every week respectively (Figure 3).

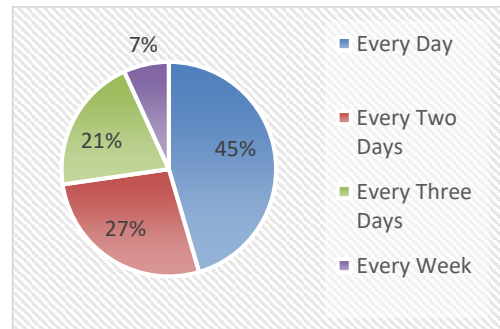


Fig. 3. Shows hair style product using rates.

The questioners showed that 80% of the community is using shampoo as washing material while as 13% using soap and 7% using both (Figure 4). In Turkey, there is no record for quantifying of WAX or such cosmetics, but according to U.S EPA annual report (2002) cosmetics annuals imports and productions increased by ten times for the last twenty-five years (U.S. Environmental Protection Agency (U.S. EPA), 2002). In China, there are more than 20000 kinds of cosmetics, the exportation reached 437000 tons, and the importation amount was 74000 tons (Editorial Department of D&C, 2015).

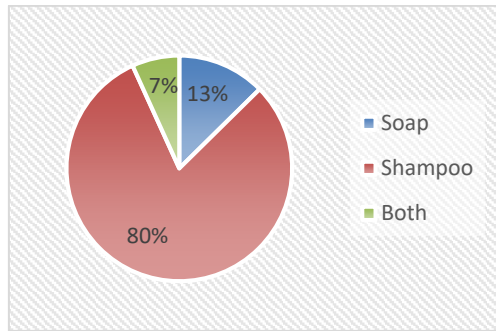


Fig. 4. Shows hair washing material.

3.2. COD and pH results

The samples were tested in terms of pH and COD as described in material and method section. The pH for all samples after shaking process varies from 8.0 to 8.3. These values are close to the result of other researches. Ma and Chen (2018) have studied the characteristics of cosmetic wastewater. They found that the pH values range from 8.6-8.7 (Ma & Chen, 2018).

Minimum pH and COD values were noted in the combination human hair with water tap and they were 8.0 and 504 mg/L respectively. While the maximum pH and COD values were noted in the combination (human hair, WAX, and Shampoo) where they were 8.3 and 1896 mg/L respectively. It was noticed that approx. 40% of WAX was volatile, even though that presence of

small amount of WAX caused a relatively high COD value. The cosmetic wastewater may cause a high level of COD. It can be larger than 100000 mg/l (Jan Bogacki et.al, 2011). Ma and Chen (2018) have found the COD value concerning a certain product. It was 5490 mg/l (Ma & Chen, 2018).

The pH results of the combinations consisting of Shampoo reflect the formulation conditions of shampoos, which are near neutrality (Robbins, 2012). COD results for the same group can be explained by the sorption capability of hair, which depends on the relationship between the interaction with keratin (binding or attraction) versus hydrophilicity (Robbins, 2012).

This paper suggests that a significant amount of shampoo have remained at the tested hair, and the hair should be rewashed to extract the total amount of shampoo. Unfortunately, this amount had not been determined in this paper.

It is noticed that whenever shampoo was mixed with WAX, the COD values become higher than using WAX alone. The possible explanation implies that the shampoo might expedite dissolving WAX in the water and causing relatively high COD values. These results reflect the capability of anionic surfactant shampoos in aiding removal of fats and WAX'es (Bouillon & Wilkinson, 2005).

The test results of the other combinations can be shown in Table 2.

Table 2: Combinations Results

NO.	Combination	Hair (g)	Water (mL)	Wax (g)	Shampoo (g)	pH	COD (mg/L)
Ref	Tap Water		100			7.3	25.0
1	Wax		100.0	0.1		8.1	1096.0
2	Shampoo		100.0		0.1	8.2	584.0
3	Wax + Shampoo		100.0	0.1	0.1	8.3	1896.0
4	RC Hair	2.0	100.0			8.0	504.0
5	Shampoo + RC Hair	2.0	100.0		0.1	8.1	592.0
6	Wax + RC Hair	2.0	100.0	0.1 *		8.1	1296.0
7	WAX +Shampoo + RC Hair	2.0	100.0	0.1*	0.1	8.1	1328.0

* This is the weight of WAX before volatilization average and after the volatilization is 0.0608g.

4. CONCLUSION

The effects of the hair care product WAX and shampoo were examined on the domestic wastewater in this paper. It had been found that 40% of WAX volatilized in 30 minutes after applying to the hair, at room temperature, even though the residue part caused an increase of COD to 1328 mg/L. Shampoo could increase the COD to 584 mg/L when applying it directly to the water. When applying it to the hair shampoo should be washed more than one time to have the exact amount of COD.

It has been assumed that no WAX residue on the hair. In future researches, this assumption should be verified and the other parameters like turbidity, toxicity,

total solids, etc. could be controlled. The experiments were accomplished in normal water temperature (18 °C) the effect of water temperature on the solubility of WAX's water should be examined.

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