The use of sanitary pads and menstrual cups and their impact on environment

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***Abstract*— This article presents the identification and evaluation of the impacts generated during the use and disposal of sanitary Pads and menstrual cups. The methodology adopted for the environmental assessment is based on the Conesa methodology [4]. Likewise, to determine the environmental significance based on the evidence or probability of occurrence, laboratory analyses were conducted to evaluate some physicochemical parameters to two human menstrual blood samples and the amount of solid waste generated by the use of each was determined for each one of these products taking into account a population sample. As a result, the quality of the disposed liquid waste was determined; that is, menstrual blood, and possible impacts were identified on the biotic, abiotic, and socio-economic media, which were compared for each one of the products. The most relevant negative impacts were "*Alteration of the local economy*" present in the activity called disposal of sanitary pads' solid waste and "*customs*" present in the activity called the use of menstrual cups.**

Keywords—environmental contamination, menstrual cups, environmental impact, sanitary pads.

I. INTRODUCTION

Women all over the world live through on the of the most controversial physiological processes in their lives, as they all experience menstrual cycles in different manners. While some see it as a wonderful gift of nature, others suffer through it and wish it would never occur, among other things because they are afraid of bleeding. Regardless of each experience, the reality is that there is an industry which has historically been in charge of manufacturing all kinds of products such as: sanitary pads, tampons, menstrual cups, menstrual discs, reusable pads, water-proof underwear, etc.; some of them are more popular than others, but they all have the same purpose in the end: to make those "red days" stain-free days. In terms of the latter claim, have we ever stopped to think of the environmental impact of these products? Do we actually know what synthetic compounds and toxic agents are used in their fabrication? It appears to be like that, but the reality is different.

According to the International Standards Organization [7], the lifecycle of any product corresponds to multiple interdepending systems that should be taken into consideration (every process is linked to a subprocess and so on). Life Cycle Analysis (LCA) is a process that allows to assess the environmental loads associated to a product, process, or activity.

Due to scarce studies in LCA for sanitary pads and menstrual cups, the project shown in this article is limited to the environmental impacts generated during the stages of use and waste disposal through surveys, the laboratory analysis performed on two [3] samples of human menstrual blood for the physicochemical parameters shown in **Table I**, and the evidence or probability of occurrence of the assessed impacts that determine the Environmental Impact Importance – EII, supported by articles and recent studies that determine the presence of toxic agents in human menstrual blood [8].

TABLE I. PHYSICOCHEMICAL PARAMETERS AND THEIR MAXIMUM PERMISSIBLE LIMIT VALUES

Parameter	*Unit*	*Permissible value*
Chemical Oxygen Demand (COD)	mg/L O2	180,00
Biochemical Oxygen Demand (BOD)	mg/L O2	90,00
pH	pH units	6,00 a 9,00
Temperature	°C	□ 40°C*
Turbidity	UJ - NTU	10,00 - 189,00*

Source: Article 8 Resolution 631 of 2015 and Decree 1076 May 26 of 2015.

II. METHODOLOGICAL PROCESS

A. Methodology for assessing environmental impacts

The methodology used to identify and qualify impacts in based on the one performed by Conesa [4] to establish the environmental impact importance. It is related to the Risk Assessment Matrix (RAM), to find the environmental significance of impacts according to their evidence or probability of occurrence.

The Environmental Impact Importance (EII), was performed with the sum of the ratings given to each of the parameters: Intensity (I), Moment (MO), Extension (EX), Moment (MO), Persistence (PE), Reversibility (RV), Recoverability (MC), Synergy (SI), Accumulation (AC), Effect (EF) and Periodicity (PR). The result of the IAI is given by the following equation:

$$EII = (C \pm) (3I + 2\,EX + MO + PE + RV + SI + AC + EF + PR + MC).$$

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Taking into account the result of the EII, the Consequence Scale corresponding to the range calculated between 1 and 4 is identified with levels of importance (1) Mild, (2) Moderate, (3) Severe and (4) Greate.

The Evidence or Probability of Occurrence (A. Little evident, B. Moderately evident, C. Evident, D. Very evident and E. Outstanding) is the variable that conditions all the qualification of the parameters that determine the EII, to the evidence or the possibility or certainty that the impact will occur. The value of the Environmental Significance of the Impact (ESI) is obtained from the result of the Environmental Importance of the Impact (EII), based on (§) of the Evidence or Probability of Occurrence (E, P); It is classified as Very Low, Low, Medium, High and Very High and is given by the following equation:

$$ESI=(EII).§.E,P$$

B. Data collection through surveys

Considering the low popularity of menstrual cups in Colombia and aiming at identifying their associated impact, a survey was performed among the female population at Escuela Colombiana de Ingeniería "Julio Garavito". The target population will be composed by fertile females, ages 16 to 48, from a sample framework of 30 students. [1].

The survey design, which was prepared through Google Docs server with the following questions:

- What is your age range?
- Do you know what menstrual cups are?
- Of the following products, which one do you use or have you used?
- How long have you used or use that product?
- How many sanitary towels do you use for each menstrual cycle?
- Which product do you think generates the least environmental impact?
- What is the management that you give to this type of waste?

C. Methodology to collect the specific sample for physicochemical laboratory analyses

The activities to collect menstrual blood samples were done directly from two volunteers, as suggested by the laboratory.

1) Sample selection

Two menstrual blood samples were collected for the analysis of physicochemical parameters described in **Table I**, bearing in mind the information from **Table II**. Additionally, laboratory analyses were performed complying with the ethical principles of the volunteers, who signed an informed consent form.

TABLE II. SAMPLE GENERALITIES

Id	Age	Location	Menstrual flow amount	Health state	Observations
M1	40	Bogotá (CDM)	Normal	Good	The volunteer has been using a menstrual cup for about 10 years.
M2	27	Soacha (CDM)	Normal	Good	The volunteer has regularly used sanitary pads during her menstrual cycle for about 10 years.

2) Sample collection

Sample collection was performed on May 15, 2018 for M1, 15ml, and on May 17, 2018 for M2, 10ml. As the sample had to be collected in less than 24 hours, menstrual cups were used.

III. RESULTS

A. Impact identification and assessment matrix

1) Impact identification

The matrix was built from the desegregation of the activities chosen within each product's life cycle, as this analysis would only be carried out for the use and disposal stages, as illustrated in **Fig 1**.

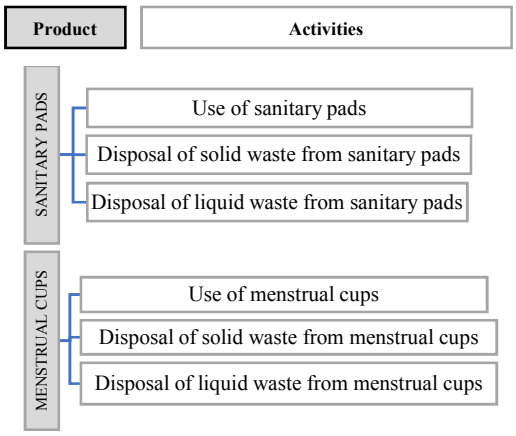

Fig. 1. Activities Desegregation. [1]

Once the life cycle's stages and activities desegregation was obtained, the classification into means, components, elements, and impacts was performed, as illustrated in **Fig 2**.

Subsequently, each impact is qualified through the proposed methodology, obtaining the importance level from the calculation of the environmental importance and the consequence scale. Likewise, the impact significance assessment is obtained based on the importance level and the evidence or probability of occurrence of the impact.

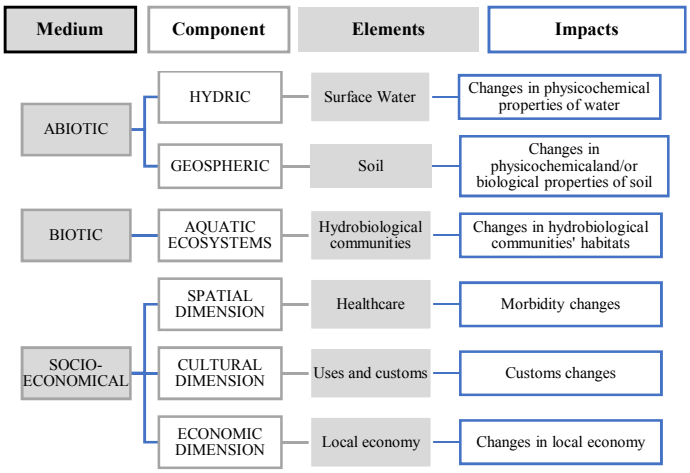

Fig. 2. Environment Desegregation. [1]

2) Impact assessment and analysis

a) Abiotic medium

Changes in physicochemical properties of water: It means a change in the bodies of water. Wastewater generated by the use of menstrual cups (menstrual blood) are characterized for having high BOD and COD and, in some cases, it can carry toxic compounds such as methylparaben and benzophenone-3 [8].

During the disposal of solid and liquid waste generated by each of the products under study. The two products present this negative impact, with a Moderate level of Environmental Importance of the Impact (EII), evidence rated A and an Environmental Significance of the Impact (ESI) Medium.

Changes in physicochemical and/or biological properties of soil: This impact was identified during the survey stage, as females either follow different criteria to dispose solid waste generated by sanitary pads, or they simply do not care.

During the disposal of solid and liquid waste generated by each of the products under study. The two products present this negative impact, with a Moderate level of Environmental Importance of the Impact (EII), evidence rated A and an Environmental Significance of the Impact (ESI) Medium for the disposal of solid waste from sanitary pads. Moreover, a level of Environmental Importance of the Impact (EII) Mild, evidence rated A and a mean Environmental Significance of the Impact (ESI) for the disposal of liquid waste from sanitary pads and the disposal of liquid waste from menstrual cups.

b) Biotic medium

Changes in hydrobiological communities' habitats: They are conformed by ecosystems wherein different hydrobiological communities can be found, containing animal and vegetal species, as well as micro and macro organisms that inhabit, in close relationship, the aquatic means. Any alteration in these components can produce important changes in the habitat's structure potentially affecting the abundance and distribution of aquatic species.

During the disposal of the waste generated from each of the products under study. The two products present this impact negatively, with a level of Environmental Importance of the Impact (EII) Mild, evidence rated A and an Environmental Significance of the Impact (ESI) Medium.

c) Socio-economic medium

Changes in morbidity: It occurs in line with the increase or decrease of number of females who have suffered from health issues related to the use of such products, such as: allergies, pH alteration, infections, among others.

Allergies: Allergies, as a result of using the products studied in this paper, can be inflammatory skin or mucous reactions around female genitalia caused by external agents, especially the products' raw materials. Among these allergies, the following can be accounted for: Contact Irritation Dermatitis, Contact Dermatitis Allergies, and Vulvovaginitis. Some medical professionals state that Contact Irritation Dermatitis is a pathology commonly activated by chemical substances found in products such as sanitary pads [11].

pH alteration and increase in infections: Using products such as sanitary pads is on the rise, and some professionals are concerned as they are linked to increased vaginal flow as a result of pH alterations, the increase of vaginal infections, and even a risk of suffering from more serious issues such as septic shock syndrome [9].

During the use of each of the products under study. The use of sanitary pads presents this impact negatively, with a Moderate level of Environmental Importance of the Impact (EII), evidence rated B and a Medium Environmental Significance of the Impact (ESI). On the other hand, the use of menstrual cups presents a positive impact, with a level of Environmental Importance of the Impact (EII) Moderate +, evidence rated C and an Environmental Significance of the Impact (ESI) Medium.

Change in customs: Menstrual cups are far from being novel as their manufacture started in the early 20th century, and the Museum of Menstruation and Women's Health in Maryland (USA) claims that there were rudimentary menstrual cups in 1867. However, varying commonly used products, highly publicized and offered in the market such as sanitary pads with menstrual cups requires some time, recognition, and practice, as current female population has become accustomed to using these types of products, and replacing them with menstrual cups might change customs.

Taking into account the popularity of sanitary pads and that women are already used to their use; for the present evaluation, the impact identified as "change in customs" was applied only to menstrual cups during the activities called "use of menstrual cups" and "Disposal of solid waste". For the first activity the impact is negative, obeys a Moderate level of Environmental Importance of the Impact (EII), with evidence rated B and an Environmental Significance of the Impact (ESI) Medium. For the second activity the impact is positive, obeys a level of Environmental Importance of the Impact (EII) Moderate, with evidence rated B and an Environmental Significance of the Impact (ESI) Medium.

Changes in local economy: Regarding the demand of the studied products, it is important to consider that using sanitary pads requires women to spend money along their fertile life, thus becoming a negative impact on costs when compared with the

use of menstrual cups. Gignac recently wrote an article in a popular newspaper in Toronto stating that "the cost to end "period poverty" would amount to 1.9 million dollars (enough money to manufacture menstrual hygiene products -sanitary pads and tampons- for around 22,000 women in shelters and low-income schoolgirls in Toronto) [6].

Although a menstrual cup costs much more than a pack of sanitary pads, the first one lasts for 10 years, while the second lasts about a cycle.

Therefore, if this impact is compared taking into account the use of the products, we have that for sanitary pads the impact is negative, obeys a Moderate level of Environmental Importance of the Impact (EII), with evidence rated C and an Environmental Significance of the Impact (ESI) Medium. While for menstrual cups, the impact is positive, due to a level of Environmental Importance of the Impact (EII) Severe +, with evidence rated B and an Environmental Significance of the Impact (ESI) Low.

On the other hand, if the disposition of the two products is compared, it is obtained that the handling of solid waste from sanitary pads and the materials of which it is composed (43% of wood pulp, 12% of absorbent polymer, 31 % of polyethylene and 14% between adhesives and elastics. Alters the local economy in a negative way due to their volume, for this case it is presented that the impact is negative, with a level of Environmental Importance of the Impact (EII) Moderate, evidence rated A and an Environmental Significance of the Impact (ESI) Medium.

B. Survey results analysis from the student community

68% of the surveyed population varies from between 20 and 30 years, 18% are women with an age range between 30 and 40 years, 7% are women under 20 years and 7% are women over 20 years.

In addition, although more than 96% of the women surveyed believe that menstrual cups generate less environmental impact, ignorance of the operation of this product creates mistrust.

The number of sanitary pads you use in average a woman during each menstrual cycle is 11 units and a volume of solid waste per year of 832 g.

C. Laboratory results analysis from the menstrual blood sample.

Table III shows the results of the physicochemical characterization performed on samples M1 and M2 respectively.

The results obtained were compared with the permissible values of Resolution 631 of 2015.

The COD and BOD concentrations of the samples present values that triple the permissible COD value in domestic wastewater and in non-domestic wastewater derived from service activities (hospital setting).

The pH parameter is within the established limit and the temperature registered a value of 25.5 ° C and 24.5 ° C, respectively, these being ⩽ 40 ° C allowable.

The turbidity recorded in samples M1 and M2 are greater than 1000 NTU and exceed the allowable value for domestic wastewater.

TABLE III. PHYSICOCHEMICAL PARAMETER RESULTS SAMPLES M1 AND M2

PARAMETER	UNID	METHOD [2]	RESULT M1 [3]	RESULT M2 [3]
Chemical Oxygen Demand (COD)	mg/L O2	S.M. 5220 C	543	569
Biochemical Oxygen Demand (BOD)	mg/L O2	S.M.5210 B-ASTM D888-09 MET.C	304	384
pH	pH units	S.M 4500-H+ B	7,29	7,31
Temperature	°C	S.M. 2550-B	25,5	24,5
Turbidity	UJ - NTU	S.M 2130-B	>1000	>1000

Contamination indices ICOpH and ICOTEMP for blood samples M1 and M2 were determined, which allowed to quantify their impact on a body of water, obtaining Very Low (ICOpH) and Very High (ICOTEMP) classification values. [10].

IV. CONCLUSIONS

A survey performed with 28 women from Escuela Colombiana de Ingeniería Julio Garavito allowed to determine that most of the female population use sanitary pads during their menstrual cycles and despite the fact that 71% of respondents know menstrual cups (close to 96% of them believe they have a lower environmental impact) they do not use them.

According to the results of the survey, it was possible to determine that a woman uses, on average, 11 sanitary pads during each menstrual cycle, generating 832 grams of solid waste a year and 8,320 grams in 10 years (useful life of a menstrual cup). Using a menstrual cup (about one in ten years) generates fewer than 100 grams of solid waste.

Considering the environmental assessment, it could be determined that during the use and disposal of the two products under study, sanitary pads generate more negative impacts than menstrual cups, and the latter are mostly environmentally friendly, generating positive impacts in the socio-economical medium in the spatial and economic components. These effects occur especially on the health and local economy elements.

A larger sampling is required to analyze the impact of punctual discharges that are made by the menstruation of women in public sewers.

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