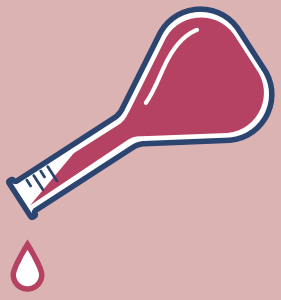
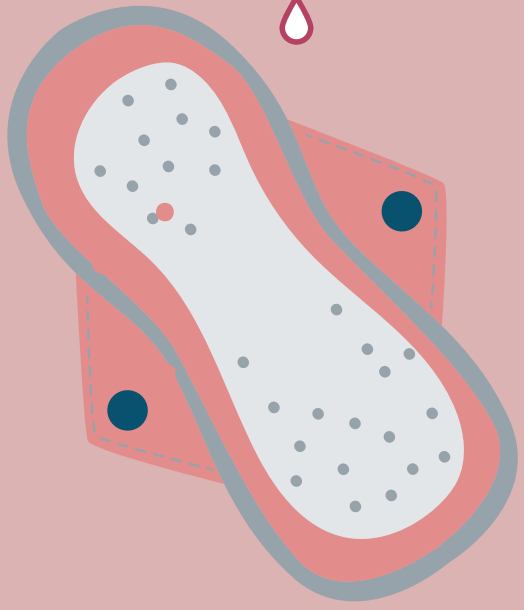
Toxics Link
for a toxics-free world

WRAPPED IN SECRECY

TOXIC CHEMICALS IN MENSTRUAL PRODUCTS





A REPORT BY TOXICS LINK

About Toxics Link

Toxics Link is an environmental NGO, dedicated to bringing toxics related information into the public domain both relating to struggles and problems at the grassroots as well as global information to the local levels. We work with other groups around the country as well as internationally in an understanding that this will help bring the experience of the ground to the fore, and lead to a more meaningful articulation of issues. Toxics Link also engages in on-the ground work especially in areas of municipal, hazardous and medical waste management and food safety among others. We are also involved in a wider range of environmental issues in Delhi and outside as part of a coalition of non-governmental organizations.

Our work on Bio medical waste management has spanned over 20 long years, entailing significant diverse body of work such as policy engagement, improving on ground compliance to the rules, involved in setting standards, creating models in healthcare facilities, ongoing research on occupational safety, training and capacity building of all stakeholders and creation of training modules. The Toxics-Free Health Care programme of Toxics Link has worked extensively for ensuring responsible health care practices and use of safer technologies in India, and strong commitment to a clean and safe environment. The programme aims to green the healthcare practices in the country.

Acknowledgement

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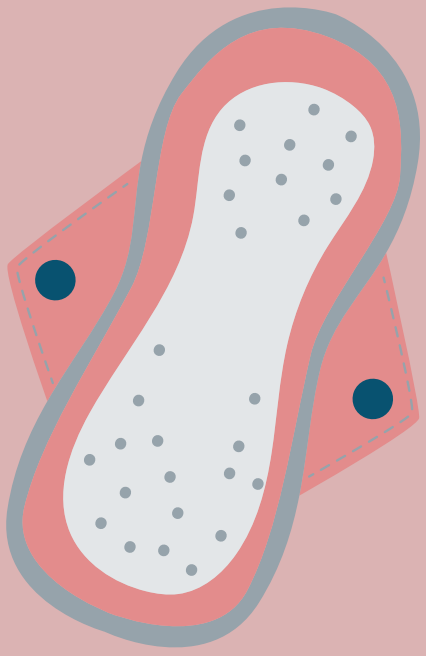
Contents

Abbreviations

BBP	Butyl-benzyl phthalate
CAGR	Compound annual growth rate
CMR	Carcinogenic, mutagenic & reprotoxic
DMP	Di-methyl phthalate
DEP	Diethyl phthalate
DnBP	Di-n-butyl phthalate
DEHP	Di (2-ethylhexyl) phthalate
DnOP	Di-n-octyl phthalate
FDA	Food and Drug Administration Agency
FHPs	Feminine hygiene products
J&J	Johnson & Johnson
P&G	Procter & Gamble
PCPs	Personal care products
SAP	Super absorbent polymer
SDG	Sustainable Development Goal
TCC	Triclocarban
THF	Tetrahydrofuran
USEPA	United States Environmental Protection Agency
VOCs	Volatile organic compounds

Introduction



EVERY MONTH, AROUND 1.8 BILLION PEOPLE ACROSS THE WORLD, INCLUDING GIRLS, WOMEN, TRANSGENDER MEN AND NON-BINARY PEOPLE, GO THROUGH THEIR PERIOD

Menstruation is a monthly process in which the lining of the uterus sheds blood and tissue through the vagina. In common parlance, this is often referred to as 'period'. This cycle begins when a girl reaches puberty (menarche), which is commonly between 10 and 13 years of age, and continues until the end of her fertility period (menopause), typically between 45-55 years of age. Every month, around 1.8 billion people across the world, including girls, women, transgender men and non-binary people, go through their period[1]. This monthly routine usually lasts two to five days every time, but this varies from person to person. A number of taboos are attached to a natural and healthy process such as menstruation. Cultural taboos, discriminatory social norms based on gender, socio-economic status and lack of basic facilities such as toilets and availability of clean water can all result in the overlooking of menstrual health and hygiene needs.

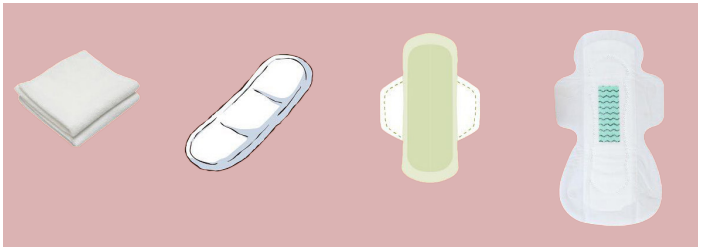
In 2016, sanitary pad sales in the country went up to 5.12 billion pieces, which was expected to grow to 10.81 billion pieces by 2021

Menstruators need safe menstrual products that help them in carrying out their daily activities without physical limitations. Though, historically, natural products were used during menstruation, necessity and availability of new materials led to the invention of new menstrual products. Currently, disposable sanitary pads are the most popular menstrual products worldwide. Most menstruators use sanitary pads as a first-choice product for an estimated average of 1,800 days in their lifetime.[2] In recent years, among other changes, synthetic plastic materials have been added to sanitary pads as liquid absorbent. This is meant to enhance functioning and improve softness. Another addition to the many commercially available sanitary pads is fragrance, in order to provide the user a feeling of freshness. Now there is a growing concern that some of these chemicals, which are component of sanitary pads, may affect user's health.

1.1 History of sanitary pads

Sanitary pads find a mention quite early on, dating back to 10th-century Greece. But the very first disposable pads were created by nurses because of the need to stop or control excessive bleeding, mainly on the warfront. The first pads, made in France by nurses, used wood pulp as the material was very absorbent, and cheap enough to throw away afterward. This idea was taken up by commercial manufacturers, who came up with disposable pads in the late 1800s. In the early days, commercial disposable pads were usually made of cotton wool or another fibrous material that was coated with an absorbent liner. The front and back ends of the liner were lengthened to fit through loops in a customised girdle or belt worn beneath underwear. Since this type of pad would keep shifting from its position, fastening adhesive was added to the

FIGURE 1: CHANGES IN SANITARY PRODUCTS



back sheet at around the 1970s. A major improvement was made with the addition of superabsorbent gel particles in the absorbent core. It increased capacity and quick absorption of the menstrual flow, providing more mobility and comfort to users. Even though sanitary pads have been available commercially for a long time, most women couldn't afford them for years. They continued to use more traditional techniques. But over time, disposable sanitary pads have become commonplace and are currently the most popular option.

1.2 Market share of sanitary pads

In India, the sanitary pad market has increased rapidly over the last two decades. In 2006, the number of pads sold was close to 1.25 billion; with the number of sanitary pads sold doubling every five years in India. In 2016, sanitary pad sales in the country went up to 5.12 billion pieces, which was expected to grow to 10.31 billion pieces by 2021.[3] However, no current data is available on the exact number of pads sold in 2021.

In terms of value, in 2020, the size of Indian sanitary pads market was worth USD 521.5 million approximately and this is expected to grow at a CAGR of 11.5% between 2021 and 2027 to reach around USD 1,185 million by 2027. The Indian sanitary napkin market, currently, is dominated by multinational giants P&G and J&J. According to a 2016 report by Euromonitor International, P&G's Whisper holds a market share of 50.4% in India in terms of sales, followed by J&J's Stayfree at 23% (with higher usage in rural areas) and Kimberly Clark Corp's Kotex at 2.2 %.

FIGURE 2: THE INDIAN SANITARY MARKET FORECAST 2021-2027

1.3 Composition of sanitary pads

Since the time of inception, sanitary pads have undergone several changes. Early sanitary pads were made mostly of flannel or woven fabric. Then came the sanitary pads made with gauze and cotton. Later, the sanitary pads began to be manufactured using cellulose, which had a higher absorption power than cotton pads. These superabsorbent pads underwent further modification in the form. First came the belt pad, which was soon replaced by the beltless pad with adhesives. More recent additions to the sanitary pads include fragrance.

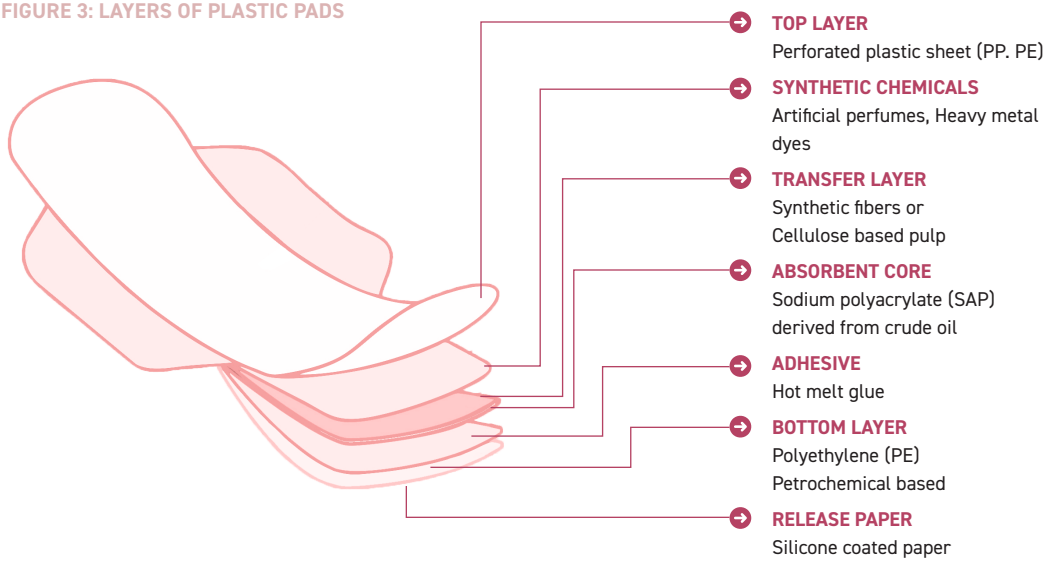
The plastic upsurge, in last few decades, changed the way sanitary napkins are designed and made. Over the years, the plastic content of a sanitary pad has increased multifold, right from the use in top sheet and back sheet to avoid leakage, to individual packaging of each sanitary pad in order to provide discreteness. Use of Super absorbent polymer (SAP) and polyethylene for back cover made the napkins waterproof and use of polypropylene in top sheets helped keep the sanitary pad dry.

Nowadays, a typical sanitary pad can be divided into four key layers, with additional packaging plastic pouch:

- Fluid permeable top sheet,
- Acquisition layer or the Transfer layer,
- Absorbent core, and
- Impermeable backing containing glue (back sheet)

In addition to these, there are adhesives, paper releases, etc.

FIGURE 3: LAYERS OF PLASTIC PADS



Fluid permeable top sheet: It is mostly made up of a thin layer of perforated polypropylene and / or polyethylene. Being the first layer, this comes in direct contact with the skin, and its major function is transference of the gathered fluid to the layers underneath. In most commercial pads, this layer is coated with emollient and lotion, in order to prevent skin irritation and also provide softness[4].

Acquisition layer: Its primary function is to spread the fluid evenly and is composed of non-woven polyester and a cellulose patch. It also helps to transfer the fluid to the next absorbent layer.

Absorbent core: This layer acts as the main storage area for the fluid. The composition is a mix of fluff cellulose and SAP, which contain non-woven polypropylene or cellulose. SAP is made up of sodium polyacrylate granules, which turns into a gel-like substance once wet, and is capable of holding liquid more than 30 times its weight. The job of the cellulose fluff is to absorb the fluid quickly and transfer it to the SAP.

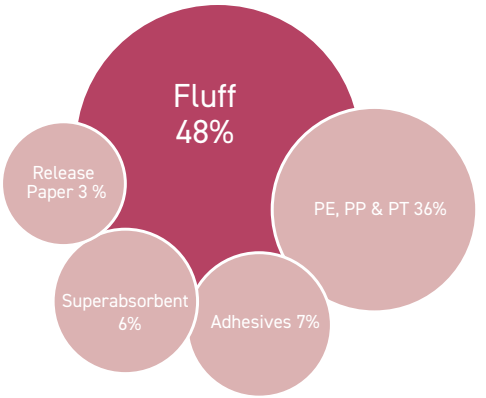
Impermeable backing containing glue (back sheet): The main function of this layer, composed of waterproof polyethylene or polypropylene laminated with non-woven polypropylene, is to prevent the fluid from leaking. Since this is the last layer, it contains adhesives to keep it fixed on cloth.

The emollient and the top sheet are in direct contact with the skin; hence it is likely that the chemicals present in this layer are directly absorbed by the skin. The acquisition layer and super absorbent layer, while not in direct contact, may have indirect interaction with the skin and lead to the absorption of chemicals. The back sheet and adhesives cause little or no exposure as they are farthest from direct skin contact (Figure 3).

FIGURE 4: EXPOSURE RISK OF DIFFERENT LAYERS OF DISPOSABLE PADS

Percentage wise, the chemical composition of sanitary pads contains the following items:

FIGURE 5: COMPOSITION OF A TYPICAL SANITARY PAD



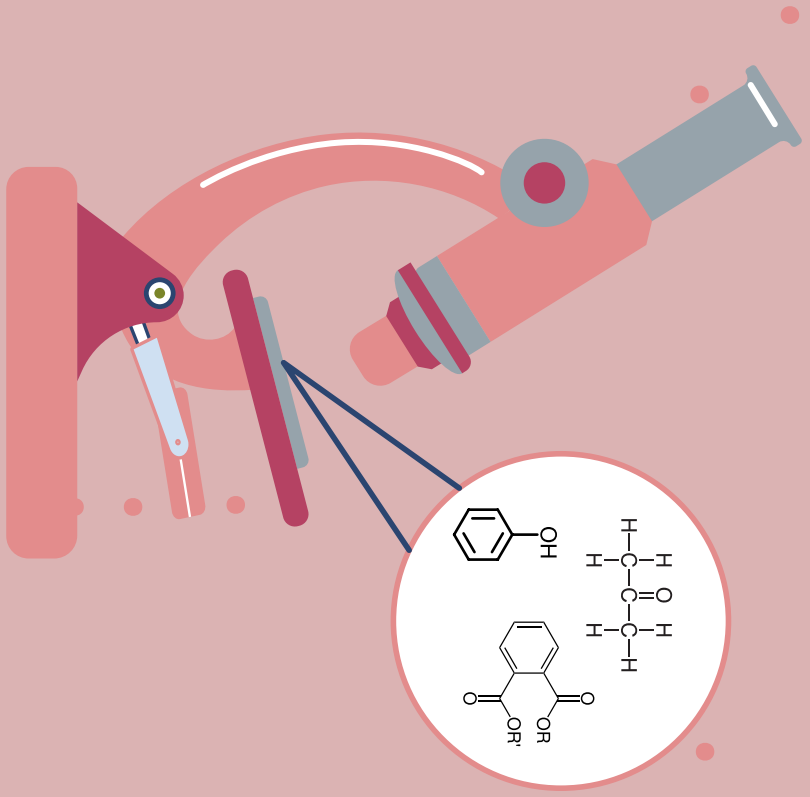
1.4 Menstrual Products & Sustainable Development Goals

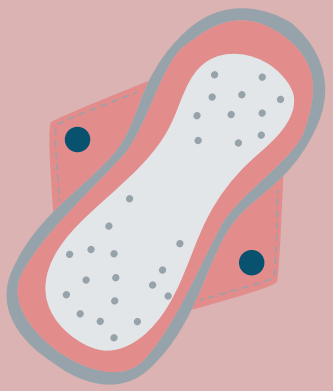
As per the Brundtland Commission, sustainable development has been defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". In 2015, the United Nations (UN) adopted Sustainable Development Goals (SDGs), also known as global goals, to achieve this end. This is a global call for action, with the primary aim of ending poverty, protecting the planet and ensuring that there is peace and prosperity across board by 2030.

Considering period poverty under SDGs, the UN, in 2018, reported that incorrect information coupled with the stigma that surrounds menstruation can lead to serious health and human rights concerns. It therefore declared menstrual hygiene as an issue that affects gender equality, human rights and public health, leading to its addition to the 2030 agenda. This can help in sustainable social and economic development that can eradicate poverty, hunger and lack of access to healthcare. The issues associated with period poverty connect to SDG 1 (no poverty), SDG 3 (good health and well-being), SDG 4 (quality education), SDG 5 (gender equality) and SDG 6 (clean water and sanitation), though it is also connected to other SDGs such as 11, 12, 14 and 15.

Access to clean menstrual products is crucial to the eradication of period poverty; it is the focus area of several menstrual hygiene programs. But SDG 3 clearly highlights good health, hence one needs to look beyond just access to sanitary products for young girls and women, and highlight the need for access to products free of toxic chemicals.

SDG 12 of 'ensure sustainable production & consumption', if applied to menstrual products, would mean producing and consuming menstrual management products which are free of toxins and single-use plastic content, It would thus bring menstrual products into the ambit of circular economy.





Toxic chemicals in sanitary Pads

Most of the commercially available sanitary pads have plastic as the main constituent; at almost 90%. Being non-biodegradable, plastic has huge environmental consequences, but the chemicals, added intentionally or present due to the processes used in the manufacture of a sanitary pad, are also a cause of concern. Sanitary pads include various chemicals which are added by manufacturers to improve presentation, functionality and consumer acceptance.

The major chemicals added during the entire cycle from manufacturer to packaging include:

a. **Plastics and plasticisers**: Synthetic plastic have been used in sanitary pads and diapers as liquid absorbents to improve functionality and softness[5]. According to health experts,[6] 'plastic in sanitary pads disturbs the balance of the vaginal microflora and can cause health problems including but not limited to uro-genital tract infection, rashes'. SAP, which are added to the absorbent core in almost all commercially available sanitary pads, are also believed to have negative effects on the health of users. Prolonged contact has been linked to skin reactions such as rash and even toxic shock syndrome. Other plasticisers of concern include bisphenols, parabens and triclocarban (TCC). Parabens are antimicrobials that are used as preservatives in feminine care products, whereas TCC is an antibacterial agent. Most of these added plasticisers are widely considered to be 'endocrine disrupting chemicals' that are known to have a negative effect on female reproductive health.[7] Exposure to parabens is linked to breast cancer while Bisphenol A (BPA) is linked to reducing the viability of germ cells involved in reproduction.

b. **Fragrance ingredients**: VOCs are added as fragrances, adsorbents, adhesives, moisture barriers and binders in feminine hygiene products. VOCs are linked to negative health effects such as endocrine disruption, infertility, birth defects and cancer.

Apart from these, some chemicals get added unintentionally as a result of processes involved in manufacturing,

- **Dioxins & furans:** Chlorine is used as bleaching agent for the fibres in pads in order to give them a clean and sterile appearance. Dioxins and furans get added as a by-product of the bleaching process of cotton.
- **Pesticide residue:** Pesticide residue is common in cotton sanitary pads.
- **Genetically modified organisms (GMOs):** The United States Department of Agriculture (USDA) states that around 94% of all cotton in the United States (US) is genetically engineered.[8]

In recent years, global studies have highlighted the presence of various toxic chemicals in sanitary pads, which may potentially harm users.

As mentioned above, sanitary pads sold commercially are designed in a way that puts some of the layers in direct contact with the vaginal area. The structure of the vulvar and vaginal tissues is different from the skin of the rest of the body; being more permeable and covered in mucous

membranes, it allows for the direct transfer of chemicals into the circulatory system. Studies show that while rapid absorption can work well for delivering a drug rapidly, it may also expose women to higher levels of chemicals from feminine hygiene products as the area of contact has a direct route to reproductive organs.

2.1 Phthalates

Phthalates or phthalic acid esters (PAES) are terms that refer to diesters of 1,2-benzenedicarboxylic acid (phthalic acid). Phthalates have been used as plasticisers to make the material softer and more flexible, increase plasticity, reduce viscosity, or reduce friction during manufacturing. Phthalates are used in various plastics since the 1930s, with DEHP (a major phthalate used in sanitary pads) accounting for a fifth of all plasticisers ever developed. The global production of phthalates went up from 2.4 million tonnes to 6 million tonnes between 2007 and 2017.[9]

Phthalates are generally added in the layers of sanitary pads to enhance the elasticity and gel properties.[10] Phthalates is also used in hot-melt adhesive, which is used to join different layers of sanitary pads.

Phthalates have become a pervasive environmental problem as a result of their widespread use in numerous industries. Phthalates are emitted or migrate throughout the whole life cycle of a phthalate-containing product, from manufacturing to consumption. Rising concern over the presence of phthalates in significant quantities in the environment and the possible toxic impact has led the United States Environmental Protection Agency (USEPA) to declare six phthalates, namely di-methyl phthalate (DMP), diethyl phthalate (DEP), di-n-butyl phthalate (DnBP), di (2-ethylhexyl) phthalate (DEHP), di-n-octyl phthalate (DNOP) and butyl-benzyl phthalate (BBP), as priority pollutants.[11]

2.2.1 ROUTES OF EXPOSURE TO PHTHALATES

Humans can get exposed to phthalates on a daily basis through ingestion, inhalation, intravenous injection and dermal contact. Most women use sanitary pads for several decades of their life, with girls starting the use at an age when their bodies are still developing and are much more vulnerable to exposures to chemicals.[12,13] Sanitary pads come into direct contact with the vulva, and the mucous membranes, as stated above, are capable of rapidly absorbing these chemicals without breaking them down.[14]

2.2.2 IMPACT OF PHTHALATES EXPOSURE ON HUMAN HEALTH

Since the beginning of the previous decade, information on the impact of phthalates on reproductive health, developmental health and other health issues has been building. Many epidemiological studies link phthalate exposure and female health. Some of the most important epidemiological research, which is required to comprehend the need of implementing effective remediation measures, is presented below:

Female reproductive health

Study has shown linkage between urinary levels of phthalate, along with other chemicals, with early onset of puberty in girls.[15] Similarly, another study[16] has shown that an early menarche and fast breast development among young girls is linked with exposure to phthalates such as DEHP, DEP, DMP, and DnBP. Another case-control study conducted in Northern Mexico found a strong link between environmental exposure to phthalates and development of female breast cancer.[17] Some other studies have found high plasma concentrations of phthalates in females suffering from endometriosis.[18,19]

Pregnancy and foetal development

The negative impact of phthalates on pregnant and breastfeeding women would affect their babies, in addition to their own health; thus, it is important that this vulnerable population gets focused attention. Some studies establish the association between phthalate exposure during pregnancy (specifically DEHP, DBP and DEP) and pregnancy-related complications including preterm birth.[20,21] Studies also show that exposure to phthalates during pregnancy may have an adverse effect on diastolic blood pressure, thereby increasing the risk of pregnancy-induced hypertensive diseases.[22] Gestational phthalate exposure is also supposed to affect foetal development. In Japan, maternal blood MEHP levels are said to be associated with reduced levels of testosterone (T)/estradiol (E2), progesterone (P4), inhibin B and insulin-like factor 3 in male cord blood,[23] indicating the impact of phthalate exposure. A study[24] states that most phthalates disturb the expression of various genes and can cause reproductive tract anomalies in male neonates. A study also highlights a possible linkage between development of asthma in children and early-age exposure to phthalates.

Effects on cardiovascular system

Exposure to phthalates is associated with cardiovascular risks such as blood pressure problems, atherosclerosis and coronary heart disease.[25] A study[26] of 1,016 subjects aged 70 years found the four phthalates of MMP, MEHP, MiBP and MEP generally linked with coronary heart disease among the old.

- To summarise, exposure to phthalates can have the following health effects:
- Early onset of puberty in girls including menarche and accelerated breast development
- Endometriosis
- Pregnancy-related complications, including preterm birth and pregnancy-induced hypertension
- Issues with foetal development
- Male reproductive tract anomalies
- Blood pressure issues

- Atherosclerosis
- Coronary heart disease
- Insulin resistance

2.2 Volatile Organic Compounds (VOCs)

Volatile organic compounds, also known as VOCs, are compounds that have a low water solubility and high vapour pressure, which is released in the form of gas from certain solids or liquids. VOCs are used as ingredients in products such as paints, deodorants, air fresheners, nail polish, moth repellents, fuels and automotive products. Some VOCs that adversely impact human health include benzene, styrene, 1-4, dioxane chlorobenzene and acetone.

In sanitary pads, VOCs are mainly added as fragrances, adsorbents, moisture barriers, adhesives and binders. VOCs may also be unintentionally present in the raw material or packaging material.

2.3.1 IMPACT OF VOLATILE ORGANIC COMPOUNDS (VOCs) EXPOSURE ON HUMAN HEALTH

VOCs have the potential to be inhaled through the human respiratory system due to their volatility. VOCs such as xylene and benzene have been linked with harmful neurologic effects on the brain,[27,28] whereas chloroform, 2-ethylhexanol, phenol, ethylbenzene and toluene cause adverse effects, including paralysis, memory loss, loss of appetite and tiredness.[29,30]

Furthermore, most VOCs have a low molecular weight and are hydrophobic, allowing them to pass through the skin easily,[31] causing major side-effects such as skin inflammation and protein oxidative damage in keratinocytes. The impact of VOCs on health came into light after a feature in the south Korean media in 2017, which wrote about a lawsuit filed by thousands of women against a South Korean firm. This was after some civic groups had found harmful chemicals in sanitary pads and also many women had reported health problems after using them. A women's health advocacy group, Korean Women's Environmental Network, released a survey on 3,009 women who responded about experiencing abnormal symptoms after using a particular brand of pads. This later led to removal of the pads from the market. Numerous side-effects such as vaginal infection, not having menstrual cycle and irregular menstrual cycle changes were seen in Korean women who used disposable sanitary pads.

The detailed health impact of different types of VOCs on human health is summarised in the table below.

TABLE 6: IMPACT OF VOCs ON HUMAN HEALTH

S. No	Name	Health Impact
1	Acetone	Nephrotoxicity
2	Dichloromethane	Exposure to high concentrations may cause unconsciousness and death.
3	N- Hexane	Exposure to n-hexane can cause toxicity in peripheral nerves, muscle wasting and atrophy.
4	Chloroform	Exposure to high concentrations may cause convulsions, coma and death due to respiratory failure or cardiac arrhythmia.
5	Tetrahydrofuran	Cause headaches, nausea and dizziness. Very high exposure can lead to unconsciousness and death.
6	Benzene	Harm the bone marrow and lead to a dip in red blood cells, causing anaemia.
7	Toluene	Cause eye and nose irritation, tiredness, confusion, euphoria, dizziness, headache, dilated pupils, tears, anxiety, muscle fatigue, insomnia, nerve damage, inflammation of the skin, and liver and kidney damage.
8	Cyclohexane	Cause headaches, sleepiness, dizziness, limb weakness, motor changes and verbal memory impairment.
9	Styrene	Chronic (long-term) exposure to styrene affects the central nervous system (CNS), leading to headache, fatigue, weakness, depression, CNS dysfunction, hearing loss and peripheral neuropathy.
10	M-Xylene	Can irritate the eyes, nose, skin and throat. Xylene can also cause headaches, dizziness, confusion, loss of muscle coordination and, in high doses, death. Can cause defatting of the skin with irritation, dryness, erythema and cracking. Blistering may occur if exposure to concentrated xylene is prolonged. Long-term exposure may also lead to headaches, irritability, depression, insomnia, agitation, extreme tiredness, tremors, impaired concentration and short-term memory loss.
11	P-Xylene	
12	O-Xylene	
13	Trichloroethylene	Acute (short-term) and chronic (long-term) inhalation exposure to trichloroethylene can affect the human central nervous system (CNS), with symptoms such as dizziness, headaches, confusion, euphoria, facial numbness and weakness.
14	Penta chloroethane	Can cause headache, nausea, vomiting, abdominal pain, diarrhoea, dizziness, confusion, tremors, drowsiness, seizures and even death.
15	Cyclohexanone	Can cause headaches, dizziness, lightheadedness and unconsciousness.

S. No	Name	Health Impact
16	Phenol	Dermal exposure to phenol causes inflammation, erythema, discolouration of the skin, burns and necrosis. Exposure to phenol may also irritate the skin, eyes, nose, throat and nervous system. Some symptoms of phenol exposure are weight loss, weakness, exhaustion, muscle aches and pain.
17	N, N-Dimethylacet-amide	Acute toxic dermal and inhalation exposure has resulted in severe hepatitis, rhabdomyolysis, hallucinations and coagulopathy
18	Carbon tetrachloride	The primary effects of carbon tetrachloride in humans are on the liver, kidneys and CNS. Symptoms of acute (short-term) inhalation and oral exposures to carbon tetrachloride include headache, weakness, lethargy, nausea and vomiting.
19	1, 2, 3 Trichloropropane	Can damage the liver and kidneys.
20	1, 1, 2-trichloroethane	The only effect that has been noted is stinging and burning sensations of the skin upon dermal exposure.
21	Trans-Di-1, 2-chloroethane	It can irritate the eyes and the respiratory system, and ultimately CNS depression.
22	Cis-dichloroethylene	Immunological, neurological, reproductive, developmental, genotoxic and carcinogenic effects.
23	1, 2 -Dichloroethane	Irritates the eyes, nose and throat. It may cause eye problems, headache, feeling of drunkenness, fatigue, CNS depression, convulsions, pulmonary oedema (excessive fluid in the lungs), unconsciousness and death from respiratory and cardiac failure.
24	1, 1, 1-Trichloroethane	Irritates skin and eyes. Inhalation or ingestion can lead to headache, dizziness, lack of coordination, stupor, coma, CNS and respiratory depression, and cardiac dysrhythmia.
25	1, 1, 1, 2-Tetrachloroethane	Skin and eye Irritation.

To summarise, VOCs can have the following health impacts

- Paralysis of the CNS
- Memory loss
- Loss of appetite
- Tiredness
- Menstrual cycle issues

2.3 Secondary studies highlighting presence of chemicals in sanitary products

In a study[32] done in the US, the presence of phthalates, parabens, bisphenols and TCC were found in feminine hygiene products, indicating a big source of EDC exposure for women. The study tested seven types of feminine hygiene products including pads, tampons, panty liners, wipes, bactericidal creams and solutions, and deodorant sprays and powders for 24 EDCs. Another study,[33] done in 2009 in South Korea, sought to check the presence of heavy metals in sanitary pads. On testing, toxic metals such as cadmium, chromium, copper, cobalt, nickel and lead were found.

Some studies have been done to check the presence of VOCs in sanitary pads. In 2014, **Women's Voices for Earth** reported that a well-known brand of sanitary pads contained styrene, chloromethane and chloroform.[34] A similar study[35] done on 10 different types of sanitary pads in South Korea tested and found over 200 VOCs including benzene, styrene and trichloroethylene. It is also important to note that most of these VOCs are hepatotoxic and nephrotoxic in nature.

VULVAR SKIN AND VAGINAL MUCOSA HAVE HIGH ABSORPTION EFFICIENCY AND PERMEABILITY AND HENCE THE CHEMICALS PRESENT IN FEMININE HYGIENE PRODUCTS CAN BE EASILY ABSORBED

A study [36]conducted in Denmark among girls under 19 years of age investigated the effects of MEP, MBP, DEHP and DINP metabolites in urine, and discovered that younger girls with less advanced pubertal development had the highest first-morning urinary concentration of MBP, MBzP, DEHP, and DINP phthalates. Another study[37] reported the concentrations of several phthalates (DEP, DBP and DEHP) in sanitary pads from six countries (Korea, Japan, Finland, France, Greece and the US). Overall, phthalates in significant quantities were found in all 11 brands used for the study. VOCs, too, were found in significant quantities in most of the same 11 brands. The presence of phthalates has also been observed in sanitary pads in studies done in countries such as the US[38], Canada,[39] China,[40] and Korea.[41]

The Korean Women's Environmental Network found 84 VOCs in sanitary pads.[42] As mentioned in the earlier section, close to 3,000 women in Korea disclosed having suffered from many reproductive health issues after using sanitary pads of the same brand.

Study has shown 10-fold higher serum estradiol levels due to vaginal application of estradiol when compared to oral dosing. This indicates that there might be greater health risks from this exposure route, which would mean that chemicals present in sanitary pads might get absorbed at a much faster pace through the vaginal route. Even then, few studies have investigated sanitary pads as a source of chemical exposure in the vagina and vulva.[43]

The table below compiles some studies done globally to assess harmful chemicals in sanitary products.

TABLE 1: CHEMICALS IN MENSTRUAL HYGIENE PRODUCTS

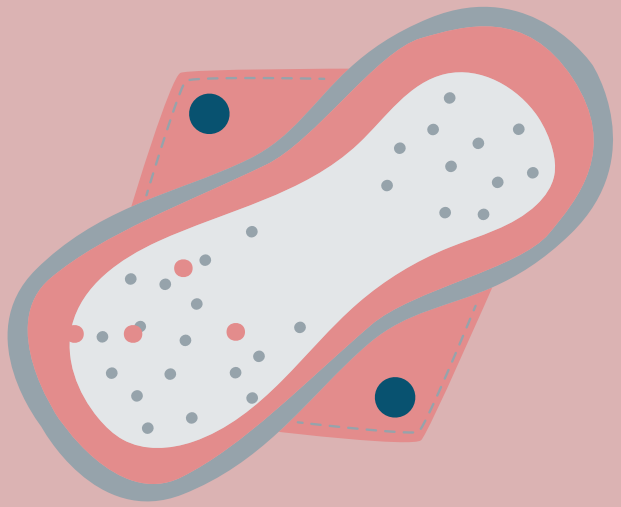
Significant studies conducted globally	Findings	Year	Ref.
US-based study examined dioxin levels in four different brands of tampons.	All tampons showed presence of polychlorinated dibenzo-p-dioxins and dibenzofurans, with total concentration ranging from 1.5 to 23.6 pg/g.	2002	44
US-based organisation - Women's Voices for the Earth -- tested four types of menstrual pads.	Detected 20 different types of VOCs in the sanitary pads, with concentrations in the range of 0.52-480 ppbv.	2014	45
The Conscious Consumers Association of Indonesia tested five popular tampons and four types of pads.	All products contained phthalates, parabens and triclosan.	2014	46
Indonesian Consumers Foundation (YLKI) tested Indonesia-based sanitary pads.	Found chlorine in all pads, with highest concentration of 5,793 PPM.	2015	47
Swiss study tested sanitary towels.	Found phthalates and formaldehydes.	2016	48
The Korean Women's Environmental Network tested 10 different sanitary pads.	Found over 200 VOCs, including benzene, styrene and trichloroethylene.	2017	46
The Ministry of Food and Drug Safety of South Korea tested 666 sanitary pads/ panty liner products in South Korea for VOCs	VOCs were detected in most products, though at a level much lower than the safety margin.	2017	49
The Voice for Women tested six popular brands of US tampons.	8 VOCs were found in the range of 0.5 to 029 ppbv.	2018	50
Sanitary pads were tested for 74 VOCs in Korea	50 VOCs were found in sanitary pads retailed in Korea at concentrations ranging from 0.025 to 3548.09 µg/pad.	2019	51
26 sanitary samples from six different countries were analysed to assess the presence of phthalates.	DMP, DEP, DiBP, DnBP, BMPP and DEHP were detected in all samples. Fifteen phthalates with concentration range (0.68-7152 PPb) measured.	2019	52

Significant studies conducted globally	Findings	Year	Ref.
US-based study of 11 sanitary pads from Korea, Japan, Finland, France, Greece and the US.	Presence of phthalates and VOCs were detected. The total concentration of phthalates was found in a range of 9.8-7820 PPb.	2019	53
Belgium-based study Desmedt reported a total of 10 samples analysed for the presence of VOCs.	The results show that five allergenic fragrance ingredients were present in concentrations <10 µg/g.	2019	54
A study conducted in China on 120 feminine hygiene products (56 feminine care products and 64 sanitary napkins).	Showed the presence of eight phthalates. Phthalates were found in 86% and 98% of feminine care products and sanitary napkins, respectively - Diethyl phthalate, dibutyl phthalate, and bis(2-ethylhexyl) phthalate were the major compounds.	2020	55
43 feminine hygiene products such as pads, panty liners and tampons tested in and around Albany, New York, US	24 EDCs, comprising nine phthalates (205-11200 ng/g), six parabens (0.04-1700 ng/g), eight bisphenols (LOD- 104 ng/g), and triclocarban (LOD- 0.47 ng/g), were detected.	2020	33
A study conducted in the US, Ding et al., tested sanitary pads and tampons to analyse the presence of VOCs.	Showed the presence of VOCs (2-butanone and methyl isobutyl ketone) in urine during the menstrual period.	2021	56

2.4 Improper disposal of sanitary products

In many countries around the world, proper disposal of used menstrual products is still inadequate. Due to a global lack of menstruation management practices, most women dispose of their sanitary pads or other period products in solid waste or rubbish bins at home, which eventually form part of solid wastes. In India, 12 billion sanitary pads are used every year, with a large percentage of it ending up in landfill sites or waterbodies. When sanitary pads enter landfills or pits, hazardous and toxic chemicals seep into the soil. Some of the chemicals from menstrual waste may lead to toxic emission, groundwater pollution and loss of soil fertility, and also microplastic pollution. The plastic containing pads can take up to 500 years to break down, release toxic chemicals into the environment over a period of time along with generating microplastics that threaten our ecosystem.

The World Health Organization (WHO) recommends that health-related trash be burned at high temperatures (over 800°C) to transform it into comparatively innocuous gas and incombustible solid waste, such as ash,[57] which can then be disposed of in authorised ash pits or controlled landfills. However, burning sanitary waste at low temperatures (via local incinerators, open burning, etc.) may further increase the problem. Due to the presence of high amounts of plasticisers as well as bleached cotton there is an ever-increasing risk of the emission of noxious, toxic gas. Furthermore, these harmful gases can travel a long distance from the place of emission, thus impacting not only the health of the population residing near these places, but in far and wide areas as well.



Regulation on the composition of sanitary pads

In the US, sanitary pads are classified under FDA Class I medical devices. Under this, manufacturers are advised to look at new compositions in terms of materials and also identify new bleaching processes or technology used during manufacturing. These regulations, however, are not legally binding and are considered as guidelines or recommendations. FDA recommends that details of quantities of all composition materials may be provided. This is again recommendatory in nature. But from 2020, New York State requires disclosure of FHP ingredients, the first such requirement of its kind in the US.[58]

In June 2021, the EU passed a new resolution, urging member states to encourage wide availability of toxin-free and reusable menstrual products. REACH (Registration, Evaluation, Authorization and Restriction of Chemicals), the EU regulation that applies to all consumer products placed in the EU market, restricts the use of phthalate that is included in the list of carcinogenic, mutagenic or toxic to reproduction (CMR) substances of category 1A, 1B or 2 under the Classification, Labelling and Packaging (CLP) Regulation, including: BBP, DBP, DEHP, DIBP. The above phthalates are restricted to a maximum content of 0.1% by weight of the plasticised material in the article (individually or in combination).

In Korea, sanitary pads are regulated under Quasi-Drugs by the Korean Ministry of Food and Drug Safety (MFDS). Fluorescent whitening agents, formaldehyde, chlorinated phenols (pentachlorophenol and tetrachlorophenol), azoic dyes, phthalates, and metal pollutants (antimony, barium, cadmium, chrome, lead, mercury, arsenic, selenium, etc.) are all prohibited by the regulations and laws in the country.

In China, safety of sanitary pads is regulated under GB 15979-2002. It is a mandatory regulation by which manufacturers should provide microbial and toxicological indicators along with pH value, infiltration capacity and water absorbency, but there are no regulations on the presence or concentrations of phthalates and VOCs.

In France, the manufacture, composition and use are not governed by any regulation but are subject to horizontal legislation including the general product safety directive (GPSD). The horizontal legislation deals with environmental legislation on various matters which cut across diverse environmental subject areas, as opposed to regulations for a specific area sector, e.g. water or air. Rather than regulating a specific area, these items of legislation are more procedural. In July 2018, the French Agency for Food, Environmental and Occupational Health and Safety (ANSES) evaluated traces of fragrances, polycyclic aromatic hydrocarbons (PAHs) and pesticides in feminine hygiene products that were carcinogenic, mutagenic or reprotoxic (CMR), endocrine-disrupting or skin-sensitising. Some of the pesticides banned in the EU were also found in the products. Thus, the agency called for restrictions and urged manufacturers to improve quality for raw material.

The Australian government regulation (2019) AS 2869:2008 does have some regulations on manufacturing of tampons to minimise risk to health associated with the use of such products. However, chemical compositions and quantity does not form a part of this guideline. Also, other menstrual products are not included.

8.1 Framework in India

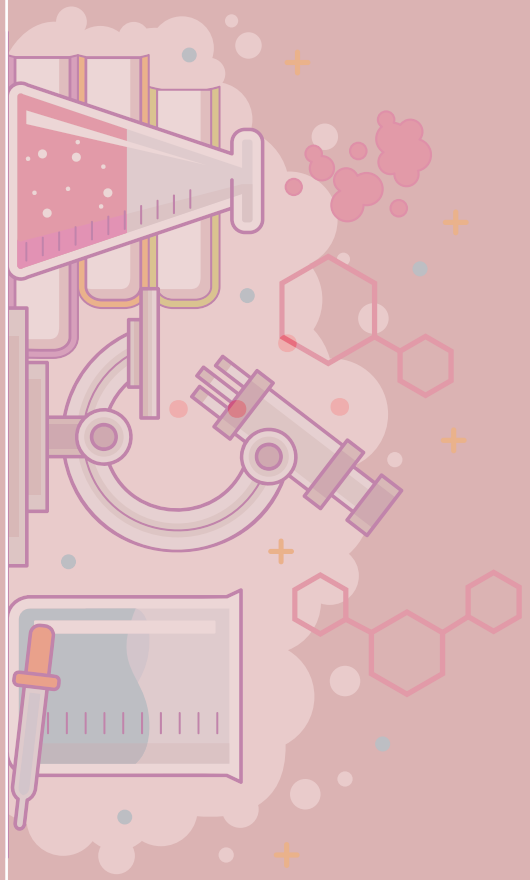
In India, there are no clear regulations on chemical content in sanitary pads for manufacturers. The Bureau of Indian Standards 1980 specifies very basic tests to determine absorbent fillers surface and pad texture. However, there is no requirement to test the toxicity of ingredients.

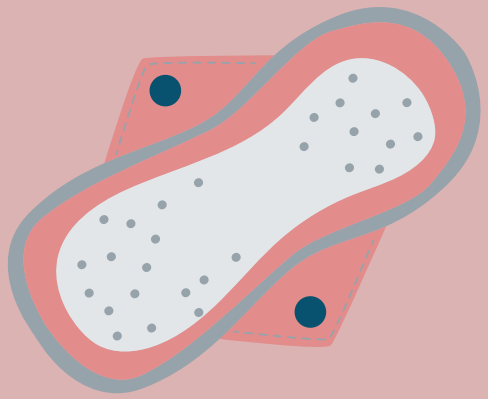
Sanitary pad manufacturing companies are not required by law to state ingredients on the packet as they are labelled as 'medical products', thus exempted from the ingredient-listing.

REGULATION FOR DISPOSAL OF SANITARY WASTE IN INDIA

Since most commercially available sanitary pads are laden with chemicals, the impact on health and environment post disposal cannot be ignored. Sanitary waste in India is classified under Solid Waste Rules, not biomedical waste. As a result of this classification, the majority of sanitary waste ends up in landfills.

Furthermore, even the new guidelines to address the issue released in 2018 mostly suggested local incineration as a viable means to divert this waste from going into landfill. Here, it is important to note that most low-cost incinerators (both at urban and local level) do not conform to stated guidelines, thereby not incinerating the sanitary waste at the required high temperatures. This in turn increases the risk of these chemicals being released into the environment as a result of incomplete burning. Some studies indicate the incineration of household waste as a source of VOCs being released in the environment.[59]





Objective and Methodology

India is a huge market for sanitary products, and the market for sanitary pads has been growing exponentially. Over the past few years, some studies done in Europe, US and other countries have reported presence of chemicals such as phthalates and VOCs in menstrual products, raising questions and concerns about the impact on the health of the users. But in a country like India, where even the usage of sanitary pads is yet to be universalised, there is little or no information on ingredients or presence of toxic chemicals in the products sold or available in the market.

Hence, the purpose of this study is to determine presence of phthalates and VOCs, commonly found chemicals, in menstrual products in the country and to influence policy and management actions to limit these.

The specific objective:

- Qualitative and quantitative analysis of phthalates in sanitary pads
- Qualitative and quantitative analysis of VOCs in sanitary pads
- Create awareness among women about the impact of phthalates and VOCs on their health

4.1 Sample collection

A total of 10 menstrual products were procured from markets in New Delhi, India as well as online portals. Both organic and inorganic sanitary pads samples were included in the qualitative and quantitative analysis. The number of inorganic pads included in the study is more, given their wide usage. Pads from popular brands with varying prices were taken. Detailed information on sanitary products analysed in this study is summarised in **Table 2.** The samples were labelled and listed before being dispatched to the testing institute.

FIGURE 2: PICTURES OF ALL SANITARY PAD SAMPLES

TABLE 2: DETAILS OF SAMPLES

Sample details			
CODE	Inorganic samples	CODE	Organic samples
ISP1	Whisper Ultra clean	OSP1	PEE Safe 100% organic cotton biodegradable
ISP2	Stayfree Dry Max	OSP2	AZAH Organic Pad
ISP3	Sofy Anti-bacterial	OSP3	Plush 100% Pure US Cotton
ISP4	Nine Dry Comfort	OSP4	NUA Light Flow
ISP5	Bella Regular Drai Wings		
ISP6	Evereve Ultra sanitary napkins		

4.2 Methodology

SAMPLE PREPARATION

To measure phthalate contents, a single pad from each pack was weighed before sample collection. Samples of small pieces (size and length 4 mm) were collected using clean scissors from four different locations of each pad. Samples were weighed and transferred to the 20 ml reaction vessel. Five ml of THF + 20 mg/l IS was added and the cap was sealed tightly and sonicated at 60 ± 5°C for 60 minutes ± 5 minutes after the sonication, the solution was cooled down to room temperature and 10ml n-hexane with 10 mg/l IS added for polymer precipitation. The solution was properly mixed using vortex for 30 seconds and made to stand still for 30 ±5 minutes. Finally, the solution was centrifuged at 700 G for 10 minutes and filtered through 0.45µ PTFE membrane filter. All the samples were then analysed using gas chromatographic and mass spectrometric to analyze phthalates.

MEASUREMENT OF PHTHALATES

Gas and mass chromatograph equipped with a DB-5ms (30 m x 250 µm x 0.25 µm) column was used for the analysis of phthalates. In the instrument, helium gas was used as a carrier gas during the analysis. Flow rate of the solution was 1 mL/min.

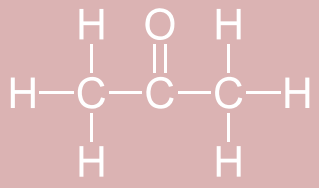
MEASUREMENT OF VOCs

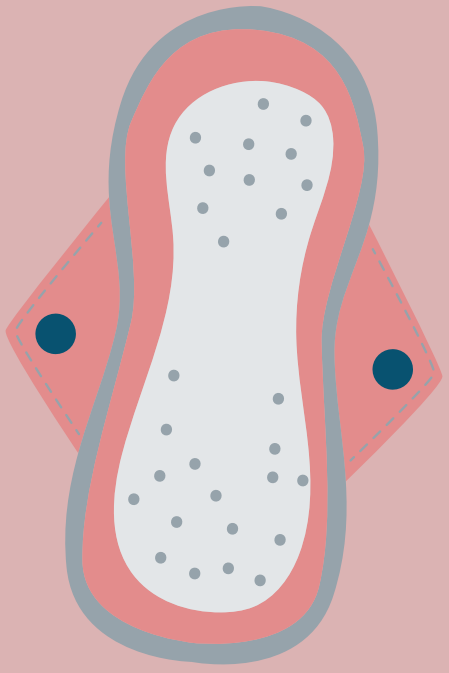
All the sanitary pad samples were analysed for VOCs using the HS-GC-MS. Sample analyses followed well-developed protocols. Chromatographic separation was performed using DB-WAX (30 m x 250 µm x 0.25 µm) with helium as the carrier gas, and a temperature program that started at 40°C (3 minutes), ramped at 7°C/minute to 150°C (1 minute), and finally ramped at 60°C/minute to 240°C. To measure the VOCs, an uncut sample was placed 1g±0.1g into a headspace vial and sealed; then the sample was incubated at 90°C±2°C for 20 minutes±2 minutes. Finally, the samples were analyzed using HS-GC-MS.

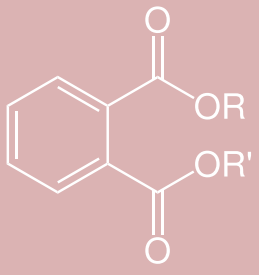
4.8 Limitations

Due to the operational limitations of GCMS and HPLC, low concentrations of phthalates and VOCs could not be detected. Extensive range GCMS and HPLC for the analysis of low concentrations of phathalates and VOCs were not available during the study.

Result and Discussion







There are different kinds of menstrual products available in the market. For this study, sanitary pads -- both inorganic and organic -- were assessed for the presence of phthalates and VOCs. As mentioned in the methodology, a total of 10 samples, six inorganic sanitary pads (ISP1-ISP6) and four organic sanitary pads (OSP1-OSP4), were sent for testing. During testing, the results for VOCs and phthalates were analysed weight-wise (µg/kg). This was then converted to pad=wise concentrations. The average weight of a pad was taken to be around 10 grams.

Among phthalates, the maximum concentration was of DIDP at 190 µg/pad in Plush 100% Pure US Cotton, an organic pad. The highest concentration of VOC was of acetone (6.9 µg/pad), detected in Bella Regular Drai Wings.

5.1 Phthalates in menstrual pads

The menstrual pads were tested for phthalates such as DIBP, DBP, DINP, DIDP, DMP, DEP, BBP, DNOP, DEHP, DHP, DIPP and DPP. All products included in the study tested positive for presence of phthalates. The total concentration of phthalates detected were in the range of 10- 19460 µg/kg. DIBP and DEHP were the only two phthalates found in all the samples.

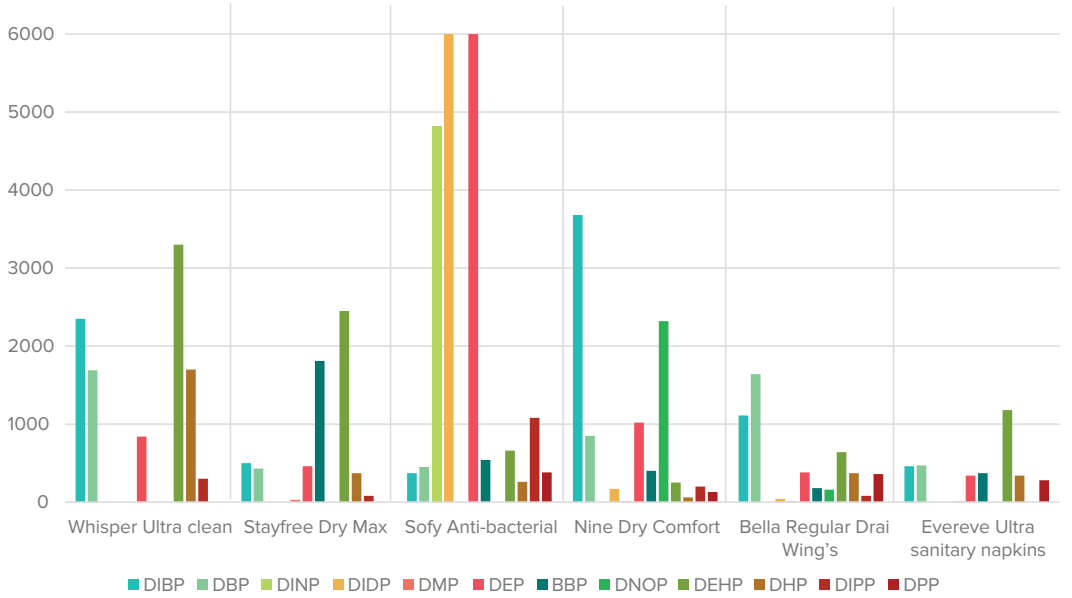
5.1.1 CONCENTRATIONS OF PHTHALATES IN INORGANIC SAMPLES

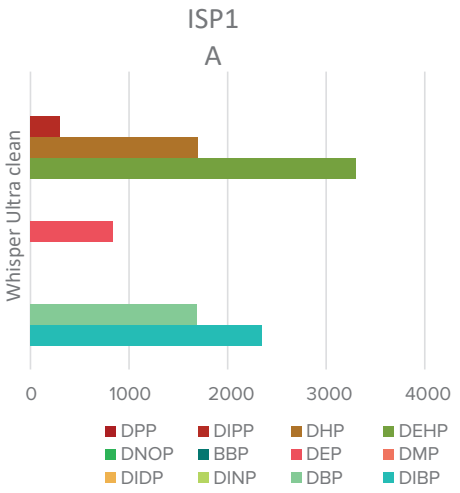
All the six inorganic menstrual pads tested showed presence of phthalates. A total of 12 different types of phthalates namely, Di-isobutyl phthalate (DIBP), Di-butyl phthalate (DBP), Di-isononyl phthalate (DINP), Di-isodecyl phthalate (DIDP), Di-methyl phthalate (DMP), Di-ethyl phthalate (DEP), Benzyl butyl phthalate (BBP), Di-n-octylphthalate (DNOP), Di(2-ethylhexyl) phthlate (DEHP), Di-heptyl phthalate (DHP), Di-isopentyl phthalate (DIPP), and Di-pentyl phthalate (DPP) were found in the inorganic sanitary pad samples. The total concentration of phthalates was found in the range of 10–10230 µg/kg. The sample from **Bella Regular Drai Wings (ISP5)** showed the **presence of all 12** different types of phthalates (DIBP, DBP, DINP, DIDP, DMP, DEP, BBP, DNOP, DEHP, DHP, DIPP and DPP). Among all the phthalates present in Bella, DBP was found to be at the highest concentration of 1640 µg/kg. Di-n-butyl phthalate (DBP) has been demonstrated to produce reproductive and developmental toxicity.

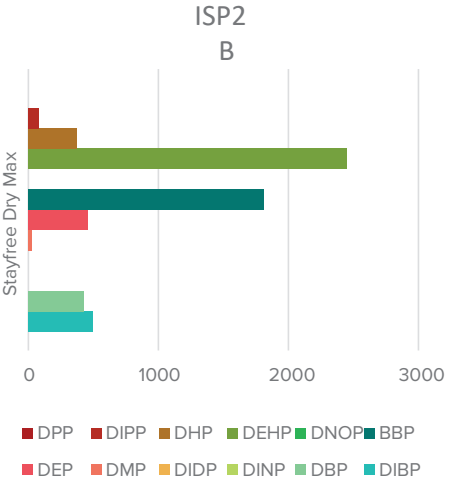
Sofy Anti-bacterial (ISP3) showed the presence of 10 different types of phthalates (DIBP, DBP, DINP, DIDP, DEP, BBP, DEHP, DHP, DIPP and DPP), with DEP having the greatest concentration at 10230 g/kg and DHP having the lowest concentration at 280 g/kg among the 10 phthalates in ISP3. **Whisper Ultra Clean (ISP1), one of the most used brands in the country,** showed presence of six different types of phthalates (DIBP, DBP, DEP, DEHP, DHP and DIPP) with concentrations of 2350, 1690, 840, 3300, 1700 and 300 µg/kg. **Evereve Ultra sanitary pad (ISP6)** showed the maximum concentration of DEHP at 1180, followed by 470, 460, 370, 340, 280 and 10 µg/kg of DBP, DIBP, BBP, DEP, DPP and DMP respectively. The toxic effects of some of these phthalates, experimentally observed in various species,[60] concern the endocrine system.

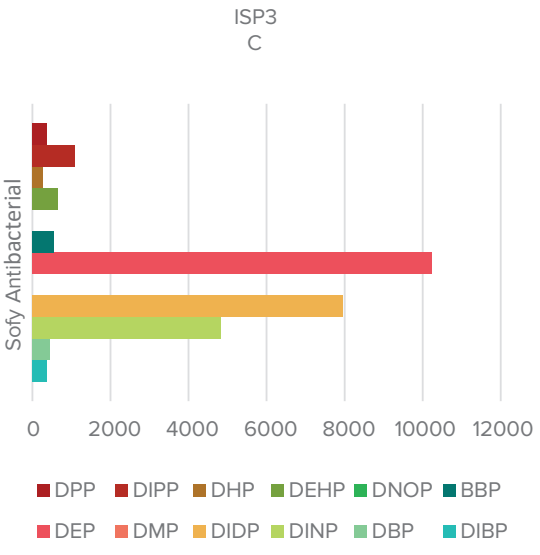
Stayfree Dry Max (ISP2) sample tested in the study showed the highest concentration of DEHP at 2450, followed by 1810, 500, 460, 430, 370, 80 and 30 µg/kg of BBP, DIBP, DEP, DIPP and DMP as reported in Figure1 (A – F). Nine Dry Comfort (ISP4) showed the presence of all 12 phthalates with the highest concentration of 3680 g/kg of DIBP and 10 µg/kg of DMP as the lowest concentration. Studies have found that low molecular phthalates such as DEP can acutely irritate the skin, conjunctiva and the mucous membrane of the oral and nasal cavities**.**

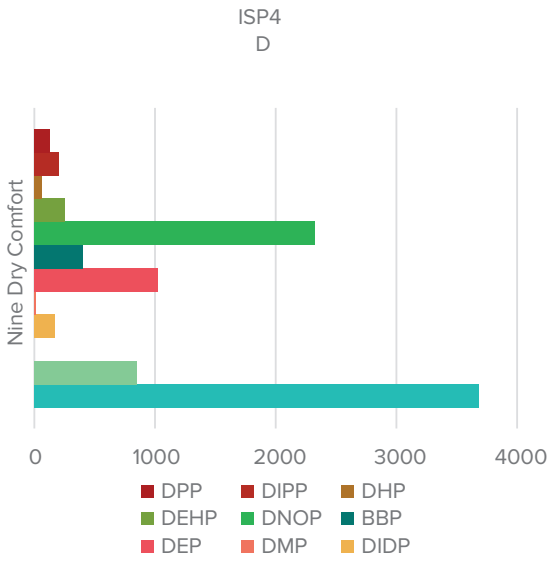
FIGURE1 (A – F): PRESENCE OF PHTHALATES IN THE 10 SAMPLES TESTED IN THE STUDY

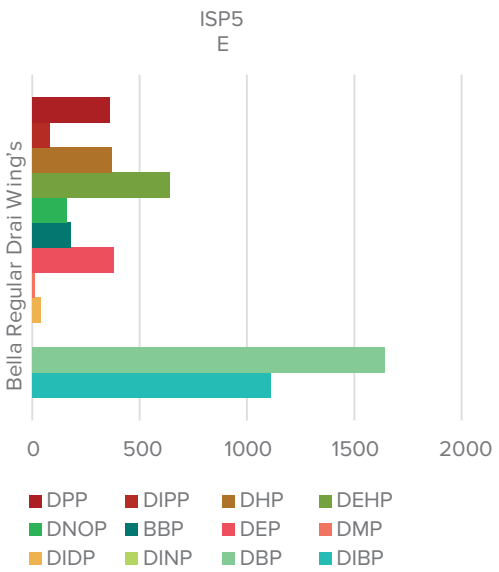







ISP3
C
Sofy Antibacterial
0
2000
4000
6000
8000
10000
12000
DPP
DIPP
DHP
DEHP
DNOP
BBP
DEP
DMP
DIDP
DINP
DBP
DIBP


ISP4
D
Nine Dry Comfort
0
1000
2000
3000
4000
DPP
DIPP
DHP
DEHP
DNOP
BBP
DEP
DMP
DIDP


ISP5
E
Bella Regular Drai Wing's
0
500
1000
1500
2000
DPP
DIPP
DHP
DEHP
DNOP
BBP
DEP
DMP
DIDP
DINP
DBP
DIBP

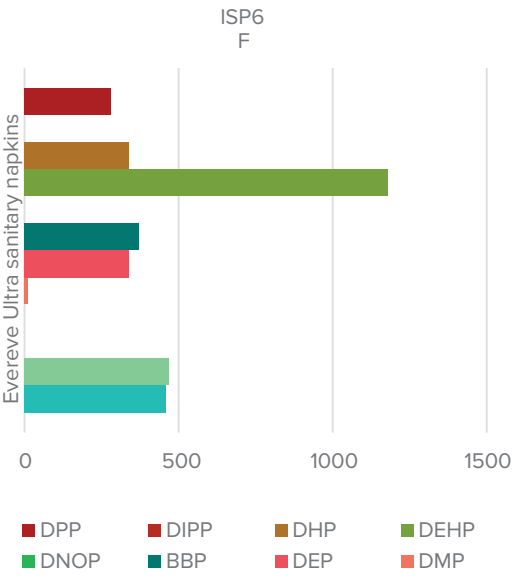

ISP6
F
Evereve Ultra sanitary napkins
0
500
1000
1500
DPP
DIPP
DHP
DEHP
DNOP
BBP
DEP
DMP

TABLE 1: PHTHALATES DETECTED IN THE SAMPLES

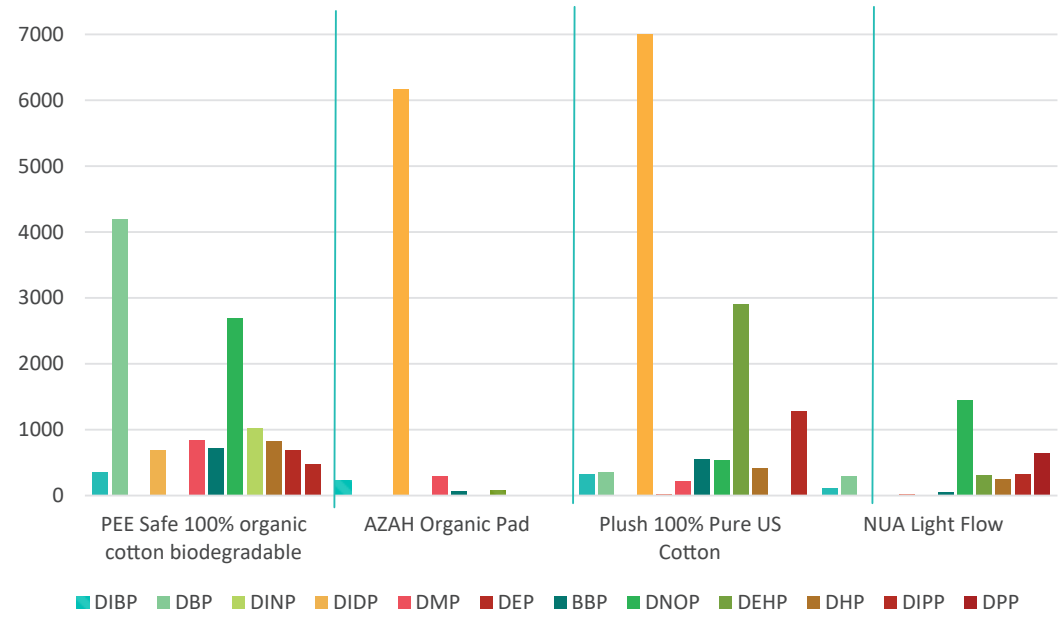
Samples details		Phthalates (PPb or µg/kg)											
Sample Id	Sample name	DIBP	DBP	DINP	DIDP	DMP	DEP	BBP	DNOP	DEHP	DHP	DIPP	DPP
ISP1	Whisper Ultra clean	2350	1690	ND	ND	ND	840	ND	ND	3300	1700	300	ND
ISP2	Stayfree Dry Max	500	430	ND	ND	30	460	1810	ND	2450	370	80	ND
ISP3	Sofy Anti-bacterial	370	450	4820	7960	ND	**10230**	540	ND	660	260	1080	380
ISP4	Nine Dry Comfort	3680	850	ND	170	10	1020	400	2320	250	60	200	130
ISP5	Bella Regular Drai Wings	1110	1640	10	40	10	380	180	160	640	370	80	360
ISP6	Evereve Ultra sanitary napkins	460	470	ND	ND	10	340	370	ND	1180	340	ND	280
OSP1	PEE Safe 100% organic cotton biode-gradable	353	4192	ND	690	ND	840	720	2690	1020	830	690	480
OSP2	AZAH Organic Pad	230	ND	ND	6170	ND	300	70	ND	80	ND	ND	ND
OSP3	Plush 100% Pure US Cotton	320	350	6060	**19460**	**10**	220	560	540	2900	410	ND	1280
OSP4	NUA Light Flow	110	290	ND	ND	**10**	ND	60	1450	310	250	320	640

5.1.2 CONCENTRATION OF PHTHALATES IN ORGANIC PADS

A total of four organic sanitary pads samples were tested to check the presence of phthalates. Phthalates were found in all four samples and the concentration detected was in the range of 10–19,600 µg/kg. Out of the 12 phthalates tested during this study, 10 phthalates (353 µg/kg DIBP, 4192 µg/kg DBP, 690 µg/kg DIDP, 840 µg/kg DEP, 720 µg/kg BBP, 2690 µg/kg DNOP, 1020 µg/kg DEHP, 830 µg/kg DHP, 690 µg/kg DIPP, and µg/kg 480 DPP were found in **PEE Safe 100% organic cotton biodegradable** (OSP1). **AZAH Organic Pad** showed the presence of five phthalates (230 DIBP, 6170 DIDP, 300 DEP, 70 BBP, and 80 DEHP). Among the four samples, the highest concentration of any phthalate was found in **Plush 100% Pure US Cotton** (OSP3), with 19460 µg/kg of DIDP. **Plush 100% Pure US Cotton** (OSP3) showed presence of DIDP (19460 µg/kg) and DINP, DEHP, DPP, BBP, DNOP, DHP, DBP and DIBP with concentration of 6060, 2900, 1280, 560, 540, 410, 350 and 320 µg/kg respectively.

NUA Light Flow (OSP4) showed presence of DNOP (1450 µg/kg), DPP, DIPP, DEHP, DBP, DHP, DIBP, BBP and DMP with concentrations of 640, 320, 310, 290, 250, 110, 60 and 10 µg/kg respectively. DIDP, detected in three of the four organic samples, can pass from mother to baby during pregnancy and exposure to this type of phthalate may affect the development of the child.[61] Exposure to DIBP, again detected in three of the samples, induces changes in body weight, liver weight, reproductive effects and developmental effects.[62] High-molecular-weight phthalates such as DEHP and BBP, or their monoesters, are the major allergens causing asthma, wheezing, hay fever, itchy rash and eczema in adults and gestational exposure of DEHP, BBP and DBP are the causative agents of allergic responses in infants and toddlers. This gestational exposure of phthalates indicates the epigenetic changes induced by phthalates.[63]

FIGURE 1: PRESENCE OF PHTHALATES IN ORGANIC PADS



Though there are no standards in India, according to EU rules and regulations, the concentration of phthalates in an article, individually or in any combination of the phthalates, shall not be equal to or greater than 0.1% by weight of the plasticised material.

5.2 Concentration of VOCs in both inorganic and organic samples

Sanitary napkins samples were checked for presence of a total of 25 VOCs. The list of VOCs tested for is as follows:-

- Acetone
- Dichloromethane
- N-Hexane
- Chloroform
- Tetrahydrofuran
- 1,2 dichloroethane
- Benzene
- Toluene
- Cyclohexane
- Styrene
- M-Xylene
- Trichloroethylene
- Penta chloroethane
- Cyclohexanone
- o-xylene
- Phenol
- N, N-Dimethylacetamide
- Carbon tetrachlorid
- 1, 2, 3 Trichloropropane
- P-XYLENE
- 1, 1, 2- trichloroethane
- Trans- Di-1, 2-chloroethane
- Cis-dichloroethylene
- 1, 1, 1-Trichloroethane
- 1, 1, 1, 2- Tetrachloroethane

VOCs were detected in all the samples, inorganic and organic. Among these, acetone, dichloromethane, N-Hexane, chloroform, Tetrahydrofuran, Benzene, Toulene, Cyclohexane, M-Xylene, Cyclohexanone, o-xylene and 1, 1, 2-trichloroethane were detected in all the samples. Trans- Di-1, 2-chloroethane, Cis-dichloroethylene and 1, 1, 1-Trichloroethane were not found in any of the samples. The highest concentration among all the VOCs was of acetone, at 690 µg/kg in Bella Regular Drai Wings (ISP5), an inorganic pad. But PEE Safe 100% organic cotton biodegradable pad also contained a high concentration of acetone (591 µg/kg). It was shocking to find high levels of VOCs in all the organic samples, thus breaking the understanding that the organic pads are safer. Acetone, cyclohexane and cyclohexanone were found in all of them.

5.2.1 VOCs IN INORGANIC PADS

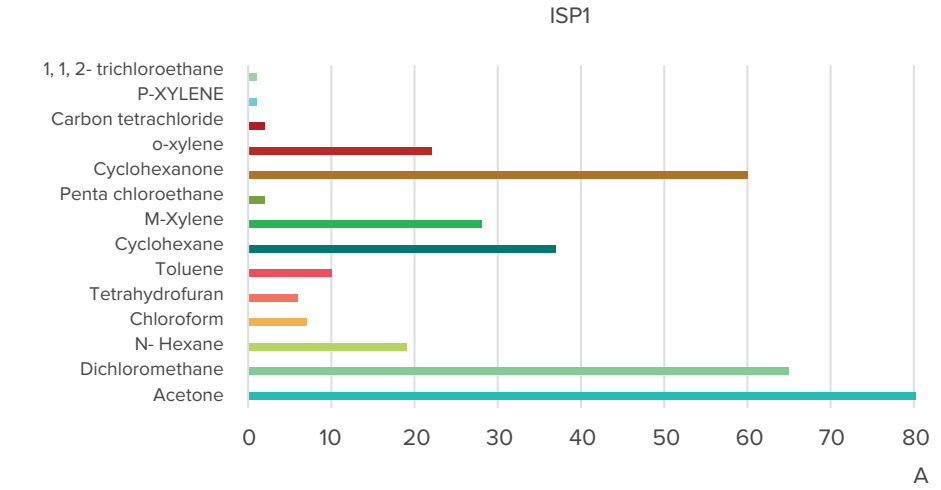
A total of six inorganic sanitary pads samples were tested to check for the presence of VOCs. VOCs were detected in all the samples, ranging from 1-690g/kg. Acetone and cyclohexanone were detected in high concentrations in all the inorganic pads tested during the study. **Bella Regular Drai Wings (ISP5) was found to contain 17 VOCs;** namely acetone, dichloromethane, N-hexane, chloroform, tetrahydrofuran, benzene, toluene, syclohexane, styrene, M-xylene, trichloroethylene, Penta chloroethane, cyclohexanone, o-xylene, phenol, carbon tetrachloride, 1, 1, 2- trichloroethane and 1,1,1,2-tetrachloroethane. **Evereve Ultra sanitary napkin (ISP6)** showed the presence of 17 VOCs and with highest concentration of cyclohexanone at 291 µg/kg; followed by acetone, phenol, N-Hexane, dichloromethane, toluene, o-xylene, tetrahydrofuran, chloroform, carbon tetrachloride

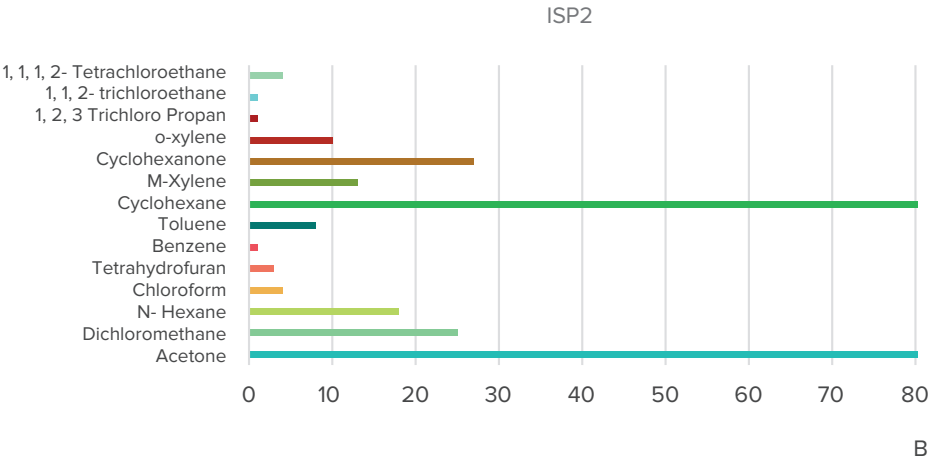
and benzene. Eighteen VOCs were detected in **Sofy Anti-bacterial (ISP3)** with the highest concentration of cyclohexanone at 231 µg/kg and dichloromethane (95 µg/kg); and varying levels of VOCs such as cyclohexane, acetone, toluene, n-hexane, o-xylene, chloroform, tetrahydrofuran, styrene and penta chloroethane in different concentrations. **Whisper Ultra clean (ISP1**), a very popular product, contained 14 of the tested VOCs, with acetone as the dominant one with a concentration of 200 µg/kg. **Stayfree Dry Max (ISP2**), another popular product, also tested positive for 14 VOCs, with high acetone (312 µg/kg) and cyclohexane (159 µg/kg) concentrations. **Nine Dry Comfort (ISP4)** had 17 VOCs, with cyclohexanone (127 µg/kg) as the dominant chemical.

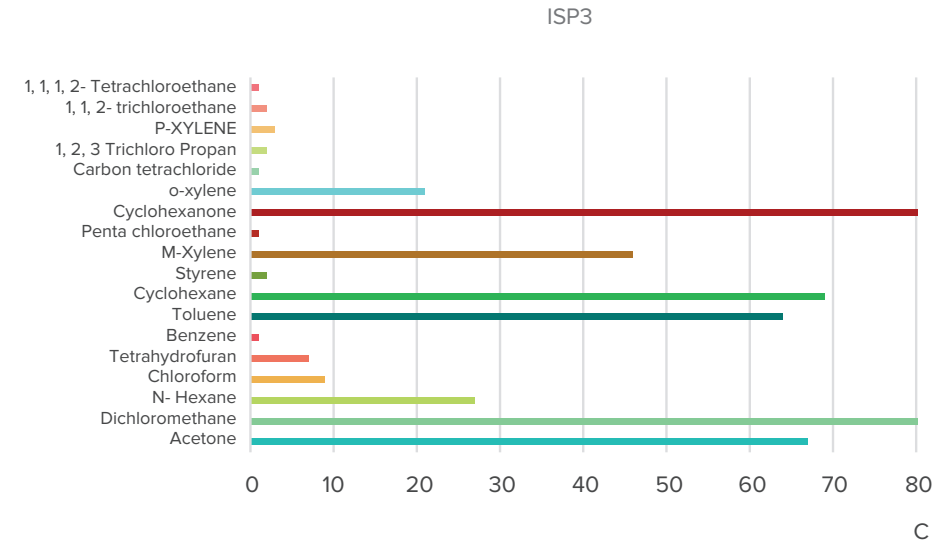
5.2.2 VOCs IN ORGANIC PADS

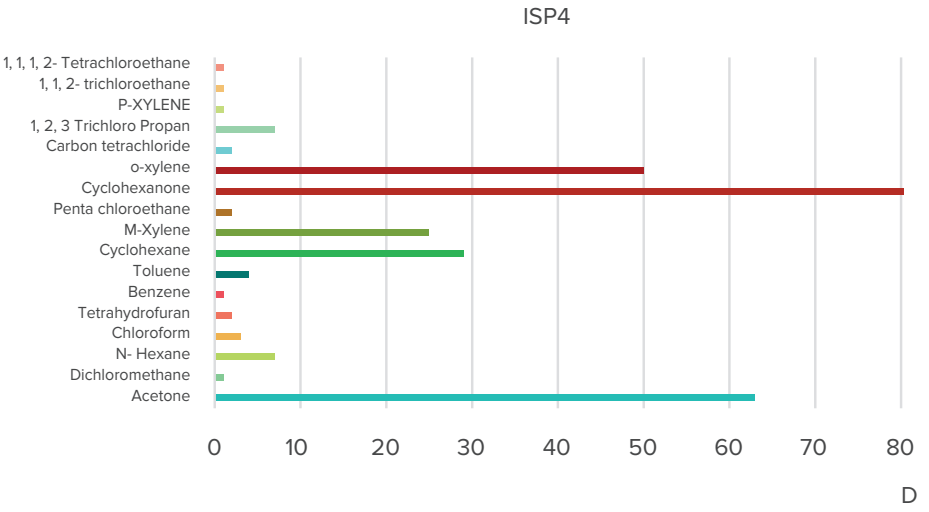
As mentioned above, all organic pads were also found to have VOCs. PEE Safe 100% organic cotton biodegradable (OSP1) was found to have 17 of the tested chemicals, with high concentrations of acetone (591 µg/kg) and cyclohexanone (66 µg/kg). **AZAH Organic Pad (OSP2)** showed high concentrations of cyclohexane (254 µg/kg) and cyclohexanone (222 µg/kg).

Plush 100% Pure US Cotton (OSP3) showed the presence of 16 VOCs, with a high concentration of acetone (225 µg/kg). PEE Safe 100% organic cotton biodegradable (OSP1) had 17 VOCs. Acetone was found to be at 591 µg/kg, highest among the VOCs detected. It also tested positive for dichloromethane, H-hexane, o-xylene, cyclohexane, M-xylene, 1, 2, 3 trichloropropane, toluene, chloroform, tetrahydrofuran, benzene, toluene, penta chloroethane, N, N dimethylacetamide, carbon tetrachloride, P-xylene, 1,1, 2-trichloroethane, 1,1,1 and 2-tetrachloroethane. **NUA Light Flow (OSP4)** showed the presence of cyclohexanone (127 µg/kg), acetone (53 µg/kg), o-xylene, cyclohexane, M-xylene, N-hexane, tetrahydrofuran and dichloromethane.


ISP1
1, 1, 2- trichloroethane
P-XYLENE
Carbon tetrachloride
o-xylene
Cyclohexanone
Penta chloroethane
M-Xylene
Cyclohexane
Toluene
Tetrahydrofuran
Chloroform
N- Hexane
Dichloromethane
Acetone
0
10
20
30
40
50
60
70
80
A


ISP2
1, 1, 1, 2- Tetrachloroethane
1, 1, 2- trichloroethane
1, 2, 3 Trichloro Propan
o-xylene
Cyclohexanone
M-Xylene
Cyclohexane
Toluene
Benzene
Tetrahydrofuran
Chloroform
N- Hexane
Dichloromethane
Acetone
0
10
20
30
40
50
60
70
80
B


ISP3
1, 1, 1, 2- Tetrachloroethane
1, 1, 2- trichloroethane
P-XYLENE
1, 2, 3 Trichloro Propan
Carbon tetrachloride
o-xylene
Cyclohexanone
Penta chloroethane
M-Xylene
Styrene
Cyclohexane
Toluene
Benzene
Tetrahydrofuran
Chloroform
N- Hexane
Dichloromethane
Acetone
0
10
20
30
40
50
60
70
80
C


ISP4
1, 1, 1, 2- Tetrachloroethane
1, 1, 2- trichloroethane
P-XYLENE
1, 2, 3 Trichloro Propan
Carbon tetrachloride
o-xylene
Cyclohexanone
Penta chloroethane
M-Xylene
Cyclohexane
Toluene
Benzene
Tetrahydrofuran
Chloroform
N- Hexane
Dichloromethane
Acetone
0
10
20
30
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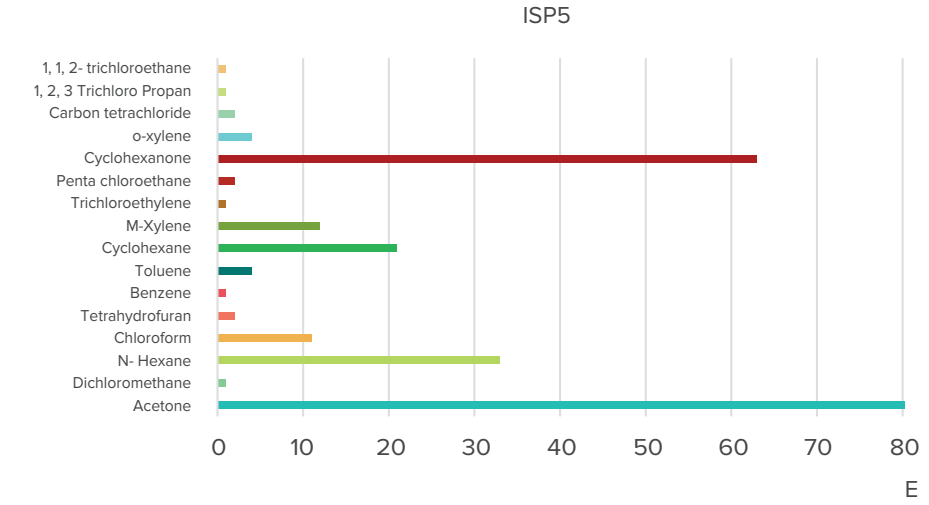
50
60
70
80

D


ISP5
1, 1, 2- trichloroethane
1, 2, 3 Trichloro Propan
Carbon tetrachloride
o-xylene
Cyclohexanone
Penta chloroethane
Trichloroethylene
M-Xylene
Cyclohexane
Toluene
Benzene
Tetrahydrofuran
Chloroform
N- Hexane
Dichloromethane
Acetone
0
10
20
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70
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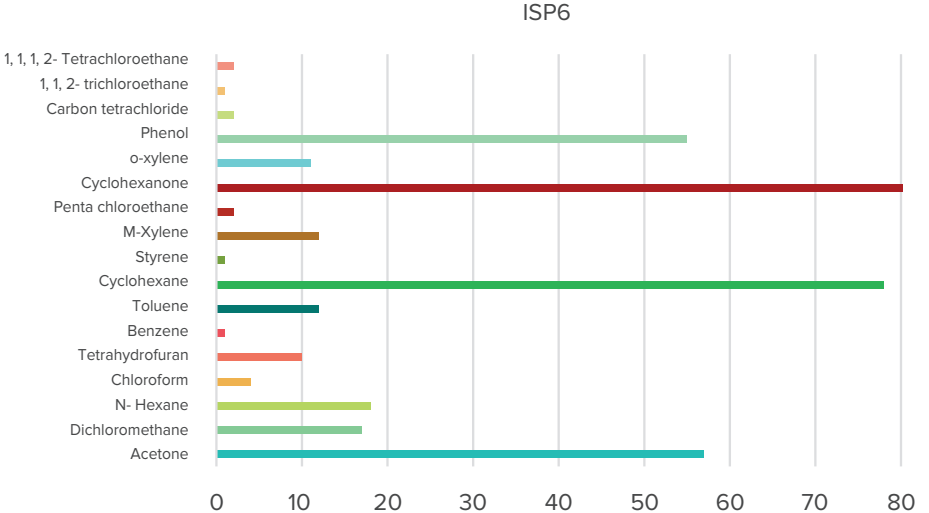
E


ISP6
1, 1, 1, 2- Tetrachloroethane
1, 1, 2- trichloroethane
Carbon tetrachloride
Phenol
o-xylene
Cyclohexanone
Penta chloroethane
M-Xylene
Styrene
Cyclohexane
Toluene
Benzene
Tetrahydrofuran
Chloroform
N- Hexane
Dichloromethane
Acetone
0
10
20
30
40
50
60
70
80

F

TABLE 5: CONCENTRATION OF VOCs IN SANITARY PAD

Compounds	Sample IDs									
Units (PPb)	ISP1	ISP2	ISP3	ISP4	ISP5	ISP6	OSP1	OSP2	OSP3	OSP4
Acetone	200	312	67	63	690	57	591	37	225	53
Dichloromethane	65	25	95	1	1	17	2	20	18	1
N- Hexane	19	18	27	7	33	18	11	16	37	7
Chloroform	7	4	9	3	11	4	3	8	5	3
Tetrahydrofuran	6	3	7	2	2	10	7	2	4	2
1,2 dichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	1	1	1	1	1	1	1	1	1	1
Toluene	10	8	64	4	4	12	7	9	14	4
Cyclohexane	37	159	69	29	21	78	22	254	56	29
Styrene	NA	NA	2	NA	NA	1	NA	1	NA	NA
M-Xylene	28	13	46	25	12	12	7	26	19	25
Trichloroethylene	NA	NA	NA	NA	1	NA	NA	NA	NA	NA
Penta chloroethane	2	ND	1	2	2	2	1	54	5	2
Cyclohexanone	60	27	231	127	63	291	66	222	91	127
o-xylene	22	10	21	50	4	11	6	19	59	50
Phenol	ND	ND	ND	ND	ND	55	ND	ND	ND	ND
N, N-Dimethylacetamide		ND	ND	ND	ND	ND	6	ND	ND	ND
Carbon tetrachloride	2	BDL	1	2	2	2	1	54	5	3
1, 2, 3 Trichloropropane	ND	1	2	7	1	NA	1	1	ND	1
P-XYLENE	1	BDL	3	1	BDL	BDL	1	1	1	BDL
1, 1, 2- trichloroethane	1	1	2	1	1	1	1	1	2	2
Trans-Di-1, 2-chloroethane	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Cis- dichloroethylene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
1, 1, 1-Trichloroethane	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
1, 1, 1, 2-Tetrachloroethane	BDL	4	1	1	BDL	2	BDL	1	1	1

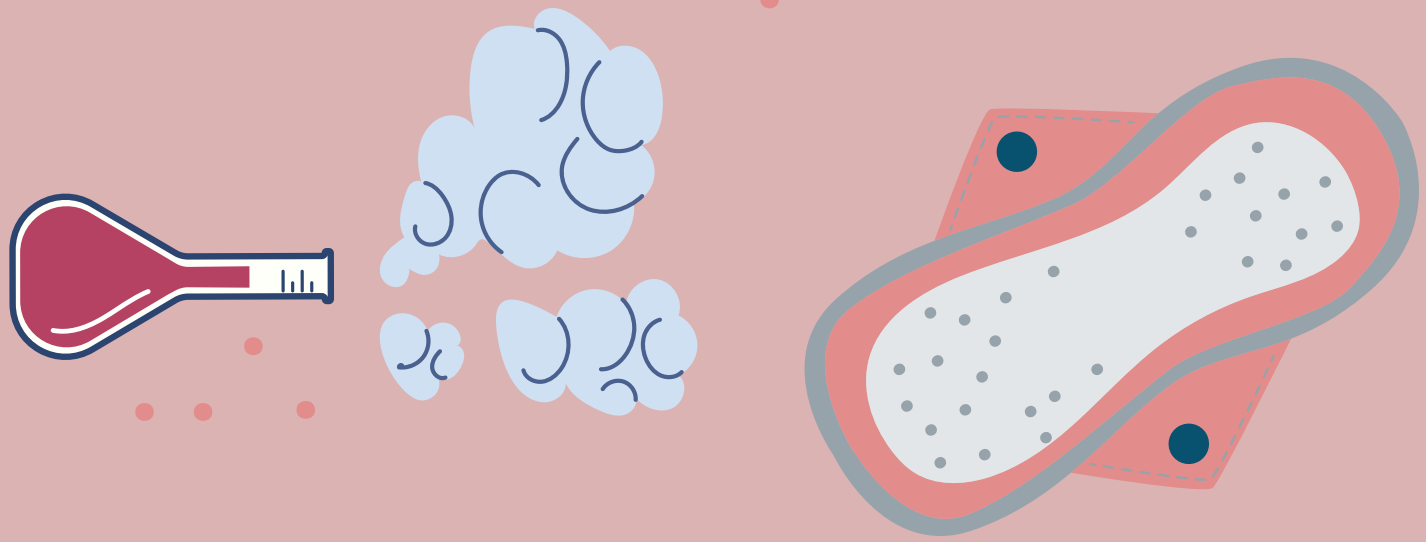
TABLE 6: CONCENTRATION OF VOCs IN SANITARY PADS (ON PER PAD BASIS).

S. No	Name	Maximum concentration (µg/kg)	Maximum concentration (µg/pad)
1	Acetone	690	69
2	Dichloromethane	95	0.95
3	N-hexane	37	0.37
4	Chloroform	11	0.11
5	Tetrahydrofuran	10	1
6	1, 2 Dichloroethane	NA	-
7	Benzene	1	0.01
8	Toulene	64	0.64
9	Cyclohexane	254	2.54
10	Styrene	2	0.02
11	M-xylene	46	0.46
12	Trichloroethylene	7-8	-
13	Penta chloroethane	54	0.54
14	Cyclohexanone	291	2.91
15	O-xylene	59	0.59
16	N, N-Dimethylacetamide	6	0.06
17	Carbon tetrachloride	54	0.54
18	1, 2, 3 Trichloropropane	7	0.07
19	1, 1, 2- Trichloroethane	2	0.02
20	Trans-Di-1, 2-chloroethane	BDL	
21	N, N-Dimethylacetamide	BDL	
22	Cis- dichloroethylene	BDL	
23	1, 1, 1-Trichloroethane	BDL	
24	1, 1, 1, 2- Tetrachloroethane	4	0.04

Average weight of sanitary pads is 10 gm.

Key Findings

- Phthalates and VOCs found in all samples, including organic and inorganic samples.
- DIBP, DBP, DEP, BBP, DEHP, DPP and DHP most commonly detected phthalates.
- The highest concentration of phthalates detected in the test sanitary pads was 19460 **µg/kg of DIDP** in an organic pad - Plush 100% Pure US cotton.
- Concentrations of a combination of phthalates were found to be 0.0321 and 0.0224 gram in OSP3 and ISP3 respectively, which is greater than 0.1% by the weight of the product mandated under EU regulations.
- The highest concentration among all the VOCs detected was for acetone at 690 µg/kg in Bella Regular Drai Wing s (ISP5), an inorganic pad.



Conclusion and Recommendations

Menstruation or Periods is a monthly, natural occurrence for the vast menstruating population across the globe, including girls, women, transgender men and non-binary persons of reproductive age. But menstrual health has been often an ignored issue, mainly because it is considered, in most cultures, a taboo subject- something which is to be discussed in whispers and wrapped in secrecy to avoid attention.

In the last decade or so though, menstrual health is beginning to be recognized as not just a health issue but also as a human rights issue in the global agenda. Though menstrual health is not explicitly mentioned in the Sustainable Development Goals targets, it does have clear linkages to health, education and gender equality issues. There have been several reports of menstruators facing social exclusion and these stigma related barriers impacting access to opportunities including their rights to education, work, sanitation, freedom and gender equality – and most importantly to good health. This recognition has led to governments trying to improve access to menstrual products by providing or subsidizing menstrual products for those who cannot afford them.

Government schemes on menstrual health in India primary focus on educating menstruators and improving access to menstrual products and in most cases include free distribution of sanitary pads, mainly disposable, commercial ones. In absence of proper standards, these schemes usually pick up the low cost or easily available products in the market. Studies have indicated that menstruators, especially young girls benefit tremendously from these schemes. But what is often missed is the impact these pads on health of users.

AS A MUCOUS MEMBRANE, THE VAGINA IS CAPABLE OF SECRETING AND ABSORBING FLUIDS AT A HIGHER RATE THAN SKIN.

This study found that all sanitary pads surveyed (inorganic as well as organic) contained both VOCs and phthalates. The amounts measured were different among the brands. As stated in the earlier sections, Phthalates, have been linked to a variety of health concerns including endocrine disruption, impacts to the heart and reproductive systems, diabetes, some cancers, and birth defects. Exposure to VOCs increases the risk of brain impairment, asthma, disabilities, certain cancers, and the proper functioning of the reproductive system. Considering the fact that women are exposed to a cocktail of chemicals through various pathways, the study findings indicate the risks of additional chemical exposure through sanitary pads. This is crucial to look into, especially as there are very limited data or information available to demonstrate the effect of cumulative chemical exposure to health. In case of exposure through sanitary pads, it is also of critical concern because of the exposure route site, i.e. vaginal area, and the long-term exposure period. The pads come in contact with some of the most sensitive and absorbent tissue in our bodies.

In absence of adequate standards and lack of proper labeling requirements mean that users have no way of making informed choices. Being a consumer product, sanitary pads are regulated under a BIS standard but these do not require any evidence of safety of raw materials. These standards

are old and hence need to be looked into, as products have changed over time, with many additives included now to attract consumers. Detection of these harmful chemicals in both inorganic as well as organic products also clearly points that an 'organic label' is not enough. The use of chemicals is of particular concern as current regulatory checks are not sufficient to ensure the safety profile of these ingredients and enforcement is not robust.

Menstrual health and hygiene are of utmost important, but menstruators expect safe products; the current study raises questions on that aspect. Though the study had limitations, mainly in terms of the number and types of products included in the study, most of the popular and accessible sanitary pads were included. Presence of phthalates and VOCs in the pads indicate the exposure risks menstruators might be having. More research and testing are clearly needed to better characterize and understand the potential health impact by the exposure, especially long-term and cumulative exposure. The study finding raises a concern for the safety of using some of the products and stresses on the need for efforts to reduce VOC and phthalate contents in these products.

Recommendations

People who choose to use menstrual products available in the market deserve to have access to safe products and have the right to know what ingredients they are being exposed to.

- A thorough investigation on the presence and potential impact of the exposure to VOCs and phthalates to the menstruators through use of sanitary products and other female hygiene products needs to be taken up.
- Government and standards making bodies should be framing Standards for chemicals (phthalates and VOCs) in sanitary products.
- It should be mandatory for Producers to disclose the list of product ingredients. Mandatory labeling to disclose ingredients should be brought in to ensure chemical disclosure.
- Responsible advertising will ensure that Producers provide relevant information and adequate warnings on the product.
- Research and use of safer chemicals which could substitute these harmful chemicals in menstrual products is required.
- There should be regulations and schemes to promote substitution or reduction in the use of harmful chemicals like phthalates and VOCs.

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