

# Odorless Intimate Garments Made Of Tourmaline Infused Cotton Fabric Produced Via A Screen Printing Process

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## Abstract:

In recent years there is a great demand for anti-odor or odorless intimate garments. The present study relates to odorless intimate garments manufactured out of inferior quality tourmaline powder (natural gem variety) adhered cotton fabric produced via a screen printing process. The design on both sides of the fabric is created out of 5% to 10% tourmaline powder (63 $\mu$ m mesh size) mixed with high opacity screen printing paint. This pattern introduces humps and valleys (0.5-1mm) on cloth leaving room for natural aeration throughout the clothing. The air circulation provides more comfort and keeps away germs, eliminating bad smells. In addition, this humps and valley structure infused with tourmaline powder gives additional strength (reinforcement of the fabric), enhancing its durability and firmly supports the intimate parts of the body. On the other hand these intimate garments maintain their size and shape for a longer period without unwanted stretching, thus prominently displaying the natural curves of the human body.

The tourmaline variety used here is called 'Schorl' a black variety generally not used for jewellery. Hence the embedded tourmaline powder is a completely natural substance and by taking the radiation temperature rise of the fabrics, far-infrared performance of the fabric was determined. In addition emission of negative ions was tested. Both emissions are completely natural and do not create harmful side effects for humans. Antimicrobial property was indirectly tested and results provide that tourmaline powder is capable of subduing or inhibiting bacteria on our body that feed or consume sweat.

All these properties help to eliminate growth of skin microbiota, thereby, ultimately creating an odorless environment. In view of the fact that most people wear intimate garments for long durations; this sort of odorless garments provide therapeutic effects for the entire duration of their use, thereby promoting a healthy life.

**Key Word:** tourmaline, odorless, Far-infrared radiation, intimate garments, negative ion

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## I. Introduction

All types of underwear including conventional bra, panty hose, swimwear, sports bra, inner-vest, maternity underwear, body shaper, and corset are considered as intimate garments. In order to develop intimate garments it is necessary to consider the beauty aspects, health aspects, human anatomy and anthropometrics<sup>1</sup>. Among them comfort characteristics are more important than that of outerwear because it contacts directly with skin and creates an inner layer between the skin and outerwear<sup>2</sup>. As such the consumers expect thermal, aesthetical, sensorial, hygienic, and motional performances from intimate garments<sup>2</sup>.

In recent years most people are mainly interested in fashionable intimate garments and not consider the health aspects. Due to the busy schedule they wear these garments for longer duration and face numerous skin disorders. Yet there is only a specific segment of consumers who seek antimicrobial, antioxidant, anti-inflammatory and anti-odor textiles /clothing capable of promoting healthier lifestyle and to retain their self-esteem<sup>3</sup>. People believe that body sweats are the main cause of bad smells emitting around places like crotch, genitals, groin and armpits. Yet it is found out that some bacteria on our body that feed or consumes sweat, resulting in breakdown of acids in your sweat and that creates body odor. On the other hand, certain diseases or hormonal changes also can trigger body odor<sup>4</sup>. Such odors are mainly organic compounds, which contain different functional groups and chemical structures. Such as amine, alcohols, aldehyde ketone phenols etc.<sup>5</sup>. On the other hand consumption of garlic, onions, alcohol and some medicinal drugs can also boost the odor produced by the body<sup>6,7</sup>. Some conditions such as sporting, exercise and hardworking generate more sweat inclining to bacterial growth causing odor.

In order to subdue or inhibit the **odor** by preventing bacterial growth or neutralizing the bad smell in the textile and keeping the fabric and the wearer fresh and comfortable requires anti-odor or odorless intimate

garments<sup>8,9</sup>. To produce these cloths so far natural fibers such as bamboo and some Nano particles such as silver, copper, zinc, magnesium, gold, tin, antimony, zirconium, nickel, titanium, activated charcoal and some of the composites were used. Once the bacteria are eliminated they can no longer produce any kind of smell<sup>10</sup>. However the harmful side-effects of these biocides are not completely understood and some cause oxidative stress, apoptosis, and inflammation in cells while some metallic compounds are suspected to cause neurotoxicity<sup>11,12</sup>. Metals on the other hand, known to be extremely toxic in both free and bounded states<sup>11</sup>. Next to health effects there can be resistance problems, and also environmental problems<sup>11,12,13</sup>.

The common technical problems that exist in most intimate garments are their early deterioration and short lifespan. Very soon these could become saggy and incapable of properly supporting the intimate parts of the body. Later on these do not match the natural curves of the human body and sometimes diminish the natural beauty of a person. These arouse discomfort during a prolonged period of use and sometimes cause skin rashes. These emit bad smells when used for a long period. These lack the mechanism that provides long-term health benefits for the user. Anyhow, most of today's undergarment manufacturers cater only to promote fashion trends and do not consider health and odor problems. On the other hand, the so-called anti-odor intimate garments are very expensive and their harmful side effects are not clearly understood.

As such for this study tourmaline infused cotton fabric produced via a screen printing process is discussed (Figure 2). The tourmaline variety used here is called 'Schorl' a black variety generally not used for jewellery (Figure 1). As such these tourmaline crystals/crystal fragments are discarded by Sri Lankan miners and could be collected either free or several kilograms for a paltry sum.

Several researchers have confirmed that tourmaline powder emits Far-infrared. Far-infrared rays activate some functions of the body helping to obtain a healthy life. Hence known as the "light of life"<sup>21</sup>. It has some capacity to penetrate the hypodermis up to a certain extent and resonate the water molecules within the body and work against inflammation by way of promoting human blood microcirculation<sup>14,15,16,21</sup>. As such used in intimate garments and health related textiles<sup>17,18,19,20,21</sup>. In recent years health aspects of tourmaline are widely discussed among the scientific literature. Therefore, intimate garments infused with tourmaline that can emit far-infrared have a broad application prospects<sup>21</sup>.

The other advantage of tourmaline is the emission of negative ions. These generally produce within or near waterfalls or when sea waves break down at the shore. Negative ions have potential health benefits such as purifying the air by adsorbing dust and hazardous substances<sup>22</sup>. As such the effect is called "vitamins and auxins" in the air<sup>23,24</sup>. Negative ions enhance the vitality of the body reducing the heart rate and temperature during hot working days<sup>25</sup>. In addition, inhibit the growth of bacteria and fungi<sup>26</sup>. On the other hand, it promotes blood microcirculation and enhances metabolism<sup>27</sup>. Tourmaline emits negative ions due to its natural polarization phenomena<sup>28</sup>.

Tourmaline crystals exhibit piezoelectric as well as pyroelectric properties. It has spontaneous and permanent poles capable of producing electric dipoles<sup>29,30,31</sup>. As such, the tourmaline was used in numerous innovative fields. Because of the piezoelectric and pyroelectric properties tourmaline is capable of destroying hydrogen bonds within water molecules. As such growth of microorganisms may be affected, diminished or reduced<sup>32</sup>.

## **II. Materials And Methods**

The tourmaline used here is an inferior quality material collected within tailings of Sri Lankan gem mines, locally called "Benz Katta" or "Kalu Katta"; this is actually a tourmaline variety called 'Schorl' (Figure 1). To carry out this study tourmaline crystals were grinded using ring mill and 63 $\mu$ m mesh size powder separated using a geological sieve shaker. Thereafter two screen printing paint mixtures were prepared adding tourmaline powder in the ratio (63 $\mu$ m mesh size) of 5% w/w and 10% w/w respectively. The viscosity of the paint was maintained in such a way as to carry out the screen printing process in a smooth manner (Figure 3). The stencil of the screen printing pattern was prepared in such a way as to produce a simple pattern leading to an alternating hump and valley texture on the cloth (0.5-1mm) (Figure 2). The selected screen printing paint is an expensive opaque paint which is nontoxic. In addition to the two sets of cotton cloths infused with tourmaline powder 5% w/w and 10% w/w another set of cloths painted with plain paint for the investigation of far-infrared performance. Another set of tourmaline infused fabric (10X10 cm) pieces were also selected to test for the emission of negative ions.



Figure 1: inferior quality tourmaline crystals, a tourmaline variety called 'Schorl'



Figure 2: Tourmaline infused cotton fabric having alternating hump and valley texture (0.5-1 mm)

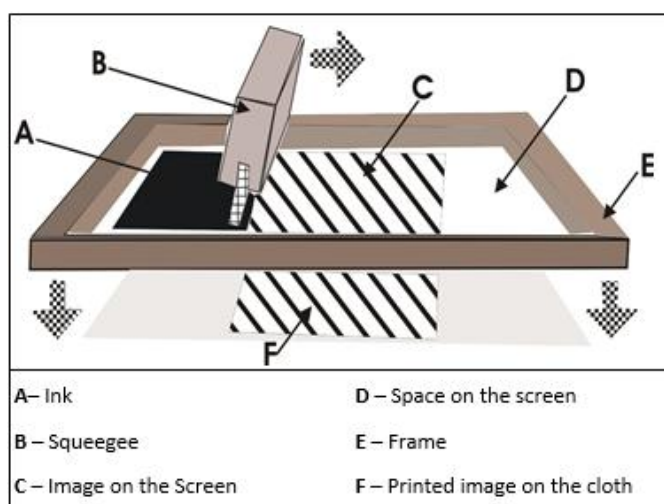


Figure 3: Schematic diagram depicting the screen printing process

### Far-infrared radiation performance

Several researchers utilized tourmaline powder to produce a number of innovative products and confirmed that tourmaline products emit far-infrared rays. As such the emission of Far- infrared intensity was measured for the two sets of fabric samples categorized as 5% w/w and 10% w/w tourmaline bearing respectively with the assistance of Atomic Energy Authority of Sri Lanka. The cotton fabrics infused with tourmaline powder 5% w/w and 10% w/w alone with fabric having the same design printed with the same paint without the addition of tourmaline powder are subjected to radiation from the infrared lamp, are shown in Figure 4 and Figure 5. The test results showed that the far-infrared emissivity was 0.83. Once the fabrics are exposed to an infrared lamp for 10 minutes the following results were obtained. The tourmaline powder 5% w/w infused fabric shows an increase of temperature 26.1°C whereas 10% w/w infused fabric shows an increase of temperature up to 28.7°C after the same amount of radiation. These results indicate that far-infrared emission wise 10% w/w tourmaline infused fabric is better than the 5% w/w tourmaline infused fabric.

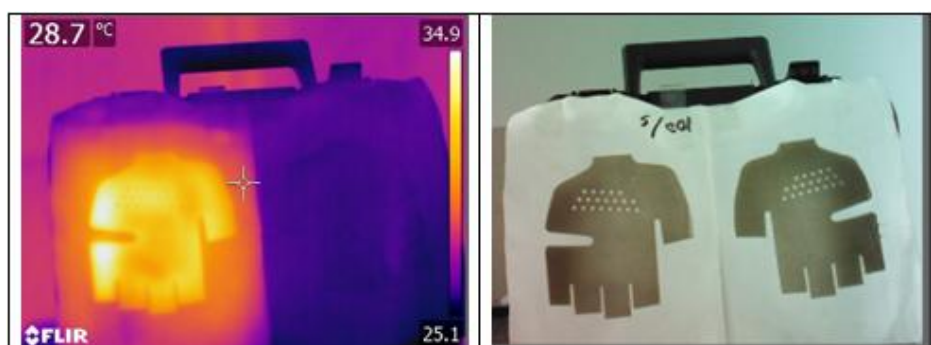


Figure 4: 10% w/w tourmaline powder infused fabric shows increase of temperature up to 28.7°C compared to same fabric with same design without the addition of tourmaline powder (after 10 min of exposure to radiation).



**Figure 5: 5% w/w tourmaline powder infused fabric shows increase of temperature up to 26.1°C compared to same fabric with same design without the addition of tourmaline powder (after 10 min of exposure to radiation).**

### Emission of negative ions

The samples taken from either set were subjected to the emission of negative ions at the Atomic Energy Authority of Sri Lanka. It has been experimented and proved throughout the world that tourmaline when exposed to temperatures above room temperature an irregular electron of each of its molecules escapes from its orbit and produces a negative electron, which in turn ionizes the surrounding air, resulting in negative ions. In general, the human body temperature is 36.5°C. Once the human body is in contact with tourmaline embedded clothing the above condition is fulfilled, therefore, the emission of negative ions takes place for the entire time the body stays in contact with tourmaline powder embedded cotton fabric.

10X10 cm fabric pieces embedded with 5% w/w and 10% w/w tourmaline were subjected to a negative ion test at room temperature and the test revealed that the emissions were 220 ions/cm<sup>2</sup> and 370 ions/cm<sup>2</sup> respectively. These items were then kept in an oven where the temperature was maintained at 36.5°C for a period of four hours, thereafter a test was carried out to estimate the negative ion emissions, which revealed that the values were 821 ions/cm<sup>3</sup> and 1154 ions/cm<sup>3</sup> respectively. This explained and confirmed that the tourmaline infused intimate garments while in contact with the human body (36.5°C) could also produce negative ions.

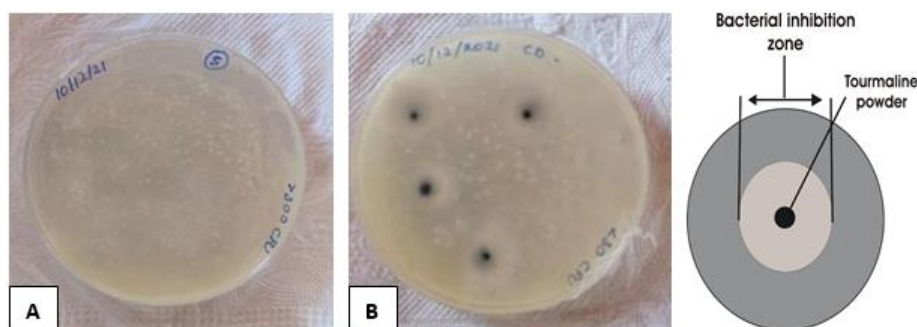
### Antimicrobial property of tourmaline

It is understood, experimented and confirmed throughout the world that the bad smell emitted from most of the undergarments worn by human beings is due to the breakdown of acids within sweets generated around human intimate parts. Most of the odorless intimate garments manufactured throughout the world have some mechanisms to react against the bacterial growth. Following experiment was carried out in two stages in order to identify the antibacterial property of tourmaline powder (63 µm mesh size).

**1 Stage** – On a hot day sterilized cotton bud was wiped over the intimate parts such as crotch, groin and armpits of the author and placed inside a petri dish containing distilled water, thereafter the contents were thoroughly shaken.

**2 Stage** - 4 mg of tourmaline powder (63 µm mesh size) were added to wells (holes created in agar) in a nutrient agar filled petri dish (B) and then the sample solution prepared in step 1 is added using a dropper at equal distances around the edge of the petri dishes (A and B), thereafter the petri dishes was kept inside the incubator for 48 hours.

The result clearly indicated that tourmaline powder has an antibacterial property because a certain area around the periphery of tourmaline bearing wells did not indicate any bacterial growth (B). In all other areas the bacterial growth was visible (B) whereas bacterial growth was also observed in control petri dish (A) Figure 6 .



**Figure 7: A is a control (no tourmaline added only the sweat) whereas bacterial inhibition zone was observed all around the tourmaline powder bearing wells within B**

### III. Conclusion

- The study exclusively uses natural mineral tourmaline powder along with accepted nontoxic opaque screen printing paint on 100% cotton fabric compared to metal /metal composite infused expensive intimate garments (having some health related harmful side effects) used elsewhere. The material tourmaline (Figure 1) is readily available in Sri Lanka (several kilograms for a paltry sum). On the other hand screen printing is a relatively inexpensive simple process and does not require heavy machinery or advanced technology (Figure 3).
- The alternating humps and valleys (0.5-1mm) texture created on the cloth as a result of the screen printing process contributes more strength to the under garments increasing its life span (Figure 2). This sort of texture provides enough room for natural aeration within the clothing while it is worn by an individual. In addition, the above texture eliminates the feeling of unease and smells experienced due to prolonged use of undergarments, promoting cheerfulness.
- Because the garment is reinforced with hump and valley texture on both sides it provides total support for the intimate parts of the body and also prominently displays the natural curves of the human body.
- This type of odorless intimate garments are rather inexpensive to produce when compared with the prices of any other odorless intimate garments available in the market and do not include harmful substances or side effects.
- Diminishes bad smells and common allergies compared to other types of intimate garments.
- These tourmaline powder embedded under garments emits negative ions, which are found to be vital in relieving various ailments of human society, including states such as depression. Negative ions also have properties that accrue various benefits to health such as improved blood circulation; the enhancement of the immune system; stress relief, and the stimulation of cell metabolism. Positive ions may create free radicals, which are detrimental to our health.
- Far-infrared emissions of the intimate garments help to enhance the blood circulation of the skin; ease pain; guard against oxidative stress and relieve inflammation.
- Antibacterial property of tourmaline reacts against bacterial growth and safeguards the intimate parts of the body as long as it is in contact with them for the entire duration the undergarments are worn.

This is only a preliminary study conducted with only limited budget, limited facilities and during the summer holiday of the university (two and half months). As such further research is necessary to ascertain the suitability of tourmaline infused cotton intimate garments produced via a screen printing process.

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