Naturally dyed trail wear for wild running forest gatherers.

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Abstract

This work explores natural dye's ability to be used for trail running wear. The sustainable aspects in the clothing industry includes the production of nontoxic textiles that do not pollute in the production process nor when using the textile close to our bodies. Natural dyes usually have low toxicity and are produced from renewable resources. The explorative nature of trail running is used as a guide and an entrance exam for the dyed fabrics to prove wash- and lightfastness durable for the sport. The idea of colouring clothes directly with nature is present in dirt prints printed with natural pigments. Organic printing with rust and vegetable oil is explored as an alternative to screen printing. The movements and comfort of running outdoors is understood by body indicated experiments as a method. Pattern construction is made from movement and sensation by exposing the body to friction, dirt and cold air. The results of these experiments were together with reshaping existing run wear the construction method. This work suggests viewing colour as nonstatic and with more dimensions such as locality and smell. By using slow dye processes and locally accessible dye materials unique expressions from natural dyes, prints and patinations can enhance sportswear in the appearance, health and environmental aspect.

Keywords

Natural Dye, Chemical, Trail running, Sportswear, Sustainable, Pigments, Chromatic, Toxins, Print, Dye, Dirt.
Introduction & motive

The cocktail

The interest for the sustainable aspects of sportswear has increased during the last years. As an example, outdoor brand Patagonia only uses environmentally friendly fibres such as recycled polyamide and polyester (Patagonia, 2014). Approximately 25% of the chemicals manufactured globally are applied in the textile industry (Greenpeace, 2013). These chemicals are applied for the process of production and for the functionality in our garments. Examples of this are fire retardants, impregnations and preservatives that prevent mould in transports and storage (ibid).

In general the word “chemical” is understood as a harmful synthetic substance. In fact, the term applies to any compound, natural or synthetic (Bortman et al, 2014, p. 233). The meaning of toxins is defined as:

“Toxins are chemicals or physical agents that exert a toxic effect on living organisms. Toxic means poisonous: that is, causing a reaction with cellular components that disrupts essential metabolic processes.”


Mannmade chemicals from pesticides, food, plastics and textiles end up in our bodies, as the documentary Submission from 2010 explains. In the documentary, film director Stefan Jarl tests his blood to examine what chemicals are in it. The film describes the issue of chemicals and plastics invented since World War II and how they affect the health of people around the world. This accumulation of substances worries a lot of us as research indicates (Tørsløv et al, 2011) that combined exposure to multiple chemicals can add up their effect, which lead to a much larger one than the chemicals would have individually. According to Tørsløv this is known as the cocktail effect. It is time to learn more about toxic free alternatives when dyeing and printing textiles.

The health aspect of textile dyeing

The dyeing process is resource intensive in terms of water, energy and chemicals and produces effluent that can be highly coloured, with textile dyes being the most likely source of metal pollutants such as zinc, copper and chromium (Fletcher, 2008). In countries with poor working conditions and few environmental protection regulations, dyeing and printing can pose a serious threat to human and environmental health (Swedwatch, 2007). Reducing this threat is a complex task since no single dye method or colour can be singled out as having the worst environmental load (Fletcher, 2008).

When focusing at the health aspects of textile dyeing, the most common contact allergy is one to disperse dyes (Ryberg, 2009). Certain disperse dyes have led to causing allergic reactions particular when they are used for skin-tight clothes made of synthetic fibres (Christie, 2007 p. 49). There are certain problems with polyamide dyed with disperse dyes, since the low sweat fastness allows the small lipophilic (fat clinging) particles to migrate into the skin (Christie, 2007). Can natural dye be an alternative when dyeing polyamide and polyester, and can allergic reactions be avoided by their use?

Lina Sofia Lundin writes in her work the Colour Manifesto – The expanded field of composting how compost can be used to dye garments (2013). She describes how the food she eats becomes connected to the clothes she wears and encourages us to try compost-dyeing. This idea is quite revolutionary, that nontoxic textile dye can be found in our garbage.

The advantages of natural dyes are low toxicity and allergic reactions and good biodegradability because they are taken from animals or plants without chemical processing (Flint, 2007). In contrast, their disadvantages are time-consuming harvesting that depend on seasons and therefore becomes costly. Further, the light and wash-fastness tend to be lower compared to synthetic dye and its repeatability is weak (Bhanu, 2014).
Natural dyes and pigments today

There are examples of clothing that take advantage of the skin’s ability to receive substances. Firstly, to incorporate microcapsules of Aloe Vera in textiles has been proven antimicrobial (Selvi et al, 2011). The technique is applied in sportswear by Proskin. Proskin use Aloe Vera (antimicrobial), caffeine (cellulite reduction), retinol (moisturising), ceramides (skin-caring), vitamin E (anti-ageing) and fatty acids in their slimming tights (Proskin, 2014). Secondly, Ayurvastra is a clothing label and a concept of creating fabrics dyed with plants and herbs from the Ayurveda system medicine (Noor, 2014). The dyes for Ayurvastra fabrics typically contain between 40 and 60 specifically blended medicinal plants, which are selected by Ayurvedic doctors who claim that they have a beneficial impact on the body’s own immune and natural healing systems. Ecological cotton is used as fabric and natural mordants are used in the dye process. See figure 2. The fact that this dye method doesn’t leave toxic residues and gives biodegradable fabrics is promising. Although the clothes are pale in pastel colours that can’t compete with the luminous colours of the gym wear section in a western sports store. See figure 3. Dyes from plants can affect our health proven by a study from 2005 where researches found antimicrobial activity from fabric dyed with Quercus infectoria/Aleppo oak (Singh et al). As a third example of sportswear with a health conscious direction stands Japanese yoga wear label Chandra. Their naturally dyed organic cotton comes in saturated hues and gives an idea of the potential of natural dyes for sportswear, even though cotton jersey is the only material they use (Chandra, 2014). See figure 4. Amongst artists and designers there are several who works innovative with natural ways of dyeing and printing. In 2012, fashion designer Daniel Larsson proposed an alternative to dyeing by wearing a shirt for 4 months without washing (Larsson, 2012). See figure 5. The worn dirt was accepted as the dye. Through this work, natural dye could be natural dirt and the wearing can be a process of colouring. Seeing dirt as something accepted and wanted is an approach that could be part of sustainable clothing habits for the future. The artist Jeanette Schäring works in an organic way with natural pigments, textiles and water in site-specific processes. She sees her work as an ongoing dialogue between location, flora, water, people, time, light and sound. She uses the dynamics of natural dyes to highlight change. As an example is the collective water installation made with chopped parts of one single tree/bush soaked in water that has been collected from different areas. See figure 7. The different composition of the water makes the hue different in every jar. Viewing water as a developer, that can communicate and reveal substances is interesting. When discussing fashion, Schäring compares to wine. She suggests that plant dyes can become a possible vintage shade, an added value in fashion (2014). Another artist working with natural dyes is India Flint. She developed an eco-printing method inspired from the Latvian Easter tradition of colouring eggs wrapped with herbs. By using receivable fabrics, leaves and flowers prints their marks directly onto the fabric. See figure 8. Printing the shape of leaves by using the leaves is referring to an ancient way of dyeing naturally. In addition, another form of printing is block printing, made traditionally in India with natural dyes. See figure 6. Several studies indicate that natural dyes can be used for screen-printing and ink-jet printing (Savvidis et al, 2013). These reports define natural dyes in a modern way and allows natural dyes to be used in the same style as conventionally screen printed or digital printed textiles.
Natural dyes are varying in appearance; the colours can shift from year to year due to earth type, growing area, weather, season and the water used in the dyeing process. It can be perceived as an uncertain, dynamic and organic dyeing method. This is intriguing for someone who wants to dye her own clothes. Do natural dyes have to be perceived as something uncertain? If natural dyes could be viewed as durable and reliable, could they become a serious alternative for industrial dyeing? Are there lots of pigments in our close surroundings that can be used with little effort? Could they compete with synthetic ones in appearance and performance?

**Trail running**

Running is accessible and can be easy to learn. A pair of shoes is everything one needs to start or not even that according to barefoot campaigners like Christopher McDougall (2011). Running is also proven to be one of the most effective methods of stress reduction and anxiety control (McQuaide, 2012). These facts are important in the choice of activity that will carry this work's target. Trail running is the wilder and more robust form of running. The definition is simply to run and hike over trails (Chase, 2010). The activity can be understood as a reflection of freedom and spontaneity since it is not even necessary to follow the trail, the running can also be used as a way of exploring nature. The body’s movements are varied when adapting to various grounds. This way of moving was chosen to be my guideline and the requirements for this sport would work hand in hand with my aim of finding functional and reliable aspects of natural dyes. The more extreme version of trail running practises running for days, this survival aspect is also an interesting angle to investigate.

Run wear for trail running is today quite similar in colour and cuts. Neon colours combined with black and slim cuts dominate as in the example of a run jacket by Gore. See figure 10. As our need for active wear increases for everyday wear as Jesper Danielsson (2013) argues, more alternatives for run wear are required to respond the demands of an ethical, environmentally conscious and colour-loving future consumer.

From the health perspective, there is not any possibility today to know exactly what dyes and processes have been used when consuming sportswear. The certifications of Bluesign and Oekotex are useful when choosing a garment from a production with concern of the environment and health. Still, for curious and skin sensitive consumers more information is wanted. This work is aiming to find ways to colour garments for a possible industrial production, as well as to make us understand and take in our hands what natural colours could be created in a DIY manner. Further, the aim is to update natural dyes in order to promote its advantages. This work attempts to prove that it becomes a credible alternative to synthetic dyes for sportswear.
Aim

This work is aiming to explore the saturated chromatic hues of natural dyes to develop nontoxic trail running wear.

General methods

When discussing design methods, let’s take a look at the craft movement and the evaluation matrix as two totally different ways of designing. According to John Chris Jones, the craftsman’s way of making an object is a process that evolves through generations. This process produces products with organic, naturally-evolved forms (1992). Significant for this way of making products is that it is slow and costly although it gives a well-balanced result and a close fit to the needs of the user (Jones, 1992). He continues by explaining that the craftsman does not draw his work and neither can he give any clear reasons for the decisions he makes. Without the facility to pronounce clear reasons this method is more a subconscious and intuitive one.

An evaluation matrix is a mathematical and logic tool that creates objective answers to several parameters of the design demands. See figure nr 11. The parameters important for both function and look can be defined and evaluated by a scale of numbers. The graded alternatives create a support for designers decisions.

When mixing the subconscious nonspeaking method with the logic and highly pronounced, a balanced result is expected. The dye exploration in this work relates to these two methods. An intuitive outset is a way to learn about the dyes, where to find them and to freely experiment. When the textile is dyed, a more logic and objective approach sorts out the dyes with low test results.

Figure 11. The evaluation matrix can be a helpful tool for making logic design decisions.
Experimenting as a research method is a scientific method invented to gain empirical knowledge. (Franklin, 1998). Experiments play many roles in science. By experimenting one can test a hypothesis, and the experiment can by this use tell if a theory is correct or not (ibid). Further, an experiment can illustrate a new phenomenon that is in need of explanation and be the base for a new theory. Another use of experiments is to investigate without theory, just because something looks interesting. Such experiments can provide results for a future theory to explain (ibid).

Experimenting in fashion design can relate to social and collaborative aspects like in the example of hacktivism by Otto von Bush (2008). By exploring new forms of craftsmanship he displays many alternatives to the conventional role of the designer. As one example, a craftivist creates her own things by hand from a political perspective, and as another, a fashion hacker is breaking the lines of control in a society (von Bush, 2008). These experimental approaches to fashion design are without clear boundaries. The idea of this work relates to Bush’s work in the craftivist meaning. When learning the craft of dyeing textiles one have more alternatives and in this meaning are becoming freer.

Specific methods

The first problem this work dealt with was “How can this work find natural dyes in saturated colours that could compete with the colourful sportswear of today? ”

When considering natural dye for the industry, even on a small scale, the parameters of evenness, repeatability, light and wash fastness are of great importance (Grose, 2012). Even more claims are expected of trail running wear, wicking properties, abrasion resistance and the fabric needs to stand frequent washing. By evaluate the outcome throughout this project by wash tests, light tests, and by running in the toiles the parameters above will lead the work in its right direction. Therefor it was decided that every dye sample would be washed after dyeing with common washing detergent to ensure washing stability. Professional wash- and light fastness tests were needed to ensure a reliable outcome. The wash fastness was tested with washing method nr 6A according to EN ISO 6330:2006A. Dye samples were washed in 40° C with Skona kulörtvätt washing detergent for coloured material. For light fastness, a test according to SS EN ISO 802 (A) was planned.

When designing for the moving body there are different approaches. Again, the logic or the intuitive path can be chosen. For the logic one stands Wang as a good example. By measuring a body exactly in the running movements, he developed a systematic dynamic pattern construction method for high-performance wear (2011). Since our bodies are complex sensing receivers, they can give so many answers to the design problems. The intuitive aspect of creating sportswear is interesting to follow. How can the slow, crafted and intuitive design method inspire sportswear? Can the body make its own constructions?

The starting point for developing the form of this work was decided to be the female running body, preferably outdoors. To clarify what parameters this work needs to aim for, the requirements for trail running wear were defined as:

1. Be comfortable/allow movement.
2. Compress arms and legs.
3. Protect the body from harsh vegetation.
4. Be lightweight.
5. Endure frequent washing.
6. The weight of the pockets should not restrict running.
7. The material closest to the body need to absorb moisture.

Further, some criteria were developed for the feeling and look of the collection:

1. The garments could be worn in an urban environment because one feels cool enough.
2. The outfits should be in harmony with the nature that is explored when running.
Development

Body sensing design method

This draping method is based on using white toiles and exposing the body to experiments. During or directly after the exposure a marker or colour is used to clarify the result. See figure 12. Next, the toile is studied on a dummy, markings sharpened and the toile is cut open to be reworked into a new construction. This is repeated until a satisfying result is reached. This method seemed like logic and direct way of testing movement and to visualise the sensations of running. The measuring body in these experiments is my own.

The copy-rework method

The second method was a copy-rework method which used existing contemporary run wear as a start. Firstly, a copied toile in white was tested in outdoor running by myself. See figure 13. After that, changes to enhance running movements was made by draping on myself or a live model. A new toile was made and then tested again. This method allows to easy and fast making changes to already working constructions.

Figure 12. The sweat experiment shows the example of the body sensing design method.

Figure 13. The copy-rework method.
Experiment nr 1: Friction

The first experiment was designed to explain where the body touches itself in the running movement, to create cuts outside these areas and adjust the fabric for a perfect feeling when running. A basic tight fitted one piece served as the empty canvas. As indicator, shaving foam that scraped off when running was applied to the body. The areas where the foam was scraped off were marked.

The markings became a reference when placing cuts for all garments in the collection. More visible, outfit nr 1, 3 and 5 has no seam under the armpit. It is of importance that the fabric for the friction areas is comfortable and feels soft, can absorb moisture and stand abrasion. Variations of the cuts were developed from the first toile into a firts layer made with polyester and wool.
The variations of cuts developed from the friction experiment.

From the chosen Salomon tights and the result from the friction test variations of cuts for running tights were developed. The pictures above display how the inner seam was moved to the front of the thighs. While this cut didn’t perform in a good way when tested because it made the fit of the tights looser, a more traditional placement (marked) of the inner seam with a diamond shaped gusset was chosen for the most comfort and best display of the prints.

The friction test also had great importance for the outfit nr 3, the first layer top and pants. The top is designed for a more comfortable fit around the arm. The movement when running is repetitive what one wear could enhance the experience by perfect fit and suitable materials. Wool is a material with good properties for the colder climate. Knitted together with microfibre polyester it becomes a durable and warm material. The sleeves are extended to ensure warm hands. The close fit around the arms with cuts that follow the bend of the elbow is making the arm pendling more comfortable.
Experiment 2: Dirt

This test was made originally to understand where to use reinforced fabric and where to use lightweight fabric for the design of a jacket and tights. The clothes used for the test was a pair of white tights and a white copy of a Nike running jacket with hood. When running through the forest against the mud-covered, harsh branches and falling on the ground the forest dirt was used as an indicator. By falling in the mud the extreme version of getting dirty was explored. When the dark mud left its graphic effect on the clothes, an interest occurred of the decorative element of the dirt and how this could enhance trail running wear. Would already dirty looking garments make the wearer feel stronger and less conscious about getting her clothes dirty? The development of dirty looking prints is explained further in the print development part. This test did show where heavier and stronger fabric could be placed, which is applied in the jacket in outfit nr 2. Another result from the experiment was that bare legs were not comfortable enough in the area, since one need to protect the legs from harsh vegetation.
This jacket has heavier ripstop at the lower sleeves as a result of the dirt experiment.

Run tights with heavier tricot for the lower front part of these tights was also developed out of the dirt experiment. This cut was cancelled because the print did not look natural enough.

Experiment 3: Coldness.

A one piece based from the cuts developed by the friction test was made of white spandex fabric. After running for 4 km outdoors in 5°C the places where the body froze were visualised with natural dyed paste in three colours based on the degree of coldness. After reworking the construction to make the freeze zones visually clear the one piece became humoristic and not as functional as intended because of the use of fake fur for illustrating the most cold body areas. The pattern was reworked into a fleece jacket but cancelled because the emphasis of the collection was shifted towards active wear. In addition, this test gave the basic information
about where to place fabric that reduces the effect of cold wind for jackets.

After working with these both methods at the same time, the results from the body indicated experiments helped the decision taking in the copy/rework method. It was important for this project to understand accessible garments in order to communicate a “normal” clothing language. A too conceptual and artistic take on natural dye was not intended mainly because the collection was aiming for a ready-to-run look. The collection was designed for a possible industrial production.

Experiment 4: Survival scenario

To visualise the idea behind this collection, a conceptual piece was needed. I wanted to explore what one would wear if one by accident ended up in the forest with just some tent fabric and still have the urge to run, or at least move around efficiently. 3 meters of woven fabric and some elastic strap served as the first sketchy toile. The lack of mirrors helped to find a feeling of freedom, which allowed the fabric to be shaped as practical as possible. When taking in the sleeves and adjusting the fabric between the legs something comfortable enough to run with was created. In a survival situation in the forest were the experiments were made, the shelter from rain, wind and coldness are the most pressing. When the final piece was sewn, it was made by double fabric which allows an insulation function. The tent fabric can provide that and when filled with dry material one can find in the wild, the outfit can be used as a primitive sleeping bag. High visibility is another thing to consider for a survival scenario. The limitation of finding exclusively local dye material resulted in using tansy and goldenrod to dye the 7 meters of ripstop for the outfit.
development of the emergency run suit. Finding a runable drape and plants that can give a bright visible dye as if there were no other alternatives.
Rain running and collecting

When running in the forest of west Sweden a rain jacket is somehow wanted. For this purpose, a lightweight Nike jacket with a loose fit from the mens department was chosen as the starting point. By draping in the forest for adjusting legspace and sleeves the function of the changes could be tested immediately. Additional functions for gathering and transporting food and dye material when exploring the forest became important when spending time outdoors and the season allows plants, mushrooms and berries to be collected. By adding these functions into the collection would make the explorative run more of an adventure and give extra value to the clothes. The solution to this need could be that part of the jacket could fold around itself into a pocket or a bag. Or as an alternative, branches taken from trees could togheter with a garment form a basket. For this jacket, extra large pockets was added in the front panel. This gives an extra space for collecting but doesn’t take up space when not used.

1. The development of the rain run jacket started with a copied toile of a lightweight Nike run jacket.
2. Printed dirt made with acrylic extender and natural pigments did not make it passed the wash fastness test.
3. Instead, the first finished model of the jacket was dyed with alkanet and printed with rust.
4. In the terrain, a longer model of the jacket was tested in running and then altered with a scissor, and some fabric.
Dye development

The first dyes this work explored was local. The idea was to find the colour of the collection just outside the door, preferably in the forest. In a mossy dense forest that keeps its emerald colour all year due to the frequent rains of the area, the trees grow tightly and the mud is slippery. The first dye samples were made from red spruce, tree-growing fungus (Banded polypore), lichens and yellow onion skins. See figure 14. Lichens were harvested from branches that were lying on the ground, the same for the spruce. The first dye samples were not so saturated, except for yellow onion, despite using a lot of dyestuff. Because this project was searching for vibrant colours that could compete with synthetic ones, experiments with many different natural dyes were carried out. The complete colour map that emerged is based on the dye’s coloration of wool and polyamide.

![Figure 14. This projects complete colour map for the different natural dyes on wool. The first dyes are marked. 1. Yellow onion, 2. Banded polypore, 3. Tree-growing lichens and 4. Red spruce.](image)

The initial try to place these colours in a sportswear setting was made by printing and dyeing a tricot material consisting of 80% polyamide and 20% elastane. Turmeric and cochineal established that natural dye was potent enough to perform saturated hues. This first try was important for keeping faith in the idea of this work. The wash fastness test would soon make the project dye rather than print because the cochineal dye of the tights lasted much longer than the print of the top in the wash tests.

By the use of turmeric and cochineal the first natural dyed fabric for sportswear was done.

### Dye guidelines

After the first experiments in the dye kitchen a few guidelines were formed. Here arranged by importance first.

1. Saturated chromatic hues
2. Good wash and lightfastness
3. Local dye material preferable
4. Dye material from waste preferable
5. Use colours that match each other

Five natural dyes; Alkanet, avocado, brazil wood, cochineal and madder and were chosen. See figure 16. The choice of avocado was of its relatively rich chromatic appearance and easy availability. Cochineal was picked because it has a saturated chromatic hue of purple and pink. Madder was chosen because it represents the warm hues of the colour red. Alkanet and Brazil wood is important for the darker brown, grey and blue hues. These five dyes were tested for

![Figure 16. From left to right, alkanet, avocado, brazil wood, cochineal and madder on polyamide ripstop.](image)
light- and wash fastness. The results from these tests gave clear facts to take in consideration. After the tests, three of these dyes were still of importance.

The result of the light fastness test according to SS EN ISO 802 (A) standards turned out to be low by measuring from the ratings. Out of 7 pieces of fabric, the sample dyed with cochineal stated best result by the rating 2 out of 8. However, when studying the pieces close up the dye with madder did shift from orange to pink. See figure 17. The sample appeared just as saturated to the eye, yet with a change in hue. Avocado was not important after turning pale and more yellow in the light test. The light test had an impact on which dyes could be considered for jackets. Madder changed in both the light test and the wash test from warm orange to a pink hue. Because madder still had a saturated chroma, it was chosen to be used for a jacket. All the dyed fabric samples stated acceptable results in the washing test, even if the majority changed their hue towards more blue when washed with common washing detergent which is an alcaline treatment.

It became clear that this work needed to accept change in hue to be able to proceed. Industrial standards for reproducing dyes were not reached.

In addition to the three dyes that passed the test, yellow onion and weld was picked because of their reputation of being reliable dyes and for their ability to add yellow into the palette. Two local plants that gives yellow was also of importance for the emergency high visibility dye. Cochineal proved good fastness but was in the end not used because pink was not a colour important for the collection. Together this formed the list of the most important dyes of this project:

Alkanet – Anchusa officinalis and Alkanna tinctoria (the root)
Yellow onion - Allium cepa (the skin) Madder - Rubia tinctorium L (the root)
Goldenrod - Solidago virgaurea (whole plant)
Indigo - Indigofera tinctoria
Weld – Reseda luteola (whole plant)
Tansy - Tanacetum vulgare (whole plant)
When making the dye samples the outcome on different fibres was high in hue contrast. See figure 18. Protein fibres absorbed the dye more intense but in different shades for wool and silk. Cellulose based fibres absorbed the dye in lighter and sometimes different hues than protein fibres. Amongst the synthetic fibres polyamide was the fibre absorbing dye the best. Polyester dyed best in 130°C and only with a few pigments. These facts were developed into a knitted material in several yarns from different fibres. Knitted in undyed/white yarns a surface pattern is developed after dyeing. This technique was considered for an outfit.

**Successful dye methods for industry and DIY**

Amongst the many dye methods explored, the most successful ones are described:

- **The traditional dye method.** Extract the dyestuff for 1 hour in 90°C. Dye in 90°C for 1 hour. Agitate every minute. Rinse by hand. Wash in washing machine 40-60°C with washing detergent for coloured textiles.
  
  This method worked well for the majority of the dye pigments. Produces even results. Works fine for DIY. Industrial translation: Continuous or batch dye.

- **Car dye.** Extract the dyestuff for 4 days in a closed container with just enough water to mix. Dilute the concentrated extraction with water. Put the fabric into the dye jars. Dye in Roaches dye machine in 130°C for 60 minutes. Wash in washing machine 40-60°C with washing detergent for coloured textiles.
  
  Industrial translation: Jet dye machine.
  
  DIY translation: Pressure cooker might work.

- **Polyester dye with powdered plants.** Extract the dyestuff for 30 min in a pot. Dilute the extraction with water put the fabric into the dye jars. Dye in Roaches dye machine in 130°C for 60 minutes. Wash in washing machine 40-60°C with washing detergent for coloured textiles.

  Industrial translation: Cold pad batch dye.

- **Alkanet oil dye.** Solve alkanet in vegetable oil in a plastic bag. Mix with water. Extract cold for 24 h. Put the textile in the plastic bag and massage the textile from outside. Dye cold for 3 days. Rinse. Wash in washing machine 40-60°C with washing detergent for coloured textiles.

  This method produces unique patterns and keep the skin moisturised by the oil used. A DIY method.
Print development

In attempt to step away from the shibori and batik techniques often associated with something naturally dyed, printing experiments were carried out on various material with the natural pigments solved in three different extenders. The first paste was made of potato starch, the second from alginate base for reactive and acid prints and the third was a conventional acrylic extender used in the industry to print pigment prints. The choice to use acrylic extender was based on the need to print on synthetic materials. Some of the pigments were able to fixate on polyamide fabrics while others came out pale. See figure 20.

For the first attempt of a screen-printed dirt, the dirt was marked with the quick selection tool in Photoshop, and then made into a screen. See figure 21. That resulted in edges looking rather unnatural. In search of a more naturally looking dirt print, white toiles were made in an absorbing jersey and the prints were made by falling in the mud. After that the tights were cut open and a photo was taken while the mud was still wet. By changing the exposure in Photoshop the mud print was extracted in a more naturally looking manner. Designing the print as natural stains on all screens made the prints more useful so they could be used independently of each other and overlap.

How to make already dirty looking run wear was explored in various materials and ways. Firstly, when screen printing, the frame needed to look as a natural dirt stain. Secondly, the print paste needs to fixate on the fabric. When using different fabrics in the same garment, the colours fixated differently making the stain look unnatural. Therefore the tights of the finished collection have the same material allover.
After an experiment with the dirt prints and an overhead it was decided to make the stains big and to let them follow the curve of the thigh as in the marked example. This makes the dirt look natural and is at the same time looking decorative. If the dirt prints would have been used as an allover print, the natural dirty feeling would probably be lost because the placement of the dirt.

Figure 22. 1. Printed dirt with alkanet in acrylic extender by hand through an open screen. Heat fixed, washed. This creates a randomly placed stains and is difficult to repeat.
2-5. Designed dirt stains printed by screen printing with powdered plants solved in acrylic extender. Heat fixed, washed. The saturation of the prints of 2, 3 and 5 is good, but the acrylic extender was replaced by an alginate based one because of the softer hand of the fabric.
The first try at making a muddy looking print paste of natural dyestuff/pigments consisted of 100 g acrylic extender, 7 g pulverized Alkanet and 5 g natural still green pulvriséd indigo. The saturation of this mixture was satisfying. The hue was dark brown when printed, heat fixated in 150°C for 7 min. The colour turned out to be ph-sensitive, changing hue when washed in different washing detergents. After a wash test this technique of printing was cancelled. The acrylic extender did not fixate satisfyingly on woven fabric meant for jackets. When printed on spandex fabric for tights the fixation was good, though it made the fabrics less elastic and less comfortable. These facts lead the project to try to print with alginate based extender.

Saturated and natural was the expression searched for. The dirt from nr. 4 in the example creates a natural but chaotic expression. Together with the more tidy and easier replicated method of nr. 2, these ways of creating a dirty look was selected for outfit nr 3.

To create naturally looking dirt stains, the most dye receiving fibre - wool - was picked as the base for the print. The reason for this was both economical an visual, less pigment could produce a more saturated print on wool if compared to polyamide. To start with, the wool/microfiber polyester knitted fabric that has push/pull qualities was kept as a base for first layer garments. Wool was the only fibre on the face of the fabric. Through a test of four methods an evaluation of the photos could select the best one.
Organic ways of printing

The prints or patinations made directly in nature, like stains, rust and oil became in focus when the printed toiles looked too finished, static or “dead” as in figure 22. Amongst the better succeeded experiments is rust printing made with rusty plates and slightly acid water. To make the water acid, plants from the family Rumex can be used or vinegar. In addition to this, printing by wrapping vegetable material tightly inside fabric and dyeing the bundles in tea for 1 hour with soaking overnight was tried. The wrap printing is an interesting technique. With the too batikey look of it, it was not taking the aim of updating natural dyes further.
Material and colour composition

In the start of this project, the idea of this work was based on running as an accessible sport and the possibility to mimic contemporary run wear with natural dyes. The first lineup sketches were not with trail running in mind. There were many decisions to be taken in the start of the collection-building. Who is the wearer, where does she run and why? Once determined to select an area where the running took place, the design decisions became much easier to take. And when nothing else works, running is giving new ideas, releasing stress and allowing viewing things from another angle.

For the lineup above fabrics that survived the first tests were assembled into a composition of the most saturated colours possible. Orange together with pink and grey is the base. The ambition to display the most saturated chromatic hues possible results in several colours competing for attention.
The single most influential colour in this work is the yellow dye for polyester that performed well in its wash and lightfastness tests. See figure 23. Microfibre polyester is a material with the right qualities for durable yet comfortable runwear. Because it is so important for the credibility of this work, the previous lineup was cancelled and replaced by another that enhanced this colour. The pink and orange of the previous lineup could have been kept, this could have made the collection more colourful yet restless. Still, choosing purple as a main colour is more of a unique and less expected from sportswear today. By remembering the second criteria for the look of the collection: harmonising with the nature- a collage was assembled. Photos from the area brings dark purples and browns together with the warm yellow in a natural harmony. Run wear label Gyakusou is embracing these colours and creating an alternative colour spectra for run wear. When the collage was working, a sense of colour harmony was found. Different shades from the same hue could be used to display the full potential of natural dyes and simultaneously be in harmony with each other.
Assembling the finished fabrics together for the planned lineup (above). The marked top was placed under the red jacket instead, because it did not match the shiny light colored tights.

This lineup is more concentrated than the previous and the existing one when dyeing the material below.

Lineup from a late stage of the collection. The last outfit stands alone, and the third one is much higher in light contrast than the others.

The materials for the collection have been picked regarding their functionality and dye- and print ability. Firstly, the materials need to function for the aim - to run in. Materials like the microfiber polyester for tops and the polyamide/elastane tricot for the tights are common among run wear today. In a colder climate, a thin wool layer is also in need, plus a layer for wind and rain protection. When similar materials with similar functionality were collected, the ones that displayed dyes and prints in the richest way were chosen. As an example of this is the for the tights from comparable compositions, but with shiny or matte complexion. The fabric with matte complexion has a soft and warm feel more associated with low intensity wear, like yoga wear. Even though the fabrics have similar performance properties the shiny one was chosen because that it updates natural dye better, as the matte one can be confused with cotton. Cotton is not a performative fibre for run wear, and it is commonly known as possible to dye with vegetable dyes.

To make the the idea of the collection even more visible, all visible zippers are also dyed with natural dyes.

Two types of tights fabric. To the left shiny polyamide/elastane. To the rights matte polyamide/elastane.
Result

6 outfits with technical descriptions.
Nr 1. Oilmarbled run dress.

The dress is a lightweight alternative. The sweat from the side of the torso and armpits is ventilated and the friction reduced by a PA/EA underwear quality mesh. The outfit is ph-sensitive and will change in hue by sweat, sun and by washing. The more active you are, the dress will show this by its change in hue.

Dress
Microfibre polyester dyed with alkanet. Marbled by olive oil and alkanet. Polyamide/elastane mesh dyed with brazilwood.

Shorts
Polyamide/elastane dyed by alkanet and olive oil. Compression socks dyed with yellow onion and madder.
Nr 2. Lightweight madder jacket. Rust printed tights.

The jacket is developed to reduce the effect of cold wind. Fitted sleeves and combination of woven and knitted material offers comfort.

Jacket
Polyamide ripstop dyed with madder and yellow onion. Ventilated polyester and zippers dyed with madder.

Tights
Polyamide/elastane dyed with madder and yellow onion, rust printed.
Nr 3. Dirty looking first layer.

This outfit is exploring the advantages of looking dirty.

Wool and polyamide/microfibre polyester jaquard knitted jersey with a push-pull effect. Under sleeves: microfibre polyester tricot dyed with alkanet and indigo.

No under arm seam. Microfibre polyester for ventilation and soft feel.

Curved inner leg seam. Flatlock seams.
Nr 4. Dirt absorbing light compression outfit.

These tights are printed with natural pigments solved in alginate, and with rust. The shiny fabric is colourabsorbing and will be altered when running. Mud, berries, bushes and flowers will leave their mark when using them for active trailrunning.

Arm compression of PA/EA dyed with alkanet.

Tights
Polyamide/elastane printed with alkanet, madder, rust.

Top
Polyamide/elastane light compression and printed with rust.
Nr 5. Blueberry picking rain run jacket.

This outfit have been created for the need to run comfortably in rain and through dense forest. The sleeves are slightly shaped for running.

Jacket
Polyamide crash dyed with alkanet and indigo.

Tights
Polyamide/elastane dyed with dock, rust printed, screen printed with madder and alkanet solved in alginate.

Large waterproof-pockets for picking of blueberries.

Adjustable straps.

This outfit is designed to be able to make out of 7 m of tentfabric. In a survival scenario it is possible to fill it completely with dry material such as grass and leaves for insulation. The hem cliclock straps make it possible to wrap it like a sleeping bag. Another option enables food/firewood gathering. The fabric is dyed by using local plants available for the season and could be dyed by heating the dyebath for 2 hours and after that, leave the fabric in the dyebath during 3 days.
The pattern for the runorack.
Discussion

This work has accomplished to explore many alternatives for dyeing primarily synthetic fabrics suitable for sportswear. Some of these experiments lead to reliable recipes for long-lasting colour. Other experiments have not succeeded, but were important in order to understand the complexity of this way of dyeing. Synthetic fibres can be dyed with natural dyes in contrast to a common disbelief exemplified by Fletcher (2008).

The most striking reflection of this project is how an understanding of chemistry is much needed to dye naturally. Different plants dye their best in certain environments. Every plant has its own properties and just to understand a few takes time. As an example of something that might not be the wisest thing to promote a reliable reputation for natural dyes stands rust printing. Rust is making textile weaker although the colours seems to have better light fastness. However, making dirt desirable and the unique patterns that is created by rust motivates its use.

The initial interest for the dirty mud on the white toiles was developed in a more decorative way by screen- and rust printing dyed fabric for the tights. These printed stains have an organic rather than dirty look. A stricter vectorised or mathematical take on the prints could have leaded the work into a less organic way. One possible angle is to abstract the dirt prints. Another to mix something natural with something plastic or imaginary to make a collection less organic since this approach already is “natural”.

Colour can be experienced in many more ways than the static expression we know from synthetic dyes. The prints made with alkanet are pH sensitive, which makes it possible to alter the hue by the washing detergent. In addition, the hues of the tights vary by the amount of iron in the water used for washing. This approach to colour as something that can change and communicate on its own can welcome blueberry and mud stains from the morning run. The stains tell a story about somebody’s life and can be appreciated as signs of an active lifestyle. Freshly naturally dyed fabrics carry a smell of the dye material that has been used. As a reminder of the plant the smell last for a short while, as an extra value.

The idea of colouring clothes with local plants is an intriguing idea. Environmentally involved companies are aiming for transparency in their supply chain as in the example of the Footprint Chronicles by Patagonia (2014). This idea of serving as much information as possible to the consumer could open up to slow and site specific added values. Imagine attached information to cope with water when running through a stream. To rely on a team of bodies which all have their unique pattern of movements and together try the same toile would cultivate the project further.

Natural dyes are credible alternatives when dyeing and printing textiles for sportswear. There is an extra dimension to natural dyes, the colours are not static. Washing and using the textiles will change the colour. Dyeing by hand is a handicraft that for some dyes requires experience for the dye to become wash- and light fast. Dyeing naturally with industrial methods could be done, although it is costly because of the extra time it demands for collection and extraction of the dyestuff. By using slow processes and locally accessible dye materials unique expressions from dyes, prints and patinations can enhance sportswear in both the appearance, health, and environmental aspect.

Natural dyes vs synthetic ones

Natural dyes will never be able to completely replace synthetic dyes, due to some facts. Firstly, the two covers different colour spectra. The second reason is the shortage of land and food is already in great demand. However, using waste vegetable material such as onion skins, the soft shell of walnuts and birch leaves has great potential in agreement with the compost dye of Lundin (2013). To further explore these dyes and maximizing their potential is a natural proceeding. Natural dye can become a complement to the synthetic one. Another sustainable aspect of this work is the successful water- and energy efficient experiments. When an uneven dye result is acceptable, the technique of dyeing with the sun as the only heater is promising. The realistic solution for dyes for sportswear is most likley to be a mix of more responsible synthetic dye production, combined with a sustainable development of natural dyes.

For the development of the form there are several experiments that can be a natural continuation. Examples of experiments that can be made are; how to deal with strong sunlight and how to cope with water when running through a stream. To rely on a team of bodies which all have their unique pattern of movements and together try the same toile would cultivate the project further.

Moreover, the use of natural dyes can be important because it links us to plants surrounding us and putting our lives in historical perspective. To be able to recognise a certain sort of lichen on a stone, and know that this lichen dyes without mordant and therefore gave colour to the wool carried by our poorest ancient relatives is enriching. The dyes used historically are still of value today because they indicate which plants are worth the effort of harvesting. Some plants pigments used in this project for example powdered alkanet and madder is time consuming to grow and harvest. Some hues, like purple and red are in this sense exclusive, just like they have been throughout history. Depending on where you live and where you travel, certain colours will occur abundant or exclusive. Yellow and brown dyes are easy to find and historically these colours were considered common.


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**Photos**

Figure 2. http://ayuvastra.ie/media/catalog/product/cache/1/image/9df78eab33525d08d6e5f-b8d27136e95/s/i/img_8657_2.jpg

Figure 4. http://www.chandra.co.jp/wp-content/uploads/products/Y-P-L003_PURPLE/Y-P-L003_PURPLE04.jpg

Figure 5. http://hdl.handle.net/2320/12203


Figure .8 http://www.abc.net.au/radionational/image/4000546-3x2-600x400.jpg

Figure 9. http://cdn.running.competittor.com/files/2014/06/TNF-extra-1.jpg

Figure 10. http://www.prodirectrunning.com/Products/Gore-MYTHOS-THERMO-LADY-Shirt-Womens-Running-Clothing-Neon-Black-63284.aspx

Figure 11. http://2.bp.blogspot.com/-9uYK0Lcvq1U/UZD0GvqrqTzI/AAAAAAAAR9k/XjsfkgP8/s1600/1.JPG

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